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Exterior of Cows of the Ukrainian Black-Spotted Dairy Breed, Obtained under Various Selection Options

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Abstract. Analysis of the effectiveness of evaluating inline and inter-line variants of combinations by type and finding their best variants in practical selective breeding is a relevant task that allows obtaining offspring of the desired quality. The purpose of this study is to figure out the specific features of the body structure of the firstborn cows of the Ukrainian black-spotted dairy breed of the western inbred type, depending on their origin, as well as to establish the type of inheritance of these indicators in line crosses based on the results of the evaluation by type. The study found the types of selection through genealogical analysis of pedigrees, linear evaluation of cows by type according to two evaluation systems – linear description of individual articles of the exterior on a 9-point scale and evaluation of complexes of exterior features of the animal type on a 100-point scale, obtained results were evaluated according to Student's t-test. Using the scheme, it was found that the firstborn cows obtained as a result of the inline selection are characterized by optimal scores by type. However, animals from the Valianta 1650414 line received the highest ratings for linear traits of height at the withers, width of chest and rear, body depth. The study analysed the evaluation of firstborn cows by type, obtained in the interline selection, and it was found that the indicators of linear evaluation by type of cross lines correspond to and prevail over the average values for the breed. Cross cows ♂Valianta 1650414 x ♀Eleveishna 1491007 received the highest score for milk type on a 100-point scale. It was proved that most of the evaluated traits in line crosses were inherited according to the intermediate type. However, in the cross ♂Chifa 1427381 x ♀Eleveishna 1491007, the evaluation of individual traits (height, chest width, angle of withers, rear attachment, and depth of udder) statistically probably exceeded the values of the corresponding evaluations of the firstborns of the paternal and maternal lines, and the dominance of the maternal line was observed in the cross-breed cows ♂Chifa 1427381 x ♀Valianta 1650414 according to the value of the assessment of individual udder traits. The obtained results will allow performing optimal selection of parent pairs from animals evaluated by type for selection and breeding work with cattle herds to consolidate them by type

Keywords: cows, firstborn cows, exterior assessment, breeding selection, cross lines, inheritance

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INTRODUCTION

Currently, the main development vector in the field of dairy cattle breeding is the creation and consolidation of highly productive breeding herds of intensive type, suitable for keeping in the conditions of industrial technology. To solve the set tasks successfully, apart from breeding for increasing the amount of milk yield and milk quality, it is important to evaluate the exterior as a complex of economic and useful features directly related to the level of milk productivity. Presently, the exterior in Ukraine is assessed based on methodological guidelines for the linear classification of dairy and milk-meat cows by type, developed by Ukrainian scientists-breeders, per the ICAR requirements (Khmelnychyi *et al*., 2016).

When breeding the Western inbred type, bulls of American and Canadian breeding, as well as Ukrainian breeding, belonging to different genealogical lines and having different proportions of Holstein blood were used. As a result, there is a certain level of phenotypic variability in both the exterior and productivity of cows in breeding herds. Analysis of the effectiveness of various selection options, considering the linear affiliation of parent pairs, is a relevant condition for building a strategy to further improve breeding and productive qualities of the Western inbred type of the Ukrainian black-spotted dairy breed.

In cattle breeding, one of the important methods is the breeding of animals along lines, which aims to consolidate and reproduce valuable traits of outstanding breeding bulls in the offspring. For this purpose, various selection options are used, considering the lineal affiliation of the animals, namely: inline selection (parental pairs belong to the same line) and inter selection or line crossing (parental pairs belong to different lines). Each of these methods has its own particular tasks, which are planned to be achieved by breeders, and is based on the assumption that the inheritance of the majority of economically useful traits in dairy cattle breeding occurs because of the additive effect of genes. Currently, a considerable number of studies have been conducted to figure out the productivity and reproductive capacity of cows of Ukrainian black- and red-spotted dairy breeds obtained from separate variants of selection of pairs by belonging to traditional lines of the Holstein breed (Khmelnychyi & Salogub, 2019; Khmelnychyi & Loboda, 2019; Khmelnychyi & Bondarchuk, 2019). The analysis of the obtained data suggests that the effectiveness of such methods in individual herds may differ substantially. Therefore, it is necessary to constantly monitor the effectiveness of using certain selection options to achieve the tasks set in each particular case. Having identified successful combinations, one can use their best options in further breeding work.

The use of linear evaluation by type is a valuable tool of breeders, which allows clearly formulating and purposefully influencing the formation of the desired animal type and the consolidation of breeding herds, lines, breeds, and inbred types (Boiko *et al*., 2017; Khmelnychyi, 2017; Pomitun *et al*., 2020). The indicators of linear type assessment depend on the assessed breed, the farm where such assessment was conducted, the qualifications and experience of the expert conducting such assessment (Khmelnychyi *et al*., 2019; Loboda & Bardash, 2019; Palii *et al*., 2020). The effect of heredity on the results of a linear type assessment is evidenced by the fact that its results can depend both on paternal origin and on belonging to a certain genealogical line (Iliashenko, 2017; Hetia *et al*., 2020). In the vast majority, the results of the assessment of descriptive traits are marked by probable inheritance coefficients (Salohub *et al*., 2018; Hakim *et al*., 2020; Karpenko, 2020; Ismael *et al*., 2021). It is established that many of the evaluated exterior traits are positively correlated with productivity and longevity indicators (Alimzhanova *et al*., 2018; Cherniak & Honcharuk, 2018; Iliashenko, 2018). A positive relationship between udder parameter assessment indicators and milk yields is found especially often (Djedović *et al*., 2020). To varying degrees, the evaluated features also correlate with each other and have high variability (Rovegliaa *et al*., 2019; Török *et al*., 2021; Khmelnychyi & Kagrepko, 2021).

The purpose of this study: using the method of linear evaluation by type, to figure out the external characteristics of the firstborn cows of the Ukrainian black-spotted dairy breed of the Western inbred type, obtained by inline and interline selection and to establish the type of inheritance of these indicators in line crosses.

MATERIALS AND METHODS

The study was conducted on cows of the Western inbred type of the Ukrainian black-spotted dairy breed in the Radekhivske Breeding Plant of the Radekhiv District of the Lviv Oblast. The authors used information from pedigree records provided in individual cards of breeding cows (Form 2-MOL) and their research. Using cards of breeding cows, the pedigrees of animals of various combinations were analysed and, accordingly, the types (variants) of selection were determined by pertinence to genealogical lines. Types of selection were figured out by genealogical analysis of animal pedigrees for 4 rows of ancestors. Selection methods were grouped according to the following scheme: inline selection – father and mother of the cow pertained to the same genealogical line; interline selection – father and mother of the cow pertained to different lines.

Linear assessment of firstborn cows by type was performed following the instructions of the method of linear classification of cows of dairy and dairy meat breeds by type (Khmelnychyi *et al*., 2016). According to the method, cows were evaluated at 2-4 months of the first lactation, on a 9- and 100-point scale. According to the 9-point scale, 17 exterior articles were evaluated, where the animal received 5 points for the average

expression of the trait. For deviations towards minimal development, the score was reduced to one point, with the maximum expression of the trait, a score of 9 points is possible.

According to the 100-point classification system, four sets of selection traits were considered, which characterize: milk type pronouncement, body development, the condition of the limbs and the morphological qualities of the udder. A 100-point score is completely subjective. According to the requirements specified in the method, the highest score for firstborn cows can be 89 points. Each group of exterior articles (complex) is evaluated independently of the others. Weight coefficients in the overall assessment of complex traits are as follows: milk type – 15%, trunk – 20%; limbs – 25%, udder – 40%. Based on the assessed features of the type, the overall rating is found according to the formula: OR=(MT·0.15)+(B·0.20)+(L·0.25)+(U·0.40), where OR is the overall rating of complex (group) type features, MT – score for milk type, B – score for body, L – score for limbs and legs, U – score for udder. Therewith, when evaluating the dairy type of animals, attention should be paid to the proportionality of the development of individual parts of the body. The cow should have a pronounced milk type (light head, long neck, flat, long ribs). When evaluating the torso, its strength, height, depth, and length are considered. When evaluating limbs and hooves, the condition of the forelimbs and hind limbs, the strength of the hock joint, and the condition of the hooves are considered. When evaluating the udder, the shape of the udder, the pronouncement of the milk veins, and the size, shape, and diameter of the teats are considered. The probability of the results obtained is estimated based on the student's t-test, where * – $p<0.05$, ** – $p<0.01$, *** – $p<0.001$.

RESULTS AND DISCUSSION

The results of studies on the indicators of linear assessment of firstborn cows by type obtained upon inline selection are presented in Table 1.

***Table 1**. Linear assessment of milk type, torso, limbs, and fatness in firstborn cows with inline selection, points (M±m)*

Indicators	Lines		
	Chifa 1427381	Valianta 1650414	Eleveishna 1491007
Number of animals, heads	32	37	42
Height	5.8±0.09	6.2±0.13	6.0±0.13
Chest width	6.4±0.10	7.0±0.11	6.5±0.11
Body depth	6.3±0.12	6.9±0.10	6.6±0.10
Milk type (angularity)	6.8±0.08	7.1±0.07	6.9±0.08
Rear tilt	5.2±0.11	5.0±0.08	5.3±0.11
Rear width	5.6±0.07	5.8±0.10	5.5±0.07
Pelvic limb angle	5.0±0.09	5.1±0.09	5.2±0.12
Pelvic limb posture	5.6±0.11	5.5±0.09	5.5±0.11
Hoof angle	5.0±0.10	5.2±0.11	5.1±0.10
Fatness	5.0±0.10	4.9±0.10	5.3±0.09

***Source:** compiled by the authors*

The analysis of the indicators presented in Table 1 suggests that during the inline selection of the firstborn of the Valiant 1650414 line, the highest evaluations of growth, chest width, body depth, milk type, and rear width were noted. According to these indicators, they outnumbered the firstborn from the Chifa 1427381 line by 0.4, 0.6, 0.6, 0.3, and 0.2 points, respectively. The first four differences are statistically significant ($p<0.05$–0.001), and the last difference is within the statistical error range. Compared to cows of the Eleveishna 1491007 line, they had a substantial predominance in terms of chest width (0.5 points, $p<0.01$), body depth and rear width (0.3 points each, $p<0.05$). According to the posterior slope assessment, the difference between the firstborn Valiant 1650414 and Eleveishna 1491007 was 0.3 points in favour of the latter ($p<0.05$). Scores of the angle and posture of the pelvic limbs, as well as the hoof angles, did not significantly differ in firstborn cows of the Chifa 1427381, Valiant 1650414, and Eleveishna 1491007 lines obtained upon inline selection. The highest fatness rating was given to cows of the Eleveishna 1491007 line, which outnumbered cows of the Chifa 1427381 and Valianta 1650414 lines by 0.3 and 0.4 points, respectively ($p<0.05$ and $p<0.01$).

The results of the evaluation of firstborn cows by type in Chifa 1427381, Valianta 1650414, and Eleveyshna 1491007 lines, obtained upon inline selection, suggest that certain exterior features inherent in each of the lines were discovered. According to these indicators, the firstborns of the Valianta 1650414 line have features

inherent in animals of the intensive milk type – they are tall, have wide chests and a deep body, which indicates a good development of internal organs (heart, lungs, digestive tract) and the ability to consume, assimilate, and process into milk sufficient amounts of bulk feed. They are not prone to the deposition of subcutaneous fat, as evidenced by the assessment of fatness. No significant differences were found between the animals of the Chifa 1427381 and Eleveishna 1491007 lines in terms of the magnitude of the exterior assessment.

In general, with inline selection in the Chifa 1427381, Valiant 1650414, and Eleveishna 1491007 lines, all firstborn cows in terms of height, chest width, body depth, milk type pronouncement, rear tilt and width, angle and posture of pelvic limbs and hoof angle received positive ratings that correspond to the average level (5 points) or predominate it.

Udder assessment is one of the key elements of linear classification of cows by type in the dairy and dairy-meat areas of productivity. Based on the characteristics of the development of the dairy system, it is possible to figure out the suitability of a cow for operation in the conditions of an industrial milk production system, the ability to produce large volumes of milk, and the tendency to injury and morbidity of the udder. The results of evaluation of the udder of firstborn cows obtained upon inline selection are presented in Table 2.

***Table 2**. Linear udder assessment in firstborn cows upon inline selection, points (M±m)*

Indicators	Lines		
	Chifa 1427381	Valianta 1650414	Eleveishna 1491007
Number of animals, heads	32	37	42
Anterior udder attachment	5.4±0.13	6.7±0.07	6.0±0.07
Posterior udder attachment	5.2±0.06	5.6±0.10	5.2±0.09
Central ligament	5.3±0.08	6.4±0.12	5.4±0.08
Udder depth	5.2±0.09	6.6±0.06	6.5±0.06
Placement of anterior teats	5.2±0.11	5.0±0.08	5.1±0.04
Placement of posterior teats	5.1±0.10	5.0±0.11	5.0±0.03
Length of teats	5.6±0.10	5.5±0.03	5.4±0.03

***Source:** compiled by the authors*

It was found that firstborn cows of the Valiant 1650414 line were characterized by the highest udder evaluation indicators, namely: according to the assessment of anterior udder attachment and central ligament, they outnumbered cows of the Chifa 1427381 and Eleveishna 1491007 lines by 1.3 and 0.7, and 1.1 and 1 points, respectively, in all cases $p<0.001$; according to the assessment of posterior udder attachment, their advantage was 0.4 points in both cases, $p<0.01$; according to the udder depth score, cows of the Chifa 1427381 line predominate with hight significance (1.4 points, $p<0.001$).

Furthermore, the firstborn of the Chifa 1427381 line had lower scores of anterior udder attachment and its depth than the peers of the Eleveishna 1491007 line. The differences were 0.6 and 1.3 points, respectively, $p<0.001$.

The results of estimating the udder depth indicate that in cows of the compared groups, this indicator was optimal for suitability for machine milking. Thus, firstborn cows from the Valiant 1650414 line, being the tallest, had a more elevated udder from the level of the hock joint. They have better developed chest and rear width, body depth, and a well-pronounced milk type.

The assessment of complex (group) type traits upon inline selection (Table 3) showed that according to all group articles and general assessment, the animals corresponded to the "good" and "good plus" classes per the international requirements.

***Table 3**. Linear assessment of complex (group) characteristics of experimental cows by type upon inline selection, points (M±m)*

Indicators	Lines		
	Chifa 1427381	Valianta 1650414	Eleveishna 1491007
Number of animals, heads	32	37	42
Milk type	79.1±0.15	82.2±0.11	82.0±0.08
Body	83.5±0.12	83.2±0.09	82.8±0.15
Limbs and hooves	84.0±0.10	82.0±0.11	82.0±0.16
Udder (milk system)	81.5±0.13	83.0±0.13	83.6±0.14
Overall rating	82.1±0.12	82.6±0.12	82.7±0.11

***Source:** compiled by the authors*

The score of complex traits of the dairy type was highest in cows from the Valiant 1650414 line, which according to this indicator statistically significantly outnumbered cows of the Chifa 1427381 line (p<0.001). Compared to the animals of the Eleveishna 1491007 line, their advantage was not significant. Group body traits in cows of the compared lines were rated "good plus", but the highest score was given to firstborn cows from the Chifa 1427381 line. They statistically significantly prevailed in this indicator of cows of the Eleveishna 1491007 line (p<0.01). The condition of the pelvic and thoracic limbs was assessed with higher scores in cows from the Chifa 1427381 line. Their superiority over their peers of the Valiant 1650414 and Eleveishna 1491007 lines was statistically highly significant (p<0.001). The highest udder score was given to cows from the Eleveishna 1491007 line, they outnumbered the peers of the Chifa 1427381 and Valiant 1650414 lines by 2.1 and 0.6 points, respectively (p<0.01). The overall score was lowest for cows of the Chifa 1427381 line, they were inferior to cows of the Valiant 1650414 and Eleveishna lines 1491007, respectively, by 0.5 and 0.6 points (p<0.01). Indicators of linear assessment of firstborn cows obtained as a result of crossing different lines are presented in Table 4.

***Table 4**. Linear assessment of milk type, body, limbs, and fatness in firstborn cows upon inline selection, points (M±m)*

Indicators	Line combination				
	♂Chifa 1427381 x ♀Eleveishna 1491007	**♂Chifa 1427381 x ♀Starbaka 352790**	**♂Chifa 1427381 x ♀Valianta 1650414**	**♂Valianta 1650414 x ♀Eleveishna 1491007**	**♂Starbaka 352790 x ♀Valianta 1650414**
Number of animals, heads	70	82	94	114	68
Height	6.4±0.03	5.8±0.06	5.9±0.08	6.3±0.09	6.5±0.04
Chest width	6.8±0.10	6.4±0.12	6.6±0.11	6.8±0.12	6.9±0.07
Body depth	6.6±0.09	6.2±0.04	6.4±0.13	7.0±0.06	7.2±0.10
Milk type	6.6±0.11	7.0±0.03	7.0±0.07	7.2±0.05	6.9±0.09
Rear tilt	5.2±0.06	5.1±0.11	4.9±0.05	5.2±0.10	5.0±0.11
Rear width	5.8±0.09	6.0±0.11	6.2±0.06	6.0±0.11	6.1±0.10
Pelvic limb angle	5.1±0.08	5.4±0.10	5.5±0.11	5.0±0.08	5.3±0.02
Pelvic limb posture	5.6±0.06	5.5±0.08	5.8±0. 02	5.6±0.09	5.7±0.09
Hoof angle	5.4±0.08	5.5±0.11	5.6±0.05	5.3±0.13	5.1±0.07
Fatness	4.9±0.09	4.8±0.10	4.8±0.04	5.0±0.11	5.0±0.05

***Source:** compiled by the authors*

It was found that cows obtained upon inline selection also have quite positive indicators of exterior assessment. All evaluated firstborns are tall. The greatest height in the sacrum is found in descendants from the combination of the lines ♂Starbaka 352790 x ♀Valiant 1650414, ♂Chifa 1427381 x ♀Eleveishna 1491007, and ♂Valianta 1650414 x ♀Eleveishna 1491007. Differences in this indicator with cows originating from the crosses of the lines ♂Chifa 1427381 x ♀Starbaka 352790, ♂Chifa 1427381 x ♀Valianta 1650414 are statistically significant, p<0.05. Evaluated cows have a deep body with a wide chest. The greatest chest width rating was given to cows from ♂Starbaka 352790 x ♀Valianta 1650414, ♂Valianta 1650414 x ♀Eleveishna 1491007, and ♂Chifa 1427381 x ♀Elewayshna 1491007 crosses, and the lowest – from the ♂Chifa 1427381 x ♀Starbuck 352790 crosses. Similar differences are observed in the body depth. Furthermore, in the evaluated firstborns, obtained during interline selection, the milk type (angularity) of body structure forms is well-pronounced. Its rating is slightly higher than the average value. It is the lowest in cows of the ♂Chifa 1427381 x ♀Eleveishna 1491007 cross and is 6.6 points, in other groups of animals under study it was within 6.9-7.2 points. The tilt and width of the rear are generally evaluated as the best option in all cases. As for the limbs, they are postured straight with the optimal angle when viewed from the side. In cows of all the compared groups, the score of limbs, including the hoof angles, has average values with small deviations towards increase. The fatness rating is within 4.8-5.0 points.

In terms of the strength of attachment of the anterior part of the udder (Table 5), the highest rating was given to cows from the ♂Chifa 1427381 x ♀Valianta 1650414 and ♂Starbaka 352790 x ♀Valianta 1650414 crosses. According to this indicator, they outnumbered cows from other crosses by 0.3-0.7 points (p<0.01). A similar pattern is observed in the assessment of attachment of the posterior part of the udder. It was found that cows of the ♂Chifa 1427381 x ♀Valianta 1650414 cross received 6.1 points for central ligament, which is 0.2-0.9 points more than those of the same age as other crosses, or 3.4-17.3%, at p<0.01.

***Table 5**. Linear udder assessment in firstborn cows upon interline selection, points (M+m)*

Indicator	Line combination				
	♂Chifa 1427381 x ♀Eleveishna 1491007	♂Chifa 1427381 x ♀Starbaka 352790	♂Chifa 1427381 x ♀Valianta 1650414	♂Valianta 1650414 x ♀Eleveishna 1491007	♂Starbaka 352790 x ♀Valianta 1650414
Number of animals, heads	70	82	94	114	68
Anterior udder attachment	5.9±0.12	6.2±0.12	6.6±0.04	6.1±0.10	6.5±0.04
Posterior udder attachment	5.6±0.11	5.8±0.08	6.0±0.04	5.7±0.11	5.7±0.02
Central ligament	5.2±0.08	5.6±0.06	6.1±0.03	5.8±0.11	5.9±0.03
Udder depth	6.7±0.05	6.8±0.08	6.6±0.12	6.5±0.05	6.6±0.04
Placement of anterior teats	5.1±0.05	5.2±0.09	5.0±0.12	5.3±0.06	5.2±0.04
Placement of posterior teats	4.9±0.03	5.0±0.04	5.0±0.11	5.1±0.06	5.1±0.09
Length of teats	5.0±0.04	4.9±0.05	4.9±0.07	5.0±0.06	5.0±0.02

***Source:** compiled by the authors*

The bottom of the udder is raised quite high above the hock joint in animals of all crosses, as evidenced by the results of assessing the depth of the udder. According to this indicator, the daughters of bulls of the Chifa 1427381 line from cows of the Starbaka 352790 and Eleveishna 1491007 lines received the highest score. Evaluation of the placement and length of teats indicates the optimal values of these indicators in cows of the compared groups and their good adaptability to machine milking.

Animals of the ♂Chifa 1427381 x ♀Valianta 1650414 cross were distinguished by the highest comprehensive score (Table 6) of the "good plus" class, which exceeded the animals of other groups by 1.4-3.4 points ($p<0.001$). Cows of the ♂Chifa 1427381 x ♀Eleveishna 1491007 cross had the lowest overall score. They were 0.9-3.4 points inferior in this indicator to their peers derived from other interline selection variants, all differences are statistically significant, $p<0.001$.

***Table 6**. Linear evaluation of complex (group) traits of experimental cows by type upon interline selection, points (M±m)*

Indicators	Line combination				
	♂Chifa 1427381 x ♀Eleveishna 1491007	♂Chifa 1427381 x ♀Starbaka 352790	♂Chifa 1427381 x ♀Valianta 1650414	♂Valianta 1650414 x ♀Eleveishna 1491007	♂Starbaka 352790 x ♀Valianta 1650414
Number of animals, heads	70	82	94	114	68
Milk type	79.5 ± 0.11	83.5 ± 0.14	83.6 ± 0.11	84.3 ± 0.13	84.0 ± 0.16
Body	78.8 ± 0.12	80.0 ± 0.12	85.1 ± 0.14	80.0 ± 0.14	84.4 ± 0.15
Limbs and hooves	79.0 ± 0.10	79.5 ± 0.12	80.0 ± 0.10	81.0 ± 0.11	80.0 ± 0.14
Udder (milk system)	79.5 ± 0.08	81.2 ± 0.07	82.4 ± 0.12	78.4 ± 0.12	79.0 ± 0.13
Overall rating	79.1 ± 0.12	80.8 ± 0.10	82.5 ± 0.13	80.0 ± 0.10	81.1 ± 0.12

***Source:** compiled by the authors*

In general, the results of linear assessment of complex traits of firstborn cows by type according to the 100-point system found that in experimental animals obtained with both interline and inline selection options, the average score level was 82.6-83.9 points, which corresponds to the "good plus" criterion. Therewith, firstborn cows received an average score of 82.6-84.3 for milk type, body – 83.2-85.0, limbs and hooves – 82.0-83.0, udder or dairy system – 83.0-84.0 points.

The phenotypic manifestation of exterior characteristics of cows is formed as a consequence of the interaction of hereditary and paratypical factors and is mainly controlled by additive genes. Proceeding from this, one can expect that upon crossing lines, the indicators of evaluating cows by type will have values equal to the half-sum of the values of the parent lines. However, the factual assessment of some traits in cows originating from cross lines does not always follow this rule. Figure 1 shows the deviation of the assessment of the firstborns of the line crosses under study by type from the average indicator of peers of the corresponding lines, obtained upon inline selection in percentage.

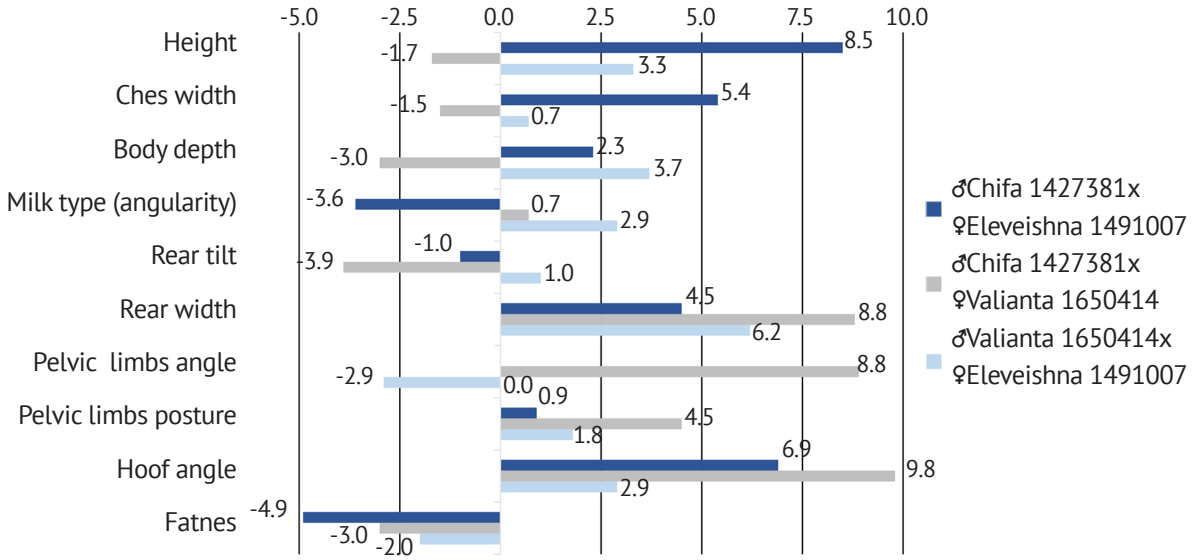

***Figure 1**. The correlation of scores for the milk type, body, limbs, and fatness in firstborn cows upon interline selection and an intermediate indicator of the peers of parental lines, %*
***Source:** compiled by the authors*

The analysis of the data presented in Figure 1 suggests that the firstborn offspring from the ♂Chifa 1427381 x ♀Eleveyshna 1491007 cross, in terms of growth, outweigh the value of the half-sum of the score of peers from inline selection in Chifa 1427381 and Eleveyshna 1491007 lines by 8.5%. Furthermore, their superiority in factual values over the firstborns of the parental lines is statistically significant (Chifa 1427381 – $p<0.001$; Eleveishna 1491007 – $p<0.01$). By analogy, statistically significant differences are observed in the scores of chest width and hoof angle ($P< 0.05$-0.01). According to the rear width score, the advantage is significant only over the peers of the Eleveishna 1491007 line ($p<0.05$), and the latter substantially outweigh them in the fatness score ($p<0.01$). Scores of other animal traits originating from the ♂Chifa 1427381 x ♀Eleveishna 1491007 cross differ from the half-sum values of the parent lines not significantly, i.e., they are inherited according to an intermediate type.

In firstborns from the ♂Chifa 1427381 x ♀Valiant 1650414 cross, the assessment of such features as the rear width, the angle and posture of the pelvic limbs, the hoof angle is more than the half-sum of the ratings of peers of the parental lines by 8.8, 8.9, 4.5, and 9.8%, respectively. According to the factual scores of the rear width, the angle of the pelvic limbs and hooves, they statistically significantly predominate cows of the Chief 1427381 and Valiant 1650414 lines ($p<0.01–0.001$), according to the assessment of the posture of the hind limbs – cows of the Valiant 1650414 line ($p<0.01$). All other differences are not significant.

Firstborns from the ♂Valianta 1650414 x ♀Eleveishna 1491007 cross have the highest score from the half-sum of ratings of peers of parental lines only based on the rear width, which is 6.2%. When comparing factual scores, they statistically significantly predominate the cows of the Eleveishna 1491007 line in this feature ($p<0.01$). Scores of all other traits deviate slightly from the intermediate value of the parent lines.

The results of the udder assessment (Fig. 2) suggest that firstborns of the ♂Chifa 1427381 x ♀Eleveishna 1491007 cross received a higher score for posterior attachment and udder depth, respectively, by 7.7% and 14.5% than the half-sum of similar scores of peers in the parent lines. According to these indicators, they were statistically significantly superior to cows from inline selection in both the Chifa 1427381 line and the Eleveishna 1491007 line ($p<0.05$-0.001). The firstborn cows of ♂Chifa 1427381 x ♀Valianta 1650414 cross, according to the assessment of the front and rear attachment of the udder, as well as its depth, exceeded the average values of the parent lines by 9.1%; 11.1%, and 11.9%, respectively. Therewith, this excess over the factual scores of these features over the firstborns of the Chifa 1427381 line was statistically significant in all three cases ($p<0.01$-0.001), over the firstborns of the Valianta 1650414 line – only in relation to the assessment of posterior udder attachment ($p<0.01$). Cows of ♂Valianta 1650414 x ♀Eleveishna 1491007 cross, based on the evaluation of the rear attachment of the udder and placement of the front teats, prevailed over the average indicator of the parental forms by 5.6% and 5.0%, respectively. There was a statistically significant difference only in the assessment of posterior udder attachment with cows of the Eleveishna 1491007 line ($p<0.001$). According to the estimation of udder length, the firstborns from all evaluated variants of inline selection significantly outnumbered cows obtained upon crossing lines ($p<0.01–0.001$).

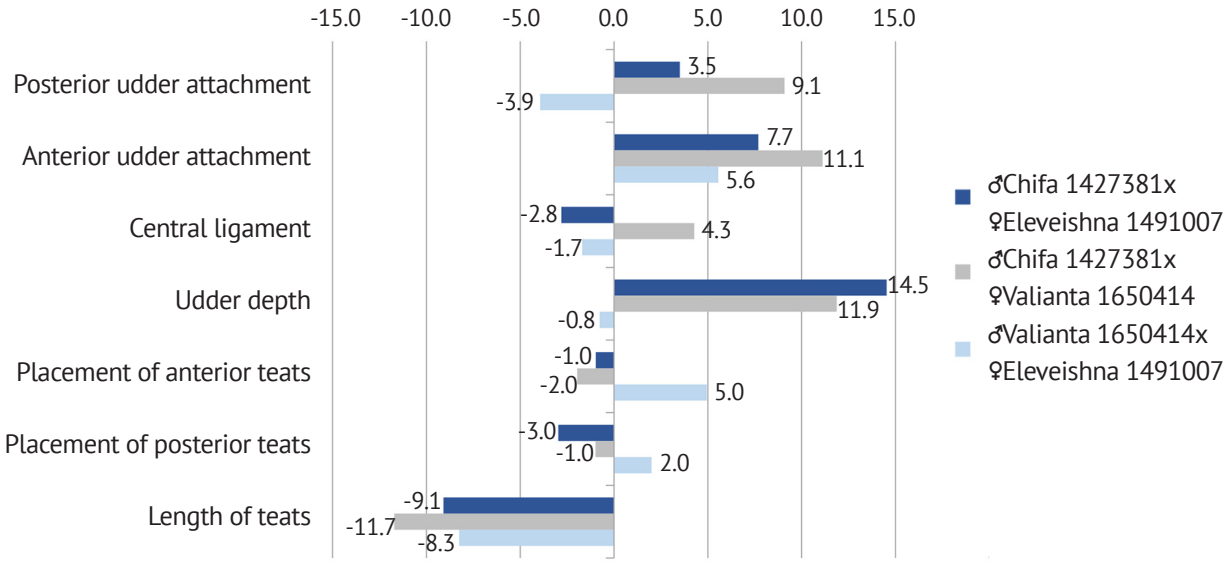

***Figure 2**. The correlation of udder scores in firstborn cows of inline selection and an intermediate indicator of the peers of parental lines, %*

Cows of the Valianta 1650414 line obtained upon inline selection were marked by the highest scores of udder attachment (anterior and posterior), central ligament, and udder depth compared to the same cows of the Chifa 1427381 and Eleveishna 1491007 lines. In cows of ♂Chifa 1427381 x ♀Valianta 1650414 cross, the value of these udder indicators shows a deviation from the intermediate nature of their inheritance and a certain level of dominance of the maternal line.

Pertinence of cows to a certain line of origin substantially affects the level of phenotypic variability of exterior features, which is manifested in the results of linear assessment of cows by type. The influence of lineal pertinence on the development of individual articles of the body of firstborn cows is substantial and predominantly reliable, it ranges within 3-36% (Bazyshyna, 2017; Khmelnychyi, 2017; Hladii & Polupan, 2018). This explains the differences between the results of linear evaluation of firstborns by type, obtained with different options of selection – inline and line crosses.

Similar results regarding the linear evaluation by type were obtained in studies conducted on firstborn cows of the Sumy inbred type of the Ukrainian black-spotted dairy breed. It was found that the highest score for both complex and descriptive traits was in cows of the Valianta 1650414 line, obtained during inline selection and Valianta 1650414 x S.T. Rokita 252803 and Valianta 1650414 x Kheneve 1629391 crosses (Khmelnychyi & Bondarchuk, 2019). The firstborns of these lines were marked by the highest coefficients of phenotypic consolidation according to the descriptive characteristics of body depth, angularity, rear width, posture of the hind limbs and attachment of the front lobes of the udder (Khmelnychyi *et al*., 2019). In this study, the positive effect of pertinence to the Valianta 1650414 line on the evaluation results was observed both upon inline selection and upon crossing lines.

The analysis of the results of evaluation by type for the cows of the Ukrainian black-spotted dairy breed of lines Chifa 1427381, Eleveyshna 1491007, Starbaka 352790, and Valianta 1650414, obtained upon inline and interline selection, revealed that the best scores according to group and descriptive traits were obtained when selecting Starbaka 352790 x Starbaka 352790, Eleveishna 1491007 x Starbaka 352790, Valianta 1650414 x Starbaka 352790. The offspring of the Chifa 1427381 line had the lowest scores both in inline selection and in all cross variants (Kochuk-Iashchenko, 2017). Similarly, the results presented by the authors of this paper show that the offspring from inline selection in the Chifa 1427381 line and the Chifa 1427381 x Eleveishna 1491007 cross had the lowest results for some complex and descriptive traits.

The necessary materials for a comparative analysis of the results regarding the nature of the inheritance of the scores of descriptive traits of firstborn cows were not found in available scientific publications. There are published research results that establish that 65.3% of Holstein cows had an intermediate type of inheritance of breeding value based on milk yield. Upon comparing inline and interline selection, it was found that 56.7% and 70.6% of cows had an intermediate type of inheritance, respectively. Upon the inline selection, parental heredity dominated in 20.7% of animals, and upon the interline selection – only 1.9%. The authors concluded that upon inline selection, the influence of parental heredity is higher than upon crossing lines (Babenko & Klopenko, 2017). An analysis of the specific features of inheritance of breeding value based on the milk yield of Holstein bulls found that 82.2% of the bulls had

a phenotypic manifestation of the additive form of inheritance (Kruhliak & Kruhliak, 2021). In the presented studies, it was proven that the intermediate type of inheritance was present in 65% of the descriptive traits upon crossing lines ♂Chifa 1427381 x ♀Eleveyshna 1491007, 75.6% – ♂Chifa 1427381 x ♀Valianta 1650414, and 94.1% upon crossing lines ♂Valianta 1650414 x ♀Eleveishna 1491007.

CONCLUSIONS

Upon inline selection, cows of the Valianta 1650414 line had the highest scores of height, chest width, body depth, milk type pronouncement, front and rear attachment of the udder, central ligament and udder depth, and were significantly superior in these features to the cows of the Eleveyshna 1491007 and Chifa 1427381 lines.

The highest values of growth, chest width, and body depth were observed in cows of the ♂Starbaka 352790 x ♀Valianta 1650414, ♂Chifa 1427381 x ♀Eleveishna 1491007, and ♂Valianta 1650414 x ♀Eleveishna 1491007 crosses, the best score for milk type was given to cows of ♂Chifa 1427381 x ♀Starbaka 352790 cross.

The highest score for udder attachment (front and rear) and central ligament was obtained by firstborn bulls of the Chifa 1427381 and Starbaka 352790 lines with cows of the Valianta 1650414 line, and the highest score of udder depth was obtained by daughters of bulls of the Chifa 1427381 line from cows of the Starbaka 352790 and Eleveishna 1491007 lines. The placement and length of the teats had optimal values in cows of all the compared groups.

In the firstborn cows obtained with all the compared selection variants, the average level of the linear evaluation of complex traits by type according to the 100-point system was 82.6-83.9 points, which corresponds to the "good plus" criterion. The vast majority of evaluated traits (64.7-94.1%) in line crosses had an intermediate nature of inheritance.

Inheritance of scores of height, chest width, hoof angle, rear attachment and depth of udder in ♂Chifa 1427381 x ♀Eleveishna 1491007 cross, scores of rear width, angle of pelvic limbs and hooves and rear attachment of udder in ♂Chifa 1427381 x ♀Valianta 1650414 cross according to the heterosis type were statistically significantly ($p<0.05$-0.001) higher than the factual scores in parental lines. In the ♂Chifa 1427381 x ♀Valianta 1650414 cross, the score of udder attachment (anterior and posterior), central ligament, and udder depth indicates the dominance of the maternal line in terms of these traits.

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Екстер'єр корів української чорно-рябої молочної породи, отриманих за різних варіантів підбору

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Анотація. Аналіз ефективності оцінки внутрішньолінійних та міжлінійних варіантів поєднань за типом та виявлення найкращих їх варіантів у практичній селекційно-племінній є актуальним завданням, що дозволить отримувати нащадків бажаної якості. Мета роботи – на підставі результатів оцінки за типом корів-первісток української чорно-рябої молочної породи західного внутрішньопородного типу української чорно-рябої молочної породи визначити особливості будови їх тіла залежно від походження, а також встановити тип успадкування цих показників при кросах ліній. При проведенні досліджень визначали: типи підбору шляхом генеалогічного аналізу родоводів, лінійну оцінку корів за типом за двома системами оцінки – лінійний опис окремих статей екстер'єру за 9-бальною шкалою та оцінювання комплексів екстер'єрних ознак типу тварин за 100-бальною шкалою, отримані результати оцінювали за Стьюдентом. Використовуючи схему, було встановлено, що корови-первістки, отримані в результаті внутрішньолінійного варіанту підбору характеризуються оптимальними оцінками за тип, проте тварини з лінії Валіанта 1650414 отримали найвищі оцінки за лінійні ознаки висоти в крижах, ширину грудей та заду, глибину тулубу. Було проаналізовано оцінку за типом у корів-первісток, отриманих при міжлінійному варіанті підбору і встановлено, що за показниками лінійної оцінки за типом кроси ліній відповідають та переважають середні значення для породи. Корови кросу ♂Валіанта 1650414 х ♀Елевейшна 1491007 отримали найвищий бал за молочний тип по 100-бальній шкалі. Було доведено, що більшість із оцінюваних ознак при кросах ліній успадковувалися за проміжним типом, однак при кросі ♂Чіфа 1427381 х ♀Елевейшна 1491007 оцінка окремих ознак (ріст, ширина грудей, кут ратиць, заднє прикріплення та глибина вимені) статистично вірогідно перевищувала значення відповідних оцінок первісток батьківської і материнської лінії, а у корів кросу ♂Чіфа 1427381 х ♀Валіанта 1650414 за величиною оцінки окремих ознак вимені спостерігалося домінування материнської лінії. Отримані результати дозволять проводити оптимальний добір та підбір батьківських пар з оцінених за типом тварин, для проведення селекційно-племінної роботи із стадами ВРХ з метою консолідації їх за типом

Ключові слова: корови-первістки, оцінка екстер'єру, племінний підбір, крос ліній, успадкування