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LIFESPAN OF DAIRY CATTLE DEPENDING ON THE LEVEL OF EVALUATION OF UDDER LINEAR TRAITS

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The dependence of cows lifespan of Ukrainian Black-and-White dairy (UBWD) and Holstein (H) breeds on the level of evaluation of linear type traits that characterize udder morphological qualities in the general system of linear classification was studied. Descriptive traits of the evaluated conformation type were: front udder parts attachment, height of rear udder parts attachment, central ligament, udder depth, front teats placement and length. A certain correlative variability was established between level of evaluation of linear type traits and lifespan of animals. The highly reliable difference between evaluated cows for linear type trait of front udder parts attachment with 1 and 9 scores is significant and was 841 (UBWD; P<0.001) and 810 (H; P<0.001) days. An interbreed comparison of cows lifespan, depending on the evaluation, testified in favor cows of Holstein breed with variability within 43-159 days by an unreliable difference. Difference between the lowest and highest scores for type trait of height rear udder attachment in cows of experimental breeds was 740 (UBWD; P<0.001) and 810 (H; P<0.001) days. Animals with an assessment for trait development of central udder ligament lower than 1-3 scores live, according to evaluated breeds, from 2089 to 2401 (UBWD) and from 2154 to 2468 (H) days. Cows with 9 scores for both breeds had the highest lifespan – 2663 days (UBWD), inferior to cows with the lowest score by 754 (P<0.001) and 2803 days (H) with significant increase on 649 days (P<0.001). Difference between the average lifespan in cows of Ukrainian Black-and-White dairy breed with 9 and 1 scores for linear type trait of udder depth was 739 (P<0.001) and 832 days (P<0.001) in Holstein cows. Lifespan of cows both breeds in the herd was characterized by slight curvilinear variability, depending on the assessment of linear type trait of front teats placement. Consequently, cows of both breeds with an average score of 7 were used in the herd for the longest period. Evaluation of correlative variability of the front teats length with lifespan of cows in controlled breeds indicated that animals with an average score of 5, which was equal to their teats length at 5 cm, had longer functional life. Research results showed that each of evaluated descriptive traits in cows of both breeds has an impact on lifespan with different variability within individual body part, so better expression of linear type trait can be a breeding trait as an indirect predictor of longevity.

Key words: *Ukrainian Black-and-White dairy breed, Holstein, linear type traits, lifespan.*

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Introduction. The created Ukrainian Black-and-White dairy breed at the current stage of breeding is absorbed by the gene pool of Holstein breed of world selection. Increasing the heredity of Holstein breed undoubtedly leads to an increase in milk production, but high-blooded cows are become more demanding on the conditions of feeding and keeping. In addition, the high mechanization of technological processes and increase in Holstein heredity, according to research evidence (Klopenko and Stavetska, 2015; Novotný et al., 2017) affect the reduction of duration productive life of cows. Therefore, in the modern conditions of intensive milk production technologies, indicators of dairy cows longevity occupy an important link in the economic chain of development the cattle breeding industry, since its profitability significantly depends on them (Polupan, 2015). Due to its high economic value, national dairy associations have registered the longevity as a breeding trait (Miglior, 2005; Polupan, 2014).

According to scientists evidence (Klopenko and Stavetska, 2015; Polupan, 2000), the longevity of cows should be considered as a complex and integral trait determined by a number of hereditary and paratypic factors. Since breeders are interested in linear traits that inherited, solving the problem of longevity due to hereditary factors is complicated precisely because of the low heritability of traits characterizing it, especially with regard to lifespan. World

studies confirm this property. According to authors of (Imbayarwo-Chikosi et al., 2015), the degree of variability in the heritability of lifespan was within 0.01-0.36, depending on the breed and research method. The authors of other studies report that heritability of lifespan of Holstein cows varied from 0.05 to 0.07 (Kern et al., 2015), heritability coefficients in animals of Simmental breed of the Czech Republic ranged from 0.04 to 0.05 (Zavadilová et al., 2009), and Holstein cows – from 0.03 to 0.05 (Zavadilová and Štípková, 2012).

The problem of dairy cattle productive longevity in the world has existed for a long time, so breeders are actively searching for methods to solve it. One of the means to solve the problem of lifespan is the selection of animals according to traits of the conformation type. The motivation for this activity is based on the existence of correlative variability between body parts of the conformation and indicators of the duration of productive use of cows. (Battagin et al., 2013; Kadarmideen and Wegmann 2003; Kern et al., 2015; Zavadilová et al., 2011; Zavadilová et al., 2009), including between udder traits and longevity (Du Toit et al., 2013).

According to the linear evaluation of Jersey cows, significant moderate and strong positive genetic correlations were established between the majority of udder traits and functional longevity of cows in the herd (from 0.23 to 0.63) (Du Toit et al., 2013). The authors of (García-Ruiz et al., 2016) based on studies of Mexican Holsteins propose to include five linear type traits (chest width, teats length, central ligament, texture and udder depth), which were positively correlated with the length of productive lifespan, as indirect predictors of longevity. Other researchers (Kern et al., 2014) are convinced that indirect genetic selection for linear type traits of height, body depth, chest width, bone quality, angularity, udder depth, rear teats placement, udder texture, central ligament, front and rear udder attachment can lead to a correlated increase in the longevity of cows.

The introduction of linear classification method into the breeding process of improving Ukrainian dairy breeds makes it possible to identify the desired development of those linear type traits that affect the lifespan of animals in order to consider them in the selection process. The effectiveness of breeding cows in the direction of longevity was confirmed by a sufficient level of the heritability of linear type traits (Bilal et al., 2016; Novaković et al., 2014; Zavadilová et al., 2009).

The aim of our research was to study the dependence of lifespan of cows of the Ukrainian Black-and-White dairy (UBWD) and Holstein (H) breeds on the level of evaluation of linear type traits that characterize the udder morphological qualities in the general system of linear classification of the conformation type.

Materials and methods. Experimental studies were carried out in the farm herd of the company "Ukrlandfarming" PE "Burynske" of the Podlisniv branch in the Sumy district for the breeding of Ukrainian Black-and-White dairy (n=278) and Holstein (n=293) breeds. The conformation type of the first-born cows was evaluated using the linear classification method according to the latest ICAR recommendations (ICAR, 2018) at the age of 2-4 months after calving. Linear type traits characterizing the development of udder were evaluated on a 9-score scale. The lifespan of cows was determined by the number of days between the dates of birth and culling from the herd.

Results and discussions. Evaluation of the udder morphological traits cows of dairy breeds in the linear classification system occupies a certain place, since in the final score of type, its specific weight is 40 % in the most countries of the world (Holstein UK, 2013). The scientific and practical experience in breeding dairy cattle has repeatedly stated that the udder morphological traits are the most important and reliable conformation indicators of high milk yield and manufacturability of cows (Alphonsus et al., 2010; Atkins et al., 2008; Campos et al., 2015). The desirable udder of a dairy-type cow in the totality of morphological traits should be large in volume, proportionally formed, bath- or cup-shaped; the size is characterized by the development both in width and in length, with parts spread far forward along the belly and back beyond the hip line. The bottom placed at a sufficient distance from the ground, front udder part tightly attached to the belly, and the rear is high and firmly attached with a well-defined, deep, highly raised furrow of central ligament. The teats are located in the center of udder parts at an optimal distance, cylindrical in shape, of the desired length and thickness, directed vertically down (ICAR, 2018).

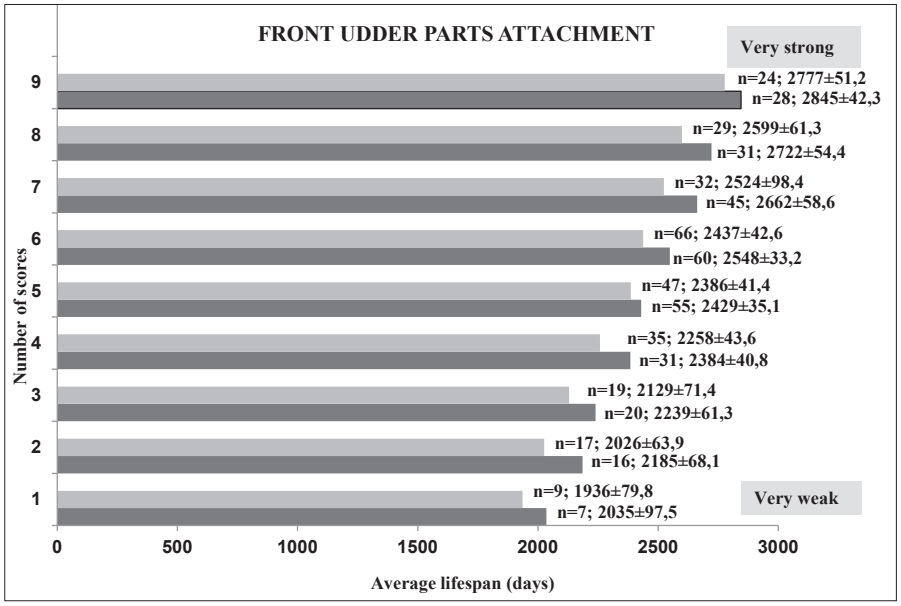
Based on the results of linear classification of descriptive traits of the conformation type that characterize the udder morphological qualities of the first-born cows of experimental breeds in the herd: front udder parts attachment, height of rear udder parts attachment, central ligament, udder depth, front teats placement and length, a certain correlative variability between the level of these traits evaluation and the longevity of animals.

One of the important udder descriptive traits, front udder part attachment to the cow's belly, measured by strength that is characterized by the angle at this place of connection. The highest score of 9 for this body part development is given to an animal in which the udder differs by gradual transition of the front part glandular tissue into the belly with help of connective lateral ligaments and formation of obtuse angle above 161° (Khmelnychyi et al., 2022). Strong udder attachment usually has excellent fore parts development, bath-like shape and according to scientific studies, reliably correlated with milk production (Gibson and Dechow, 2018). The functional feature of the strong attachment of udder front parts is to prevent it from sagging with age (Atkins et al., 2008).

The results of evaluation the udder front parts attachment (Fig. 1) showed the presence of correlation between this linear type trait development and lifespan of cows of evaluated breeds. Reliable difference between cows rated at 1 and 9 scores is quite significant and amounted to 841 (UBWD; $P<0.001$) and 810 (H; $P<0.001$) days. An interbreed comparison of cows lifespan, depending on the assessment, testified in favor of Holstein cows with variability within 43-159 days by unreliable difference. About significant impact of this trait on the lifespan of cows is reported in the studies of foreign authors. Thus, when evaluating Jersey cows, high correlation was between the udder front parts

attachment and functional life with genetic correlations for the first three lactations 0.23; 0.63 and 0.33, respectively (Du Toit et al., 2012). According to the assessment of genetic parameters of Italian brown Swedish dairy cattle (Samoré et al., 2010), a strong positive genetic correlation was between the udder front parts attachment and milk yield (0.45), but insignificant – with functional longevity (0.10).

The next linear type trait is the height of rear udder parts attachment, similarly to the previous one performs supporting function, preventing the udder from sagging with age. Desirable development of this body part estimated with the highest score. The difference between the lowest and highest scores for this trait in cows of experimental breeds was 740 (UBWD; P<0.001) and 810 (H; P<0.001) days (Fig. 2).



Note: hereinafter: **– ■ – Ukrainian Black-and-White dairy breed; ■ – Holstein breed.**

Fig. 1. Correlative variability of the score assessment descriptive type trait «front udder parts attachment» with lifespan of cows in controlled breeds

The central ligament next linear type trait of the udder in dairy cows, which is also related to supporting it at the appropriate height.The high placed udder above the ground facilitates preparation of the operator for milking process and prevents cooling and injury. A high udder placement with a deep, strength, well defined and highly raised central ligament is desirable development of the trait with the highest score.

The histogram sleepers (Fig. 3) show that average lifespan of cows of experimental breeds significantly depends on the evaluation level of “central ligament” trait. Animals with a score below 1-3 for development of the udder central ligament live, according to the evaluated breeds, from 2089 to 2401 (URWD) and of 2154 to 2468 (H) days. Cows of both breeds with score of 9 are distinguished by highest lifespan – 2663 days (URWD), giving way to cows with the lowest score by 754 (P<0.001) and 2803 (H) days with significant excess in 649 days (P<0.001).

Hence, consistent with our results, Schneider et al. (2003) and Sewalem et al. (2004) found that supporting ligament of Holstein cows is one of the most important udder traits, The udder bottom placement relative to the ground is a very important functional technological trait of dairy cattle. According to the method of linear classification, udder depth is evaluted by the distance between conditional line drawn at the hock joint level and udder bottom. The udder bottom distance relative to the ground significantly depends on the previous three traits, which are responsible for the strength of its attachment. The histogram indicators (Fig. 4) show that cows with a high udder are much less exposed to diseases and risks of being culled, therefore, they are used much longer in the herd of controlled farm. The difference between the average lifespan of cows with a score of 9 and 1 for udder depth is 739 days for Ukrainian Black-and-White dairy cows (P<0.001), for Holstein cows – 832 days (P<0.001). An interbreed comparison shows the advantage of Holstein cows over Ukrainian Black-and-White dairy breed in terms of lifespan within all score values for udder depth, and for some the difference in their favor is significant. According to the average score of 5 the difference was 170 days (P<0.05). A correlative close relationship between udder depth and functional longevity was found in the brown Swiss of Italy with genetic correlation of 0.42 ± 0.10 (Samoré et al., 2010), which confirms results of our studies since animals with lower scores (extremely weak ligaments) are almost twice as likely to be culled than animals with higher scores.

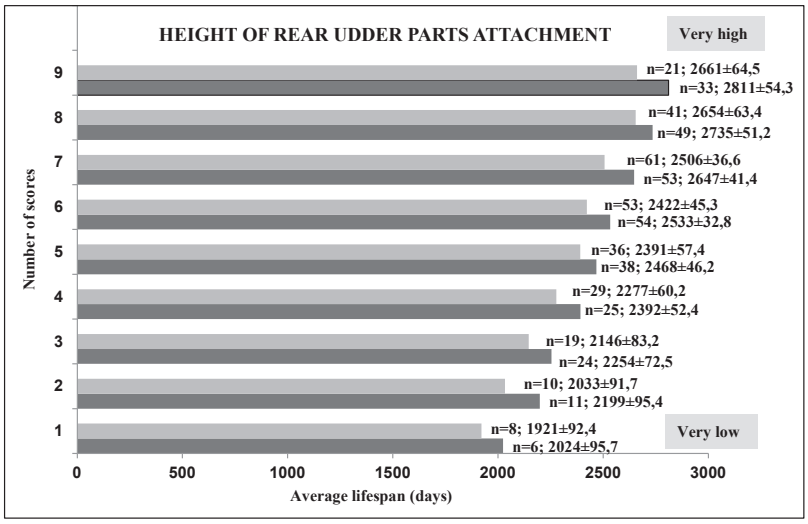


Fig. 2. Correlative variability of the score assessment descriptive type trait «height of rear udder parts attachment» with lifespan of cows in controlled breeds

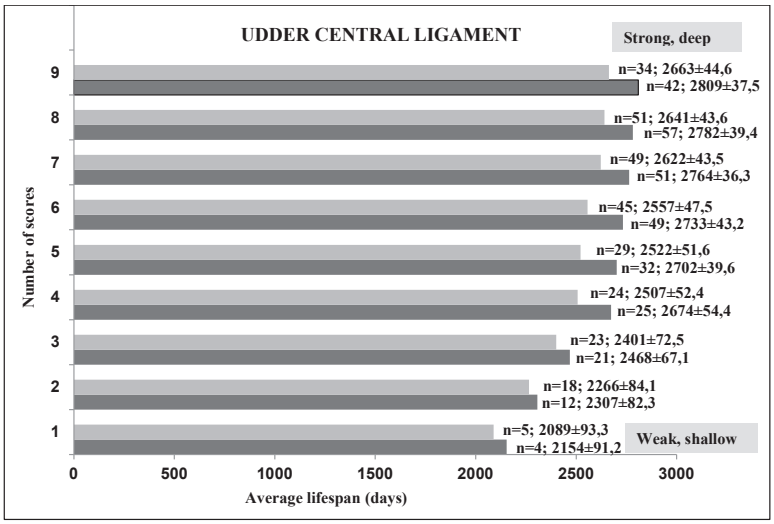


Fig. 3. Correlative variability of the score assessment descriptive type trait «udder central ligament» with lifespan of cows in controlled breeds

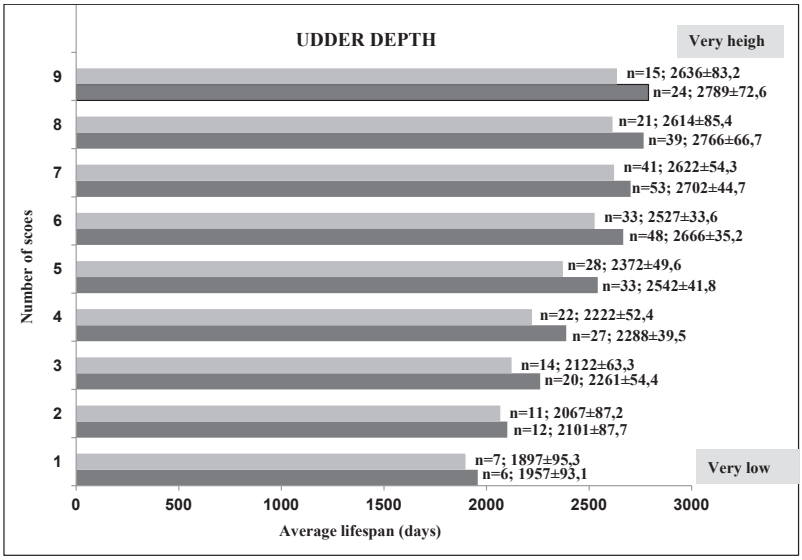


Fig. 4. Correlative variability of the score assessment descriptive type trait «udder depth» with lifespan of cows in controlled breeds

Another udder linear trait is the front teats placement, which is quite important both from the breeding and technological point of view (Fig. 5).The teats placement on the udder can be wide, almost square; wide front and narrow rear placement; close lateral at normal distance between teats of the left and right sides; close placement of all teats. Both very close (up to 6 cm) and very large (more than 20 cm) distance between teats top is undesirable. Teats located at an optimal distance (12-16 cm), in the center of udder parts, vertically directed downwards, cylindrical or conical shaped – best meet to requirements of machine milking (ICAR, 2018). In a linear classification system, very close or wide front and rear teats placement is undesirable trait development. However, if you choose from extreme options, the best is wide placement than a narrow one.

The diagram results show that lifespan of cows of both breeds in the herd of controlled farm, depending on the evaluation of front teats placement and characterized by slight curvilinear variability. Hence, cows of both breeds with an average score of 7 were used the longest time in the herd. In the future, there are deviations by an unreliable difference, towards a decrease in lifespan with scores of 8-9 and 6-5 with advantage of Holstein cows. A significant decrease in the lifespan of cows began with scores for this trait from 4 to 1.

Animals of the Ukrainian Black-and-White dairy breed rated at 7 score prevailed over five groups of cows with scores of 5-1, that was from 202 (P<0.01) to 872 (P<0.001) days and in cows of Holstein breed from 228 (P<0.01) to 891 (P<0.001) days.

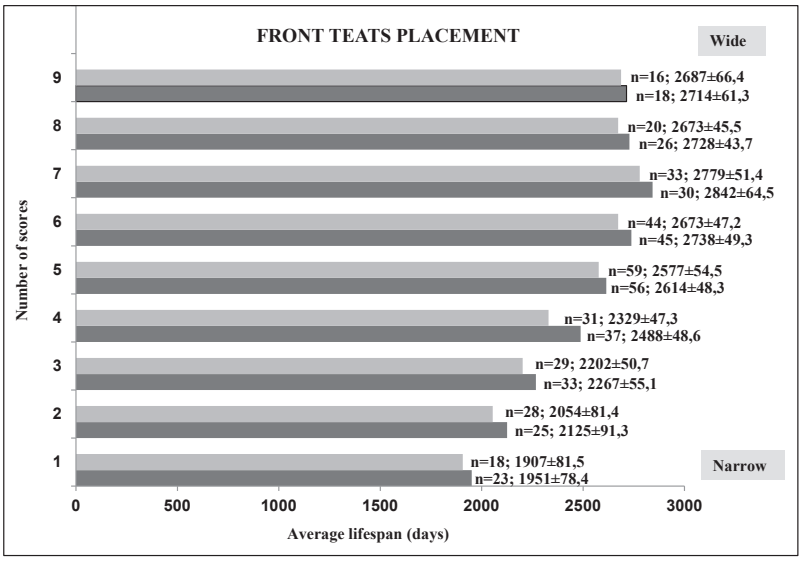


Fig. 5. Correlative variability of the score assessment descriptive type trait «front teats placement» with lifespan of cows in controlled breeds

The next linear udder trait is the teats length, which refers to technological traits. Modern dairy cattle of different breeds are characterized by different length indicators of the front and rear teats. According to studies (Stavetska and Klopenko, 2015), teats length in first-born cows of Ukrainian Black-and-White dairy breed is 5.6 cm and in Holstein breed 5.8 cm. By the data of researches (Pishchan, 2016) of morphological udder features of Swiss cows of various ecological origins at the age of first lactation, it was found that front teats length was 7.5 cm and rear teats 5.5 cm, teats length in cows imported from Austria was 6.7 and 5.8 cm, respectively. In Simmental first-born cows, these indicators for the front teats length were 6.7-7.5 cm and the rear 6.3-6.9 cm, depending on the year of evaluation (Dankiv and Kohut, 2016). Studies of first-born cows of the Ukrainian Black- and Red-and-White dairy breeds (Kovalchuk, 2006) showed that front and rear teats length was 5.6-4.7 and 5.8-4.6 cm, respectively. In first-born cows of the Ukrainian Red dairy breed (Pronoza, 2014) front teats length varied within 6.15-6.69 cm and the length of rear ones – 5.75-6.0 cm.

Based on experimental data of linear evaluation and correlations between them and milk yield, the desired expression of the conformation type in first-born cows of the created Ukrainian Black-and-White dairy breed, in the general unity of the main descriptive body parts which are included in the linear classification system, according to which teats length should be 5 cm with a score of 5 (ICAR, 2018). Analyzing the studies indicators of cows of Ukrainian dairy and Holstein breeds, we can conclude that front and rear teats length likewise to the desired type, varying within 5-6 cm, which corresponds to 5-6 scores of linear evaluation.

Evaluation of the correlative variability of front teats length with the lifespan of cows in controlled breeds indicates that long functional life was in cows with an average score 5, which is equal to the teats length in 5 cm. An increase in the score for this trait to 6-9 in cows of the Ukrainian Black-and-White dairy breed had little effect on lifespan, from 42 to 269 days, with a minimum degree of reliability at P<0.05 compared with groups of animals rated at 8 and 9 scores. A similar comparison of Holstein cows rated at 5 scores

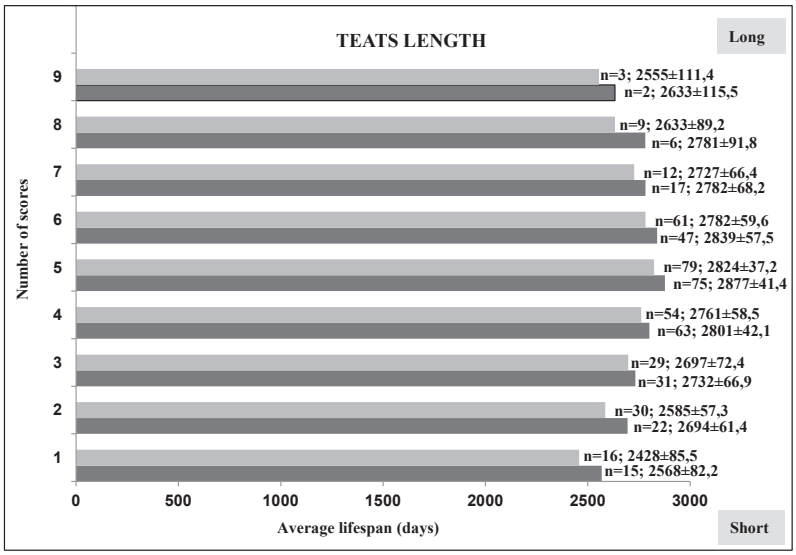


Fig. 6. Correlative variability of the score assessment descriptive type trait «teats length» with lifespan of cows in controlled breeds

with groups of animals with 6-9 scores showed a difference within 38-241 days with reliability only in comparison with animals with 9 scores at P<0.05. The decrease in the evaluation caused a slightly lower lifespan in cows of both breeds with reliability only when compared with a group of animals rated at 1 score on 396 (UBWD; P<0.001) and 309 (H; P<0.001) days and 2 scores with a difference of 239 (UBWD; P<0.001) and 183 (H; P<0.05) days, respectively.

Summarizing the research results it is important to note that each of the evaluated descriptive traits in cows of both breeds has an impact on the lifespan with different variability within each individual body part.

Conclusions. The correlative variability of the scoring of linear traits characterizing the morphological structure of the udder and the lifespan of cows in a comparative analysis of the Ukrainian Black-and-White Dairy and Holstein breeds was established. With a slight advantage and, in some cases, with a reliable difference, animals of the Holstein breed had an advantage over the Ukrainian Black-and-White dairy cattle in terms of lifespan, depending on the evaluation of the udder linear traits. The degree of correlative variability between the level of evaluation of the morphological body parts of the udder and the lifespan of animals depended on a individual linear trait, the best development of which may be a trait of selection as an indirect predictor of longevity. To increase the lifespan of dairy herd cows, it is important to select sires with a high type score, especially considering the desired development of udder linear traits in their daughters.

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Тривалість життя корів молочної худоби залежно від рівня оцінки лінійних ознак вимені

Досліджено залежність тривалості життя корів української чорно-рябої молочної (УЧРМ) та голштинської (Г) порід від рівня оцінки лінійних ознак, які характеризують морфологічні якості вимені у загальній системі лінійної класифікації типу. Оцінювали описові ознаки екстер'єрного типу: прикріпленням передніх часток вимені, висоту прикріплення задніх часток, центральну зв'язку, глибину вимені, розташування та довжину передніх дійок. Встановлено певну співвідносну мінливість між рівнем оцінки лінійних ознак та тривалістю життя тварин. Високо-

достовірна різниця між коровами, оціненими за ознаку прикріплення передніх часток вимені в один та дев'ять балів, досить значна і становила 841 (УЧРМ; P<0,001) та 810 (Г; P<0,001) днів. Міжпородне порівняння тривалості життя корів, залежно від оцінки, свідчить на користь корів голштинської породи з мінливістю у межах 43-159 днів за недостовірної різниці. Різниця між найнижчою та найвищою оцінками за ознаку висоти заднього прикріплення вимені у корів піддослідних порід становила 740 (УЧРМ; P<0,001) та 810 (Г; P<0,001) днів. Тварини з оцінкою за розвиток центральної зв'язки вимені нижчою за 1-3 бали живуть, відповідно до оцінюваних порід, від 2089 до 2401 (УЧРМ) та від 2154 до 2468 (Г) днів. Корови з оцінкою дев'ять балів обох порід відрізняються найвищою тривалістю життя – 2663 дні (УЧРМ), поступаючись коровам з самою низькою оцінкою на 754 дні (P<0,001) та 2803 дні (Г) з достовірним перевищенням на 649 днів (P<0,001). Різниця між середньою тривалістю життя корів з оцінкою дев'ять балів та оцінкою в один бал за глибину вимені становить у корів української чорно-рябої молочної породи 739 днів (P<0,001), у корів голштинської – 832 дні (P<0,001). Тривалість життя корів обох порід у стаді залежно від оцінки за розташування передніх дійок характеризується незначною криволінійною мінливістю. Тобто, найдовше використовуються у стаді корови обох порід з середньою оцінкою 7 балів. Оцінка співвідносної мінливості довжини передніх дійок з тривалістю життя корів підконтрольних порід свідчить про те, що довше функціональне життя було у корів з середньою оцінкою п'ять балів, що дорівнює їхній довжині на рівні 5 см. Результати досліджень свідчать, що кожна із оцінюваних описових ознак у корів обох порід чинить вплив на тривалість життя з різною мінливістю у межах конкретної статі, тому краще вираження ознаки може бути ознакою добору у якості непрямого предиктору довголіття.

Ключові слова: *українська чорно-ряба молочна порода, голштинська, лінійні ознаки типу, тривалість життя.*