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Exterior and Body Types of Cows with Different Levels of Dairy Productivity

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Abstract: The research aimed to study the dynamics of changes in the selection and genetic parameters of the body, to determine the relationship between the productive qualities and the exterior of cows in the population of Holsteinized black-and-white and Kholmogory cattle of the Udmurt Republic. Cows with a productivity level of more than 8000 kg of milk for 305 days of lactation had a relatively high indicator of the length of the coxal area (by 2.0 and 2.3%, P<0.05) and the depth of the loin (by 1.3 and 1.5%) with a slight difference in the length of the sacrum. High-productive cows had the smallest average conformation index of the body type (by 3.0%, P<0.05), which is evidence of the proportionality of the body, namely, the optimal ratio of the volume of the trunk to the animal growth. The harmony of bodybuilding is also evidenced by the index of the coxal area, defined as the ratio of the volume of the coxal area to the body length. High-productive cows had a more harmonious body, having the lowest value of this index (by 3.8%, P<0.01). A positive correlation was found between the conformational index of the body (r = +0.26), the index of the coxal area (r = +0.38), and the productive index. The origin of the animals had a definite impact on the level of dairy production. Cows of the wes back ideal line significantly (P<0.01) outperform their mates of the reflection sovereign lines by 693.65 kg (9.9%) and Montvic Chieftainby 827.82 kg (12.1%). The value of quality indicators of dairy productivity of cows testifies to an insignificant difference both in the fat content (by 0.02-0.03%) and in the protein content (by 0.02-0.03%) in milk.

Keywords: Exterior, Cows Body, Selection and Genetic Parameters, Dairy Productivity, Heredity, Analysis of Variance, Servicing Bulls

Introduction

In countries with advanced animal husbandry, the closest attention is paid to the evaluation of the exterior type of animal, since the exterior and body assessment has always been a necessary element of a comprehensive analysis of dairy cattle (Abugaliyev and Shamshidin, 2012; Bjelland *et al*., 2011; Konstandoglo *et al*., 2017; Bassonov *et al*., 2018; Berry *et al*., 2003).

In conditions of intensive "use" of dairy cows, cattle breeding goes through a new stage in the spiral of its development, when the highest possible good quality products can be obtained only when the technical elements of technological processes directly depend on the biological characteristics of animals and the selection of cows has been successfully carried out according to suitability for breeding under conditions of industrial technology (Abugaliyev *et al*., 2019; Bekenov *et al*., 2019a; Zhumanov *et al*., 2020a; 2021; Shamshidin *et al*., 2021; Chindaliyev *et al*., 2021).

At the same time, the integral characteristic of the whole organism, reflected through a complex of exterior indicators, is presented in a modern linear assessment of the body type of animals, which combines two criteria for

the analysis of dairy cows in terms of dairy productivity and appearance (Lefler and Bagaev, 2014; Babailova and Berezina, 2014; Holloway, 2005).

Biological science back in the 40 s of the last century began to deeply deal with the growth and development of animals, investigating the patterns of inheritance of biological characteristics and the dynamism of vital processes of organisms. As a result of numerous studies, the relationship between the growth, development, the productivity of animals with their breeding value has been described. Consequently, along with the study of biological changes in the body built proportions, studies of "numerical" measurements of individual parts of the body of animals become important for an objective judgment about the intensity of growth, hereditary patterns of development of the individual, and the population as a whole (Lebedenko, 2014; Kratochvilova, 2001).

Body type plays a pivotal role in the efficiency of animal use, in particular in dairy farming, since harmoniously developed individuals are least susceptible to the risks of early withdrawal due to non-selective reasons such as adaptation to industrial technology conditions and have a predisposition to increased dairy productivity (Zubriyanov *et al*., 2001; Karamaev *et al*., 2013).

Measuring body parts of animals allows obtaining information about the body-built characteristics, to identify the advantages and disadvantages of livestock in different productivity directions. The ability to "get" a new structural element in the genealogy of a population is a new type, a line is formed based on genetic diversity under the influence of various environmental factors (Konteh *et al*., 2017; Lu *et al*., 2021).

Exterior assessment of the animal makes it possible to expect from it not only high levels of milking capacity but also productive longevity. Currently, in dairy cattle breeding, focusing on productivity indicators, considerable attention must be given to other characteristics that affect the efficiency of the entire technological process of milk production. Many of these traits are related to the appearance of cows, such as general body built or "body type", size and shape of the udder, body size, etc., (Rodionov, 1995; Chindaliev *et al*., 2019; Zhumanov *et al*., 2020b; Zhumanov and Baimukanov, 2020).

Carrying out a targeted selection of animals, in modern conditions of industrial technology for the production of agricultural products, it is necessary to think about improving the body shape of cattle, which is a prerequisite for the normal functioning of the whole organism (Holloway, 2005; Chindaliyev *et al*., 2019a, b). Thus, the body type and productivity of animals are the main features in doing selective breeding work. Understanding the biological patterns of growth, development, formation of the exterior-constitutional type of body and productive traits of animals will allow to make a correct assessment and predict the productive, reproductive potential, and breeding progress (Bekenov *et al*., 2019b).

The main goal of breeding work is to accelerate genetic progress in animal populations in terms of a set of selective traits for the shortest period. This formulation of the question requires the creation of an integrated multifunctional system, including both the optimization of breeding methods and the creation of part typical conditions conducive to the maximum manifestation of the genetic potential of animals during their reproduction (Abugaliyev *et al*., 2021; Despal *et al*., 2021; Bekenov *et al*., 2019c).

Selection by exterior indicators associated with an increase in dairy productivity and longevity of cows in a herd will help reduce the causes of forced culling of animals (Abugaliyev *et al*., 2021; Bekenov *et al*., 2019a).

In the general list of factors affecting the efficiency of using cows, one should maximally take into account such a factor as body type (Abugaliev *et al*., 2021; Baimukanov *et al*., 2021).

One of the most effective ways to improve dairy cattle is line breeding. In breeding work with each herd and in general, with the breed, line-breeding is assigned the main role as a selection method aimed at improving the biological characteristics of animals. It is impossible to concentrate on everything valuable inherent in a given breed (Yelemesov and Baimukanov, 2020; Bekenov *et al*., 2020; Abugaliyev *et al*., 2021; Baimukanov *et al*., 2021).

In this connection, the purpose of the scientific research was to study the patterns of inheritance and the formation of phenotypic traits in the implementation of the genetic capacity of dairy cows.

Thus, the exterior, body type-these elements can be considered as "links of one chain"-the body type of animals. The body type determines the relationship between the ability of animals to perform certain functions in conditions of intensive technology use and to show genetically inherent productivity.

Based on the above mentioned, the research aim is to study the dynamics of changes in selection and genetic parameters of exterior indicators, to determine the degree of the interrelation of productive qualities and body type of cows in the population of luteinized black-and-white and kholmogory cattle of the udmurt republic.

Materials and Methods

Scientific research was carried out in 2018-2021 on the breeding stock of cows of the Kholmogory and Black-and-white breeds of the Udmurt Republic. The sample animals amounted to 449 cows, including 161 animals in the breeding plant of Put Ilyicha JSC in the

Zavyalovsky district, 69 animals in the Chutyrsky agricultural enterprise in the Igrinsky district, 131 cows in the Uchkhoz Iyulskoye JSC of Izhevsk State Agricultural Academy, 88 animals in Rossiya of Mozhginsky district of the Udmurt Republic. The main data on the origin and dairy productivity of animals were taken from the forms of zootechnic accounting and the IAS electronic database of the "Seleks-Dairy Cattle". Among the indicators of productivity, the following were taken into account: Milk yield for 305 days of lactation, Fat Content (FC), and Protein Content (PC).

The body type of the animals was assessed in the period from 90th to 150th day of lactation by measuring and calculating the conformational index of the body type and the index of the coxal area. To calculate the body indices, such measurements were chosen, which in the process of ontogenetic development changed in parallel and the index itself remained relatively constant.

The exterior was evaluated by the following measurements: Height at the withers, straight body length, chest depth, chest width, body depth at the waist, width at the hips, the width of the hindquarters in the tuber ishii, straight length of the coxal area, length of the sacrum, metacarpus girth. These parameters most accurately characterize the dimensions (carcass) of the animal.

Exterior parameters were determined by image processing, obtained using a depth sensor-structure sensor 3D. A depth sensor is a camera that attaches to your tablet device and allows you to capture a 3D image of objects. The software for the sensor allows you to obtain information about the distance between objects, the distance from the camera to the object, and determine any linear dimension of the object itself in real-time. The main advantage of using the depth sensor is the ability to determine the size of an object without stressing the animals. All the studied exterior parameters were determined from the obtained animal model.

Based on the initial data, the selection and genetic parameters of the exterior and productivity of cows in the study population were calculated and the body type of cows with different levels of dairy productivity was analyzed.

The research results were processed using the MS Excel software. The reliability of the difference in indicators (P) was determined by Fisher's criterion (Baimukanov *et al*., 2016).

The analysis of the research results was carried out with general methods of statistical processing of digital data used in biological research (Baimukanov *et al*., 2016).

Results

The stabilization and further development of dairy cattle breeding should be based on the acceleration of scientific and technological progress in all areas. One of the most important areas of the research is the improvement of existing technologies in feeding, keeping, assessing, and selecting animals. With the intensification of animal husbandry, the importance of the ability of animals to adapt to external conditions increases, and in this regard, the importance of assessing the exterior-body features increases, as the properties of animals individually respond to the influence of changing environmental conditions.

In improving the productive traits of animals, it is of great importance to identify individuals of the desired body type. In this case, a key role is given to the exterior. The exterior type as an external expression of the animal's constitution should be considered in all the complexity of its relationship with productive traits in a complex manner, from the standpoint of the integrity of the organism (Bassonov *et al*., 2018).

Our exterior assessment of cows (Table 1) showed that the animals have a strong, elongated, and deep body, good parameters of body height development, and correctly set front and hind limbs.

The animals were well adapted to industrial technology. Of particular interest is the degree of development of the third rear of the body in animals of the analyzed population. This is a very important confirmation trait in the system for assessing the body type of dairy cattle since a wide rear and a well-developed third rear of the body provide a large area for udder attachment, a large pelvic cavity, and expands the birth canal, which facilitates easy calving. Dairy cattle, harmoniously developed in exterior and with a strong body type, have a well-developed rear part of the body, with a long and almost wide the (Abugaliyev and Shamshidin, 2012; Lebedenko, 2014).

To study the variability of the exterior trait, we used individual assessments of animals, which together characterized the level of development of the livestock population according to the studied parameters. The most objective indicator of the variability of the trait is the coefficient of variability, since, expressed as a percentage, it is universal for any trait. The development of the conformational features of the cows of the analyzed population has a fairly leveled character. The variability of the studied traits in cows during the first lactation ranged from 4.48 to 16.78% and in mature cows (2; 3; 4 lactations), respectively, from 4.57 to 16.58%. It was found that the least variable characteristics are the height of the animal (4.48-4.57%), the straight body length (4.83-5.62%), the length of the coxal area (5.74-6.34%), and the complex index of the body built (4.02-4.16%).

The maximum variability was distinguished by the width in the hips (10.71-10.95%), the sacrum length

(13.70-14.34%), and the width of the tuber ishii (16.58-16.78%). According to these traits, a more successful selection is possible than traits with a low coefficient of variability.

Analysis of the age-related dynamics of changes in the parameters of the body type of cows revealed a biological pattern of an enhancement in exterior measurements. It should be noted that the value of the body built to index and the index of the coxal area did not change significantly and remained within the statistical error, which shows the reliability of the chosen method for determining these indicators. The obtained results show that the average exterior index and the index of the coxal region in the studied cows are relatively constant values and vary between groups of cows of different ages in lactations between 0.6 and 0.9%.

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%, the content of 339.6±54 thousand somatic cells. Holstein cows (6,380±67 kg) had the highest milk yield.

The main criterion for assessing the biological characteristics of dairy cattle is the level of dairy products and milk quality indicators. The selection and genetic parameters of indicators of dairy productivity and body type of cows are presented in Table 2.

Studies of dairy products in the aggregate sample showed that in the analyzed cow population, a fairly high level of dairy productivity was revealed. Milk yield for 305 days of 1 lactation averaged 6085.12 kg of milk and for lactations of mature cows (2; 3; 4 lactations) -7047.56 kg with fat and protein contents in milk, respectively, 4.08; 3.86 and 3.02; 3.03%. The productive index was 6765.17 kg and 7628.52 kg. In terms of dairy productivity level, a high level of variability is characterized by milk yield for 305 days of lactation (16.42-17.97%) and the productive index (16.30-19.08%).

To study the variability of exterior traits, we used individual assessments of animals, which together characterized the level of development of the livestock population according to the studied parameters. The most objective indicator of the variability of a trait is the coefficient of variability, since, expressed as a percentage, it is universal for any trait.

The data analysis shows that dairy cows have relatively low variability in terms of physique. It was found that the least variable characteristics are the animal height (4.48 and 4.57%), the straight body length (4.83 and 5.62%), the straight length of the coxal area (6.34 and 5.74%), and a complex body built index (4.02 and 4.16%). The maximum variability was noticed in the width in the hips (10.71 and 10.95%), the sacrum length (13.70 and 14.34%), and the rear width in tuber ishii (16.78 and 16.58%). According to the indicators characterizing dairy productivity, a high level of variability is characterized by milk yield per 305 days of lactation (16.42 and 17.97%) and the productive index (16.30 and 19.08%). Based on these traits, a more successful selection is possible than the traits with a low coefficient of variability.

The exterior assessment is important and necessary for the knowledge of the biological and economic traits of animals since the exterior serves as an external expression of the body type and built, predisposition to a certain level of productivity. Exterior and bodybuilding have a great influence on the production and therefore on the breeding qualities of animals. In this regard, it is of certain interest to study the relationship between the exterior parameters and the dairy productivity of cows (Table 3).

All analyzed cows were divided into 3 groups according to the level of productivity: 1-low (up to 6000 kg); 2-medium (from 6000 to 8000 kg); 3-high (over 8000 kg).

Analysis of the exterior parameters of cows showed that animals with different levels of productivity have some differences in bodybuilding. High-productive cows have a well-developed chest, indicating a strong body and higher growth, with a height at the withers higher by 1.5 and 1.4% ($P<0.05$), as well as a more stretched body (by 1.0 and 0.8%) compared with animals of groups 1 and 2.

Low-productive cows (up to 6000 kg) were characterized by short stature and had a wide-body type with a more developed skeleton. They surpassed high-productive mates in chest width (by 1.6%), width in the hips (by 7.3%, $P<0.01$), the rear (by 13.2%, $P<0.01$), and the metacarpus girth (by 3.2%, $P<0.05$). Of particular interest is the degree of development of the third rear of the body in animals of the analyzed population. Cows with a productivity level of over 8000 kg of milk for 305 days of lactation had a higher indicator of the length of the coxal area (by 2.0 and 2.3%, $P<0.05$) and the depth of the lower back (by 1.3 and 1.5%) with a slight difference in the sacrum length.

Separate measurements, considered in isolation from each other, do not characterize the exterior of the animal as a whole. Therefore, in practice, they are most often expressed concerning each other or as a percentage of some basic measurement, that is, the body-built indices are calculated. The formulas developed by us made it possible to conduct a comprehensive exterior assessment in numerical terms and to analyze the relationship between the body built and the level of cow productivity. The obtained results show that the average exterior index of the body type was the smallest (by 3.0%, $P<0.05$) in high-productive cows, which is evidence of the proportionality of the body built, namely, the optimal ratio of the volume of the body to the growth of the animal. The harmony of the body building is also evidenced by the index of the coxal area, defined as the ratio of the volume of the coxal area to the body length. High-productive cows had a more harmonious body type, having the lowest value of this index (by 3.8%, $P<0.01$).

Table 1: Selective and genetic indicators of the exterior of cows

Indicator	1st lactation (n = 253)			2nd, 3rd, 4th lactation (n = 196)		
	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %
Heightatwithers, cm	136.91±0.410	(120-151)	4.48	138.94±0.470	(122-153)	4.57
Straight body length, cm	147.68±0.470	(130-170)	4.83	150.48±0.630	(127.10-178.00)	5.62
Chest width, cm	47.27±0.210	(41.60-56.30)	6.40	49.66±0.240	(43.00-58.00)	6.52
Chest depth, cm	76.88±0.390	(62.20-95.00)	7.61	78.81±0.430	(60.10-92.30)	7.26
Widthinhips, cm	63.61±0.450	(45.10-80.00)	10.71	64.38±0.530	(50.00-79.00)	10.95
Rear width in tuber ishii, cm	50.31±0.580	(30.00-70.00)	16.78	52.88±0.630	(32.00-72.00)	16.58
Length of the coxal area, cm	107.34±0.450	(85.40-135.00)	6.34	108.40±0.460	(93.00-122.60)	5.74
Body depth in the lower back, cm	71.22±0.430	(55-97)	9.15	73.73±0.450	(58.00-90.00)	8.11
Sacrum length, cm	54.43±0.500	(38-75)	13.70	57.11±0.610	(36.00-75.00)	14.34
Metacarpus girth, cm	22.07±0.120	(18.00-28.80)	8.12	22.89±0.130	(16.70-27.00)	8.01
Index of body built	0.469±0.002	(0.417-0.534)	4.02	0.472±0.001	(0.422-0.543)	4.16
Index of coxalarea	0.438±0.002	(0.352-0.521)	6.90	0.442±0.002	(0.355-0.520)	7.62

Table 2: Selective and genetic parameters of dairy productivity of cows

Indicator	1st lactation (n = 253)			2nd, 3rd, 4th lactation (n = 196)		
	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %
Milk yield per lactation, kg	6085.12±66.46	(3917-8588)	16.42	7047.56±94.380	(4770-10895)	17.97
Fat content, %	4.08±0.03	(3.51-5.08)	6.32	3.86±0.0200	(3.34-5.01)	5.28
Protein content, %	3.02±0.01	(2.70-3.22)	2.72	3.03±0.0100	(2.84-3.48)	2.41
Productiveindex, kg	6765.17±73.33	(3904.76-9285.78)	16.30	7628.52±108.48	(5136.81-12819.06)	19.08

Table 3: Selective and genetic indicators of the exterior and productive traits of cows with different levels of dairy productivity

Indicator	Low milk yield (up to 6000 kg, n = 128)			Medium milk yield (6000 to 8000 kg, n = 266)			High milk yield (over 8000 kg, n = 55)		
	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %	$\bar{x} \pm \Delta\bar{x}$	Lim (min-max)	Cv, %
Milk yield per lactation, kg	5237.41±44.12	(4770-5991)	9.53	6882.04±33.70	(6002-7996)	7.99	8511.71±65.40	(8009-10895)	5.70
Fat content, %	4.06±0.04*	(3.52-5.05)	9.94	3.93±0.02	(3.41-5.08)	9.05	3.82±0.03	(3.34-4.94)	6.51
Protein content, %	3.01±0.01	(2.75-3.20)	2.54	3.02±0.01	(2.70-3.22)	2.37	3.05±0.01*	(2.96-3.20)	1.85
Productive index, kg	5847.61±79.50	(5136.81-12819.06)	15.38	75.31±40.65	(5803.58-9446.53)	8.80	9058.36±96.58	(6449.10-11082.26)	7.91
Height at withers, cm	136.17±0.52	(120.60-152.70)	4.80	136.29±0.39	(120-156)	4.50	138.19±0.81*	(122.00-150.40)	4.44
Straightbodylength, cm	149.19±0.65	(132-178)	4.95	149.47±0.47	(130.00-170.40)	5.17	150.71±1.29	(127.10-172.50)	6.34
Chest width, cm	49.04±0.28	(41.00-55.80)	6.49	48.68±0.20	(42-58)	6.56	48.29±0.44	(42-58)	6.77
Chest depth, cm	78.05±0.51	(60.10-95.00)	7.35	77.31±0.36	(62.20-90.00)	7.61	77.65±0.74	(67.00-92.30)	7.06
Widthinhips, cm	65.02±0.51	(53-80)	8.94	62.36±0.47	(45.10-79.00)	12.28	60.58±1.00	(50.00-76.50)	12.27
Rear width in tuber ishii, cm	52.77±0.73	(32.50-72.00)	15.63	49.95±0.57	(32-70)	18.53	46.61±1.16	(32-63)	18.53
Length of the coxal area, cm	107.49±0.60	(88-135)	6.26	107.16±0.39	(85.40-125.00)	5.95	109.64±0.81*	(93-120)	5.69
Body depth in the lower back, cm	72.17±0.61	(58-97)	9.56	72.05±0.38	(55-89)	8.57	73.13±0.76	(60-88)	7.79
Sacrum length, cm	56.07±0.75	(39-75)	15.19	55.40±0.47	(36-73)	13.78	55.96±1.02	(46-75)	13.50
Metacarpus girth, cm	22.97±0.15*	(19.00-25.90)	7.47	22.54±0.12	(16.70-28.80)	8.86	22.26±0.23	(18-26)	7.56
Index of body built	0.480±0.002*	(0.424-0.534)	3.79	0.474±0.001	(0.422-0.529)	4.21	0.466±0.003	(0.431-0.543)	4.12
Index of coxalarea	0.444±0.003**	(0.367-0.521)	6.68	0.434±0.002	(0.352-0.520)	8.07	0.427±0.005	(0.355-0.488)	8.18

P<0.05*; P<0.01**

The exterior type, as an external expression of the animal's body built, should be considered in all the complexity of its relation with productive traits in a complex manner, from the standpoint of the integrity of the organism. The type of animals is related to their health and productivity.

The results of our research revealed that the traits of the exterior and productivity of dairy cattle are characterized by a certain interrelation with each other. Many traits are positively or negatively related to each other. In this case, the relation between the traits can be strong or weak.

Analysis and evaluation of the correlation coefficient between the traits make it possible to predict the so-called indirect selection, when, by selecting one trait, we indirectly change the other associated with it. Analysis of the correlation coefficient between various traits of the body type of the studied population shows that between the main measurements characterizing the exterior features of animals, a positive and rather strong relationship was revealed in the following values: "Height at the withers-straight body length" -0.43; "Height at the withers-chest depth"-0.43; "Height at the withers-straight length of the coxal area" -0.59; "Height at the withers-metacarpus girth"-0.43; "Height at the withers-depth of the lower back"-0.37; "Straight body length-chest depth"-.45; "Straight body length-sacrum length"-0.55; "Straight length of the hip region-chest depth"-0.43; "Straight length of the coxal area-metacarpus girth"-0.66. At the same time, a weak tie was found between the height at the withers and chest width (0.21), height at the withers and width at the hips (0.15), the straight body length and the chest width (0.18), the width at the hips and the straight length of the coxal area (0.28).

It is of some interest to study the relationship between the conformation index and measurements that form the body type. A positive relationship was revealed between the conformational index of body built and measurements describing the degree of development of the animal's body (straight body length, chest width, chest depth, straight length of the coxal area, width in the hips), which varied from 0.11 to 0.48. A negative relation (r = -0.19) between the conformational body build index and the growth of the animal is logical.

The meaning of the relation between milk yield and Fat Content (FC), between milk yield and Protein Content (PC), between the percentage of fat and the percentage of protein in milk, as well as the relation between milk yield and the productive index, between milk yield and the conformation body, built index were determined. It was found that, in general, for the controlled livestock, the ratio between milk yield and the qualitative composition of milk was weak (r = -0.15 and 0.04, respectively). Fat and protein contents are associated with a weak positive correlation r = 0.23. The productive index is strongly (r = 0.98) positively influenced by the milk yield of cows with a weak relation with FC and PC in milk.

The interrelation between milk yield, milk quality indicators, and exterior characteristics was weak or absent altogether (r from -0.18 to +0.34). At the same time, it should be noted a weak (r = +0.26) positive correlation between the index of body building and the productive index.

The animals of the analyzed population had a high level of daily productivity. The milk yield per lactation varied from 4770 to 11162 kg and averaged 6577 kg of milk, the fat and protein contents in milk, respectively, from 3.04 to 5.08% (3.94%) and from 2.84 to 3.22% (3.03%).

Achieving high results in breeding work is possible with a more reliable determination of the share of hereditary diversity of animals according to breeding characteristics. In breeding work, the most interesting is the share of the variability of a trait caused by the action of genetic factors, i.e., the heritability of the trait. Genetic advantages of the breed accumulate in individual lines and families, which is important for its further improvement (Abugaliyev and Shamshidin, 2012). The results of studies by several authors have established that cows of various origins in line belonging have certain differences in their phenotypic characteristics, such as bodybuilding, level of dairy products, and quality indicators of milk (Konstandoglo *et al.*, 2017; Zubriyanov *et al.*, 2001).

The main criterion for assessing the biological characteristics of dairy cattle is the level of dairy products and quality indicators of milk. To determine the degree of impact of genotypic factors on the biological characteristics of cattle, cows (2 and 3 lactations) of different linear origins were selected: Reflection Sovereign (117 animals), wes back ideal (131 animals), and Montvic Chieftain (97).

The selection and genetic parameters of the conformation and dairy productivity of cows are presented in Table 4.

The origin of the animals had a definite impact on the level of daily productivity. The wes back ideal cows significantly (P<0.01) outperform their mates of the Reflection Sovereign lines by 693.65 kg (9.9%) and Montvic Chieftainby 827.82 kg (12.1%) in milk yield. The value of the quality indicators of dairy productivity of cows of different lines indicates an insignificant difference in both the fat content (by 0.02-0.03%) and the protein content (by 0.02-0.03%) in milk.

The analysis of the dependence of the values of the exterior parameters on the linear origin of cows did not reveal a significant effect, but a reliably large width in the hips was revealed in the wes back ideal cows. They (P<0.05) outnumbered the Montvic Chieftain cows by 5.3% and the Reflection Sovereign cows by 2.9%.

When using mass selection, breeding progress in any herd depends on how much or to what extent the high productive traits of the parents will be inherited by the offspring. Revealing the level of manifestation of the genetic potential of animals in certain conditions of their habitat will make it possible to establish the degree of reliability that the selection of the best animals by phenotype will also "catch" the best genotypes. At the same time, the selective efficiency of animals for reproduction according to one or another trait increases as its dependence on environmental conditions decreases.

Based on the results of the sample, mother-daughter pairs were selected (n = 57) and the parameters of their dairy productivity and body built were assessed (Table 5). When analyzing the biological characteristics of the animals of the studied population, certain differences were revealed between the groups in terms of productive and exterior parameters. Daughters significantly (P<0.05) surpassed their mothers in such indicators as the rear width in the tuber ishii (by 8.2%), the sacrum length (6.2%), the index of the coxal area (4.4%), as well as in terms of fat content in milk and productivity index by 0.18 and 5.4% respectively.

The described features of the inheritance of the milk yield and fat content clearly show that if only the offspring of the best part of the herd is left for reproduction (for breeding), then, on average, each new generation will be better than the previous one in terms of the parameters and characteristics according to which selection is made. The more intensive selection goes in the same direction, the more the herd or breed is saturated with the hereditary inclinations of high-productive ancestors, and the average indicators of each new generation improve, ensuring the continuous improvement of animals.

Research results have shown that, for the most part, heritability coefficients have an average level. According to theoretical and practical experience, the coefficient of

heritability, determined by the analysis of variance, makes it possible to take into account the influence of a large number of par atypical factors, and genetic variability is manifested in a purer form. In the group of exterior parameters, the greatest heritability indicators are characterized by the chest depth (53.3%), the rear width in the tuber ishii (42.7%) and the straight body length (30.8%), and the shortest length of the coxal area (8.3%), sacrum length (8.9%). The highest heritability indicator according to parameters characterizing dairy productivity was noted for the fat content in milk (22.4%) and the productive index (21.9%). In this regard, when conducting breeding work to implement the optimal selection of servicing bulls and accelerate breeding progress, it is necessary to determine and take into account the patterns of inheritance of biological traits of dairy cattle.

The creation of technological herds with an increased genetic capacity in dairy productivity will largely be determined by the breeding traits of the bulls used and their prepotency. It should be noted that the genetic progress of the dairy cattle population by 75-85% is determined by the breeding value of the servicing bull. For breeding, not only the general phenotypic variability of traits is of interest, but also that part of the variability is due to the genetic nature.

Table 4: Selection parameters of the exterior and dairy productivity of cows of different lines

Genealogical group (line)	Parameter	$\bar{x} \pm \Delta\bar{x}$	Cv, %
Wes back ideal	Dairy productivity		
	Milk yield per 305 days of lactation, kg	7660.25±106.21**	8.32
	Fat content, %	3.94±000.030	8.32
	Protein content, %	3.03±000.010	2.00
	Productivity index, kg	7278.24±112.790	18.79
	Exterior measurements		
	Height at withers, cm	136.97±000.530	4.72
	Straight body length, cm	149.20±000.680	5.55
	Chest depth, cm	78.19±000.530	7.75
	Widthinhips, cm	65.34±000.59*	11.02
	Length of the coxalarea, cm	107.76±000.560	6.35
	Chest width, cm	49.14±000.270	6.73
	Metacarpus girth, cm	22.39±000.150	7.87
	Body built index	0.475±00.002	4.07
Reflection sovereign	Dairy productivity		
	Milk yield per 305 days of lactation, kg	6966.60±117.940	20.56
	Fat content, %	3.93±000.030	9.91
	Protein content, %	3.02±000.010	2.19
	Productivity index, kg	7130.89±124.620	20.00
	Exterior measurements		
	Height at withers, cm	137.39±000.570	4.71
	Straight body length, cm	150.30±000.680	5.15
	Chest depth, cm	79.06±000.460	6.68
	Widthinhips, cm	63.51±000.620	11.19
	Length of the coxalarea, cm	107.88±000.520	5.54
	Chest width, cm	48.64±000.280	6.63
	Metacarpus girth, cm	22.32±000.160	8.39
	Body built index	0.472±00.002	3.90
Montvic chieftain	Dairy productivity		
	Milk yield per 305 days of lactation, kg	6832.43±151.220	19.64
	Fat content, %	3.96±0.05000	9.82
	Protein content, %	3.05±0.01000	2.38
	Productivity index, kg	7261.09±182.070	21.28
	Exterior measurements		
	Height at withers, cm	136.92±000.790	4.89
	Straight body length, cm	148.88±000.830	4.72
	Chest depth, cm	78.39±000.790	8.59
	Widthinhips, cm	62.04±000.760	10.43
	Length of the coxalarea, cm	106.61±000.350	5.37
	Chest width, cm	48.24±000.350	6.13
	Metacarpus girth, cm	22.19±000.190	7.09
	Body built index	0.469±00.003	4.80

*P<0.05, **P<0.01

Table 5: Inheritance of productive and exterior parameters of dairy cattle (n = 57)

	Mother		Daughter		
Parameter	x± $\Delta\bar{x}$	Cv, %	x± $\Delta\bar{x}$	Cv, %	Heritability coefficient, h^2
Dairy productivity					
Milk yield per 305 days of lactation, kg	6243.22±179.48	14.94	6395.59±71.70	15.26	16.5
Fat content, %	3.88±0.06	8.40	4.06±0.05*	8.93	22.4
Protein content, %	3.03±0.02	3.02	3.04±0.02	2.68	17.9
Productivity index, kg	6732.26±187.80	14.50	7095.11±64.20*	16.64	21.9
Exterior measurements					
Height at withers, cm	137.93±1.20	4.51	136.64±1.03	3.91	26.2
Straight body length, cm	148.95±1.01	3.52	147.34±1.12	3.99	30.8
Chest width, cm	48.31±0.54	5.85	49.20±0.61	6.41	21.8
Chest depth, cm	77.62±1.04	6.96	77.25±0.73	4.92	53.3
Widthinhips, cm	63.98±1.42	11.55	63.84±1.14	9.28	23.3
Rear width in the tuber ishii	39.19±0.67	8.92	42.40±0.58*	7.08	42.7
Length of the coxal area, cm	106.61±1.11	5.40	106.31±0.90	4.40	8.3
Body depth in the lower back, cm	70.52±1.08	7.96	71.98±0.64	4.63	27.8
Sacrum length, cm	53.07±1.39	13.58	56.17±0.85*	7.85	8.9
Metacarpus girth, cm	21.68±0.36	8.63	22.36±0.33	7.67	29.5
Body built index	0.464±0.004	3.98	0.470±0.004	4.01	23.4
Coxalarea index	0.388±0.005	6.70	0.405±0.004*	5.01	12.1

*P< 0.05

Table 6: Impact of servicing bulls on the formation of body built and productivity of daughters

	Name and inventory number of the servicing bull						
	Parliament 52800347		Vero 568		Khan 191		
Parameter	$x \pm \Delta\bar{x}$	Cv, %	$x \pm \Delta\bar{x}$	Cv, %	$x \pm \Delta\bar{x}$	Cv, %	The strength of the factor impact, η_x^2
Dairy productivity of daughters							
Milk yield per 305 days of lactation, kg	7788.86±127.86*	15.87	7769.95±123.06	13.16	7421.94±105.98	11.77	0.142±0.034
Fat content, %	4.03±0.07**	9.28	3.84±0.06	6.93	3.79±0.03	3.53	0.211±0.032
Protein content, %	3.05±0.02	1.93	3.06±0.03	1.81	3.01±0.02	2.35	0.200±0.032
Productivity index, kg	8616.53±102.49**	15.10	8386.86±164.87	14.47	7781.44±138.85	13.06	0.106±0.036
Exterior measurements of daughters							
Height at withers, cm	137.22±1.31	3.68	137.84±1.66	5.54	136.34±0.68	2.18	0.224±0.031
Straight body length, cm	152.56±2.12	5.21	151.96±2.01	6.05	148.38±1.04	3.06	0.204±0.032
Chest width, cm	49.34±0.76	5.74	48.66±0.81	7.65	47.34±0.39	3.54	0.073±0.037
Chest depth, cm	80.81±1.11	5.13	79.05±1.42	8.26	78.14±1.17	6.59	0.158±0.033
Widthinhips, cm	67.65±1.85	10.26	66.42±1.67	11.52	64.96±1.18	8.07	0.120±0.011
Rear width in the tuber ishii, cm	50.47±2.36	16.20	45.26±0.92	9.70	45.66±0.66	6.39	0.289±0.028
Length of the coxal area, cm	108.08±1.89	6.53	108.45±1.71	7.26	105.62±0.63	2.56	0.075±0.037
Body depth in the lower back, cm	77.00±0.95	4.61	73.01±1.03	6.50	71.83±1.40	8.48	0.245±0.030
Sacrum length, cm	58.14±1.42	9.13	53.59±1.29	11.04	54.23±1.74	15.27	0.283±0.029
Metacarpus girth, cm	23.16±0.64	10.40	21.89±0.38	7.98	22.50±0.44	8.23	0.065±0.037
Body built index	0.485±0.005	3.49	0.473±0.003	3.32	0.482±0.004	3.18	0.099±0.036
Coxalarea index	0.429±0.009	7.26	0.418±0.008	9.07	0.414±0.006	6.34	0.132±0.034

* P<0.05, ** P<0.01, *** P<0.001

The widespread use of Holstein bulls for crossing with domestic dairy cows is of great practical importance from the point of view of genetics. In this regard, the assessment and identification of bulls that have the greatest impact is an urgent task.

We selected three servicing bulls with the largest number of lactating daughters of the wes back ideal line: Parliament 52800347 (n = 32), Vero 568 (n = 41), Khan 191 (n = 39). Cows of the 2nd and 3rd lactations were selected to assess the body-built parameters and milk production.

Our assessment of the exterior parameters of cows showed that the animals have a strong, stretched, and deep body, good parameters of body height development, and correctly set front and rear limbs. The animals showed good adaptability to industrial technology (Table 6). The studies have established that the daughters of the bull Parliament 52800347 had a larger body built and surpassed their mates, the daughters of the bulls Vero 568 and Khan 191 in all exterior features. At the same time, there were no significant differences in the parameters that determine the body type between the groups.

Research on dairy products in the aggregate sample showed that in the analyzed population of daughters from different servicing bulls, a fairly high level of dairy productivity was revealed. The milk yield for 305 days during the 1 lactation in the groups was 7 on average 788.86, 7769.95, and 7421.94 kg. Intergroup differences in the level of productivity of cows were revealed. Daughters of the bull Parliament 52800347 in milk yield exceeded cows of the 2nd and 3rd groups by 18.9 kg

(0.24%) and 366.9 kg (4.94%) (P<0.05) and in the productive index, respectively, by 229.7 kg (2.74%) and 835.1 kg (10.73%) (P<0.001).

The results of the one-way analysis of variance found that the "father" factor influenced the studied biological traits with different strengths and varied from 10.6 to 21.1% in terms of parameters characterizing dairy productivity and from 6.5 to 28.9% in terms of exterior measurements (Table 3). We found the greatest influence (more than 20%) on the mass fraction of fat in the milk (21.1%), height at withers (22.4%), straight body length (20.4%), rear width of the tuber ishii (28, 9%), the body depth in the lower back (24.5%) and the sacrum length (28.3%). At the same time, to a lesser extent (less than 10%) the "father" factor had an impact on the length of the coxal area (7.5%), the metacarpus girth (6.5%) and the body built index (9.9%).

Conclusion

Thus, the study of the selective and genetic parameters of the exterior traits in high-productive dairy cattle will contribute to the improvement of the breeder's work. The magnitude of the variability parameters allows assessing the situation with the evenness of animals by individual statuses, measurements, and, in general, by the animal body type, to a certain extent to predict the success of selection. The application of digital technologies and new methods in assessing the biological characteristics of animals will allow production conditions to characterize the body type with greater accuracy and to identify the relations between the exterior and productive traits of dairy cattle. At the same time, the correct application of the assessment results will contribute to an increase in milk yield and productive longevity of cows, as well as quality indicators of milk.

Analysis of biological characteristics of cows of different lineage showed that the strength of the influence of the factor "line" was at a sufficiently high level and varied within 24.4-33.4%. It should be noted the high influence of the "line" factor on the parameters fully characterizes a separate group of phenotypic traits, such as the body type index (30.2%) and the productivity index (27.9%).

Thus, as a result of the analysis of variance, the impact of the "father" factor and the "line" factor on the dairy productivity and body built of cows was established with high reliability. Moreover, the use of breed resources is one of the necessary conditions for increasing productivity and creating the desired groups of animals, adapted to the conditions of their breeding. The significance of the analysis of the patterns in the formation of dairy productivity and body built of animals is, of course, of paramount importance when creating a “model type of cows", the suitability of which for industrial technology is indisputable. In the future, by carrying out targeted selective breeding work in the herd, and strict selection of animals and pairs according to "desirable" exterior parameters, it is possible to improve milk qualities and obtain cows with a harmonious body built.

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Author’s Contributions

Dastanbek Asylbekovich Baimukanov: The author of the idea, head of the event, generalization, preparation of the manuscript, 20%.

Anuarbek Temirbekovich Bissembayev: Responsible executor, 20%.

Stepan Dmitrievich Batanov: Performer, analysis of research results 20%.

Irina Andreevna Baranova and Nadezhda Nikolaevna Kuzmina: Contractor, conducting experimental research, 20%.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

References

Abugaliev, S., Bupebayeva, L., Kulbayev, R., & Baisabyrova, A. (2021). Introduction of the Modern Methods of Assessing the Breeding Value of Cows in the Selection of Dairy Cattle in the Republic of Kazakhstan. Archives of Razi Institute. Pp, 1715-1726. doi.org/10.22092/ari.2021.356236.1810

Abugaliyev, S. K., Rodionov, G. V., & Babich, E. A. (2021). Breeding and genetic parameters of productivity and exterior features of animals of the intra-breed type "Karatomar". News of the national academy of sciences of the Republic of Kazakhstan series of biological and medical. 5-12. doi.org/10.32014/2021.2519-1629.94

Abugaliyev, S. K., & Shamshidin, A. S. (2012). Analysis of breeding and productive features of domestic breeds of cows and world breeding cows in the South-East of Kazakhstan. News of the National Academy of Sciences of the Republic of Kazakhstan, (2), 52-54.

Abugaliyev, S. K., Yuldashbayev, Y. A., Baimukanov, A. D., & Bupebayeva, L. R. (2019). Efficient methods in breeding dairy cattle of the Republic of Kazakhstan. Bulletin of national academy of sciences of the Republic of Kazakhstan. 4(380), 65-82. doi.org/10.32014/2019.2518-1467.94.

Babailova, G. P., & Berezina, T. I. (2014). Dairy productivity and lifelong milk yield of Black-and-white cows of different body types. Animal Science. 15-17. (in Russ.).

Baimukanov, A. D., Yuldashbayev, Y. A., Demin, V. A., Magomadov, T. A. & Aubakirov, K. A. (2021). Efficient Breeding in Kazakhstan Alatau Cattle Breed Population. American Journal of Animal and Veterinary Sciences, 16(4), 318-326. doi.org/10.3844/ajavsp.2021.318.326

Baimukanov, D. A., Tarchokov, T. T., Alentayev, A. S., Yuldashbayev Yu, A., & Doshanov, D. A. (2016). Fundamentals of genetics and biometrics. Study Guide.

Bassonov, O.A., Klipova, A.V., Shkilev, N.P. (2018). Exterior and constitutional features of Black-and-white cows of different genotypes. Animal Science. Moscow. 5-8. (in Russ.).

Bekenov, D. M., Chindaliyev, A. E., Zhaksylykova, G. K., Baigabylov, K. O., & Baimukanov, A. D. (2019a). Accelerated reproduction of breeding stock using sexed semen in conditions of" Bayserke-Agro" LLP. News of the National Academy of Sciences of the Republic of Kazakhstan series of agricultural sciences. 4(52), 11. file:///C:/Users/User/Downloads/94586.pdf

Bekenov, D. M., Semenov, V. G., Chindaliyev, A. E., & Baimukanov, A. D. (2020). Biological features of young dairy cattle in the context of adaptive technology. News of the National Academy of Sciences of the Republic of Kazakhstan: Series of agricultural sciences. 4(58), 24. doi.org/10.32014/2020.2224-526X.31

Bekenov, D. M., Spanov, A. A., Kenchinbayev, N. S., & Baimukanov, A. D. (2019b). Updating the treatment method of the follicular ovarian cysts in cows of the dairy productivity direction in the East-Kazakhstan region. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of agrarian sciences. 5(53), 83-87. doi.org/10.32014/2019.2224-526X.64.

Bekenov, D.M., Spanov, A.A., Chindaliyev, A.E., Baimukanov, A.D., Sultanbai, D.T., Zhaksylykova, G.K., Kalimoldinova, A.S. (2019c). Comparative study of fruitfulness of cow insemination of a milking herd at various levels of productivity in the conditions of Bayserke-Agro LLP. Bulletin of national academy of sciences of the Republic of Kazakhstan. 6(382), 335–338. doi.org/10.32014/2019.2518-1467.178.

Berry, D. P., Buckley, F., Dillon, P., Evans, R. D., Rath, M., & Veerkamp, R. F. (2003). Genetic parameters for body condition score, body weight, milk yield, and fertility were estimated using random regression models. Journal of Dairy Science. 86(11), 3704-3717. doi.org/10.3168/jds.S0022-0302(03)73976-9

Bjelland, D. W., Weigel, K. A., Hoffman, P. C., Esser, N. M., Coblentz, W. K., & Halbach, T. J. (2011). Production, reproduction, health, and growth traits in backcross holstein × Jersey cows and their Holstein contemporaries. Journal of dairy science. 94(10), 5194-5203. doi.org/10.3168/jds.2011-4300

Chindaliyev, A. E., Kalimoldinova, A., Alipov, A., & Baimukanov, A. (2019a). Using a linear estimate of the exterior of cows. Chief zootechnician. Moscow. No. 8. p. 32-37. (in Russ.).

Chindaliyev, A. E., Zhaksylykova, G. K., Baigabylov, K. O., & Baimukanov, A. D. (2019b). Structure and basic parameters of the nutritional value of the diet of Holstein milking cows in «Bayserke-Agro» LLP. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of agrarian sciences, 4(52), 15-18. file:///C:/Users/User/Downloads/94586%20(1).pdf

Chindaliyev, A. E., Kharitonov, S. N., Sermyagin, A. A., & Konte, A.F., Baimukanov, A.D. (2021). Comparative analysis of the BLUP-estimates of servicing bulls by the exterior of daughters and their indices by the official instructions (linear assessment system). Reports of the national academy of sciences of the Republic of Kazakhstan. 6**(**340), 79-85. doi.org/10.32014/2021.2518-1483.114

Despal, D., Anzhany, D., Permana, I. G., Zahera, R., Rofiah, N., Nuraina, N. & Hamidah, A. N. (2021). Estimation of Milk Fatty Acids Health Index as Milk Value Added Determinant using FT-NIRS. American Journal of Animal and Veterinary Sciences. 16(4), 335-344. doi.org/10.3844/ajavsp.2021.335.344

Holloway, L. (2005). Aesthetics, genetics and evaluating animal bodies: locating and displacing cattle on the show and in figures. Environment and Planning D: Society and Space, 23(6), 883-902.

Karamaev, S. V., Korovin, A. V., & Bakaeva, L. N. (2013) Features of the growth and development of dairy heifers in an industrial complex. Bulletin of the Orenburg State Agrarian University. No. 2 (40). 137-140. (in Russ.).

Konstandoglo, A., Focsha, V., Stratan, G., & Stratan, D. (2017). Evaluation of the exterior of Holstein and Simmental primiparous cows. In Scientific Papers Series D. Animal Science (Vol. 60, pp. 35-39).

Konteh, A. F., Kharitonov, S. N., Sermyagin, A. A., Ermilov, A. N., Yanchukov, I. N., & Zinov'eva, N. A. (2017). Variability of genetic parameters for linear type traits in the Russian black-and-white cattle population. Dairy and beef cattle breeding.

Kratochvilova, M. (2001). Relationship between growth and milk production in dairy cattle. Czech Journal of Animal Science-UZPI (Czech Republic).

Lebedenko, E. Y. A. (2014). Innovative approaches to developing growth models for the mathematical description of the age-body size relationship in model bodies and ideal cows International Journal of Applied and Fundamental Research. 4246-4250.

Lefler, T. F., & Bagaev, V.V. (2014). Comparative assessment of exterior-constitutional types of Red cows. Bulletin of Kras SAU. No. 12. p. 179-183. (in Russ.).

Lu, H., Wang, Y., & Bovenhuis, H. (2021). Phenotypic and genetic effects of season on milk production traits in dairy cattle in the Netherlands. Journal of Dairy Science. 104(4), 4486-4497.

Rodionov, G. V. (1995). Selection of cows in a dairy complex. Animal Science. Moscow. 23-26.

Shamshidin, A. S., Bissembayev, A. T., Saginbayev, A. K., Abylgazinova, A. T., & Kozhahmetova, A. N. (2021). Dairy productivity of first-calf cows and their average age at first calving in the context. News of the national academy of sciences of the Republic of Kazakhstan series of biological and medical. 3(345), 74-79. doi.org/10.32014/2020.2519-1629.83

Yelemesov, K. Ye., & Baimukanov, A. D. (2020). The estimated breeding value of servicing bulls of domestic breeds by offspring quality using the BLUP method. Bulletin of national academy of sciences of the Republic of Kazakhstan. 3(385), 51-59. https://doi.org/10.32014/2020.2518-1467.69

Zubriyanov, V. F., Lyashenko, V. V., & Morozov, I. M. (2001). Exterior and productivity of Black-and-white cattle of the Povolzhiye type. Animal Science. Moscow. p.4-6.

Zhumanov, K. Zh., Karymsakov, T. N., Kineev, M. A., & Baimukanov, A. D. (2020a) Estimated breeding values of servicing bulls of the holstein black-and-white breed by quality of offspring using the BLUP method. Reports of the national academy of sciences of the Republic of Kazakhstan. 5(333), 35 – 41. ISSN 2224-5227 doi.org/10.32014/2020.2518-1483.116

Zhumanov, K. Zh., & Baimukanov, A. D. (2020b) Dairy productivity of cows of the holstein black-and-white cattle of the Kazakhstan population. Reports of the national academy of sciences of the Republic of Kazakhstan. 6(334), 109-114. doi.org/10.32014/2020.2518-1483.143

Zhumanov, K. Z., Karymsakov, T. N., Kineev, M. A., & Baimukanov, A. D. (2021). Development and optimization of the equations of the mixed BLUP model for the evaluation of the breed value of bulls-producers of the golstin black-motioned breed of the Republic of Kazakhstan. Agrarian science. (2), 33-36. doi.org/10.32634/0869-8155-2021-345-2-33-36