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LIFESPAN OF UKRAINIAN BROWN COWS OF DAIRY BREED DEPENDING ON THE EVALUATION LEVEL OF UDDER LINEAR TRAITS

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Morphological udder traits of dairy cows occupy a leading place in the system of linear classification of dairy cattle with the highest weighting factor of 40 %. Such a significant attention to the udder evaluation explained by the existence of a correlative relationship between the udder descriptive linear traits and milk productivity, especially with the functional life duration of dairy cows. In this regard, research results presented in this article on the study of influence the evaluation level of udder linear traits on the cows' lifespan of Ukrainian brown dairy breed are sufficiently motivated and relevant. The evaluation of first-born cows by type was conducted in the advanced farms of Sumy region using the method of linear classification. We took into account the results of evaluation of descriptive traits on a 9-score scale. Five descriptive udder traits included in the linear classification system were studied: front udder attachment, rear udder attachment height, central ligament, udder depth and location of front teats. The research results proved the existence of a reliable correlation between the udder morphological traits and cows' lifespan of controlled herds. It was established that each of evaluated linear traits exerted its influence on the cows' lifespan with different correlative variability of scores within each evaluated trait. The front udder attachment evaluation showed a difference of 654 days between cows scored 1 and 9 (P<0.001). The difference between evaluation the trait of rear udder attachment height in 1 and 9 scores was 610 days (P<0.001). First-born cows (17.3%) with scores for the condition of central udder ligament downward from the average (1–4 scores) had a lifespan of 2436–2156 days, while the same age group with the highest score of 9 differed a high functional life – 2786 days. The advantage was 350-630 days (P<0.001). In evaluated cows with the udder located the highest relative to the hock, with a score of 8, the difference in lifespan, compared to animals with lowered udder, was 597 days (P<0.001). First-born cows with the trait of front teats location with an average score of 5 had a longer lifespan by 156–484 days (P<0.001) compared to the same age cows with scores from 4 to 1.

Key words: *Ukrainian brown dairy breed, first-born cows, udder, linear type traits, lifespan.*

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Evaluation of dairy cattle by udder quality features is most important element in the linear classification system. Since, of comprehensive evaluation of dairy cows by 4 groups of conformation traits, with their independent assessment by 100-score system, the largest share – 40% in the final score occupied the set of morphological traits characterizing udder. Such close attention to the evaluation of udder morphological traits is explained, on the one hand, by adaptation of udder to existing machine milking technologies, and, on the other hand, by correlation between udder linear traits and indicators of dairy productivity and longevity of cows (Campos et al., 2012; Caraviello et al., 2004; Khmelnychyi, 2018; Khmelnychyi et al., 2008; Khmelnychyi & Vechorka, 2015; 2016; 2018; Novotný et al., 2017; Zink et al., 2014). Therefore, the selection of cows by high scores of udder traits will improve milk productivity and lifespan of animals.

Studies (Khmelnychyi & Vechorka, 2015) were carried out in the aspect of determining relationship between of udder

linear traits evaluation and cows' lifespan of Ukrainian Black-and-White dairy breed. It was found that cows with higher scores for condition of development udder morphological traits – strength of front parts attachment (8 scores), height of rear parts attachment (8 scores), central ligament prominence (9 scores) and udder depth (9 scores), had a significant advantage in lifespan, exceeding animals with the lowest score by 762-970 days. According to the evaluation of conformation linear trait – front teats placement, cows with score of 5 for this trait development were used the longest in herd of the farm.

Research conducted with the aim to determine relationship between evaluation of udder linear traits and cows' lifespan in the herd of breeding farm AF "Mayak" of Zolotonosha district in Cherkassy region on livestock of Ukrainian Red-and-White dairy breed (Khmelnychyi & Vechorka, 2016). It was found that by linear evaluation of the front udder parts attachment (9 scores), animals were used in the herd on 710 days longer than cows with 1 score. Cows with an evaluation based on trait height of rear udder parts attachment lived on 687 days longer. Animals evaluated for development of central udder ligament lower than average (1-4 scores) were used from 1688 to 1832 days. Cows with a central ligament score of 9 had a higher lifespan on 2377 days, exceeding cows with the lowest score by 702 days. It has been established that cows with a high udder placement are much less at risk of injury and disease and are used in the herd longer. The difference between the average lifespan of cows scoring 9 and 1 for udder depth was 618 days.

By the studys' results of brown breeds in Sumy region (Lebedyn, Ukrainian brown dairy and Swiss), existence of reliable positive correlation between udder descriptive traits and milk yield for the first lactation was determined (Ladyka & Khmelnychyi, 2017). Positive and reliable relationship with milk yield observed to the fore (r = 0.204 ... 0.418) and rear parts attachment (r = 0.136 ... 0.367) and udder depth (r = 0.195 ... 0.339).

The long-term use of cows, in addition to the economic component, acquires special importance when conducting selectional-breeding work, since the duration of economic use is closely related to the rate of herd repair, and hence the intensity of selection. Premature culling of cows not only reduces breeding resources of breeds, but also causes economic damage to the industry as a whole, since costs of raising high-yielding cows begin to pay off only after the third calving. If the average duration of breeding stock use would less than 2.5 lactations, mothers will start to leave the herd before their daughters give birth. In such situation, the herd will stop exist as an integral biological system and its disintegration will occur (Khmelnychyi, 2016).

Breeders in many countries recognized the economic importance of cows' lifespan, calculated genetic parameters of longevity and included them in the breeding programs for dairy cattle development (Forabosco et al., 2009). However, direct selection for longevity traits is limited by the time required to obtain records, usually after death of cows (Lagrotta et al., 2010) and low heritability ranging between 0.03 to 0.13 (Daliri et al., 2008; Novotný et al., 2017; Zavadilová et al., 2009).

Therefore, significant number of researchers evaluated a possibility of using linear type traits as alternative indirect predictors of longevity due to the existence of favorable genetic correlations (Daliri et al., 2008; García-Ruiz et al., 2016; Novotný et al., 2017; Zavadilová et al., 2010; Zink et al., 2014). Linear type traits are obtained at an early stage and monitored around productive life; they are easily measured and have higher heritability than longevity, from 0.08 to 0.59 (Campos et al., 2012; Daliri et al., 2008; Novotný et al., 2017).

Based on the evaluation of primiparous cows in the population of Czech Holstein cows, researchers (Zink et al., 2014) found the largest positive genetic correlation by udder width and fat yield (0.51±0.04). The strongest negative phenotypic correlations were among udder depth, milk yield and protein yield (both -0.17), while the strongest positive phenotypic correlations were between milk yield, protein yield and udder width (both 0.32).

Studys' results of Czech Simmental cows indicate that such udder traits as front part length, height of rear part attachment and front teats placement have a high influence on cows' lifespan (Novotný et al., 2017). Highest genetic correlations between type traits and functional longevity found for final udder score (0.25) and udder depth (0.33), confirms that these traits can serve as indicators of functional longevity. Similar data obtained when studying Holstein cows USA regarding effect of udder traits – depth, front attachment and central ligament on functional longevity (Caraviello et al., 2004).

By the research of Canadian dairy cattle, was established that typical traits, which have the highest influence on cows' lifespan, are traits related with udder parts: front udder attachment, texture, udder depth, udder rear part height attachment, udder rear part width attachment and central ligament (Morek-Kopec & Zarnecki, 2012; Sewalem et al., 2008). Similar results were obtained by linear evaluation of Czech Holsteins. In accordance to which, cows with well attached front udder part, high attached rear part, strong central ligament, front teats close placement and teats moderate length showed the longest functional productive life ($P<0.05–0.001$) (Vacek et al., 2006).

An analysis of linear traits influence on the longevity of Croatian Simmental cattle showed that low scores for length of udder front part related with a lower risk of culling. Conversely, cows with lower scores for traits of udder depth, central ligament, udder rear part length, and teat thickness were more likely to be culled than animals with higher scores (Jovanovac & Raguž, 2011).

Considering that profitability of dairy cattle breeding industry significantly depends on indicators of economic use duration, which accordingly effect of animals lifelong productivity, selection and technological importance of development of udder morphological traits of dairy cattle, we set the task to study the impact of scores of udder descriptive linear traits on cows' lifespan.

Materials and research methods. The conformation type of primiparous cows was evaluated according to the linear classification method (Khmelnychyi et al., 2008) in the leading farms of Sumy region for the breeding of Ukrainian brown dairy breed: PJSC "Plemzavod "Mykhailivka" of Lebedynskyi, PAF "Kolos" and SE "Pobyeda" of Bilopolskyi, and breeding breeders – ACJSC "Zorya" of Okhtyrskyi and ACJSC "Mayak" in Trostyanetskyi districts.

The exact description of each linear descriptive type trait clearly defined. A full range of scores was used to identify intermediate and extreme values for each trait. The evaluation parameters based on the expected extreme biological values of the cow during the first lactation. The scale covers the extreme biological indicators of this population. Eighteen defined mandatory linear descriptive traits of the cow type were evaluated on a single 9-score scale. The average trait severity was estimated at 5 scores, and biological deviations towards minimum development are reduced to 1 score. If the trait development was approaching in maximum prominence, it increased to 9 (ICAR, 2014). The cows' lifespan was determined by the number of days from birth to leaving the herd. The experimental indicators worked out on the formulas given by O.G. Blyznyuchenko (2003).

According to the descriptive method of 9-score scale, 7 udder morphological traits were evaluated from the mandatory 18 linear traits, but we will characterize only the 5 most important in terms of selection and technology: front attachment, rear attachment height, central ligament, udder depth and front teats placement.

Research results. The results of studies of primiparous cows based on the evaluated 5 udder linear traits proved the reliable influence of the score indicators on their further lifespan (Fig. 1–5).

The first udder linear trait is front part attachment. This trait evaluated by the angle formed at the junction of the udder with belly. The best trait development characterized by a gradual transition of udder glandular tissue into the belly with help of connecting lateral ligaments and formation of an obtuse angle above 161^0 (Khmelnychyi, 2007). Strong attachment of the udder front parts prevents it from sagging with age. It is important to note that cows with a strong forepart attachment tend to have a tub-shaped udder with well-developed front parts, which closely correlated on productive life. Thus, according to the evaluation cows of brown Swiss dairy breed of America, which was the parent when creating Ukrainian brown dairy breed, a close correlation was determined between the udder front parts attachment and longevity (r = 0.44) (Gibson & Dechow, 2018). It was established (Du Toit et al., 2012) that duration of functional life of Jersey breed depended on the strength of attachment the udder front parts with correlation coefficients between these traits of 0.23 for the first lactation, 0.63 for the second and 0.33 for the third and longevity of Polish Holsteins (r = 0.10) (Sawa et al., 2013).

Our research results on determining the relationship between the score for attachment of udder front part and lifespan presented in the diagram (Fig. 1). They testify about significant influence of this trait on the animals' longevity. The difference between cows scored of 1 and 8 was 681 days (P<0.001). Extreme deviations by the evaluation of this trait, especially towards its undesirable condition, are quite insignificant, with a score of 1–4 for 64 heads, which was only 20.9%. In general, animals at the age of the first calving are characterized by this, quite important in the technological aspect a trait from average development to desirable. In addition to the supporting function, the strength of front parts attachment closely related to milk yield, with correlation coefficients: 0.355±0.051 according to evaluation cows of Holstein breed (Khmelnychyi et al., 2018); 0.326 – Ukrainian Black-and-White dairy (Khmelnychyi, 2018); 0.368±0.053 – Ukrainian Red-and-White dairy (Khmelnychyi, et al., 2015).

It was also reported (Khmelnychyi, 2018) that attachment of the udder front parts closely correlated with group traits sets of primiparous cows of Ukrainian Black-and-White

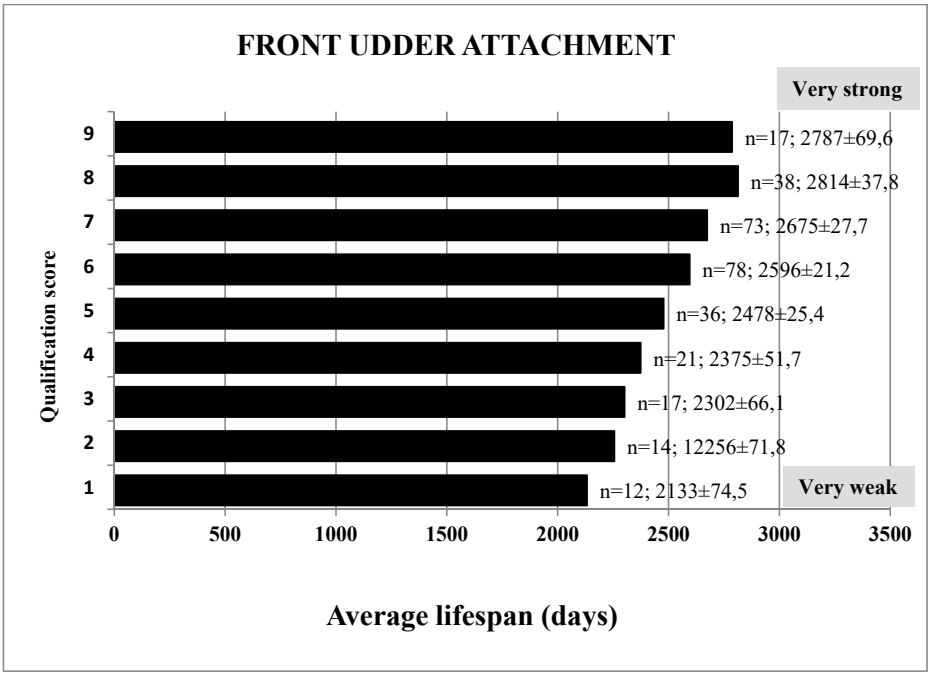

Fig. 1. Correlative variability of the 9-score evaluation of descriptive type trait "front udder attachment" and cows' lifespan

dairy breed in Sumy region, characterizing the dairy type of animals (r = 0.472), body (r = 0.436), limbs (r = 0.246), udder (r = 0.439) and final type score (r = 0.518) with reliability at P<0.001. Similar data obtained in the study cows of Ukrainian Black-and-White dairy breed, only in Cherkassy region (Khmelnychyi & Vechorka, 2017). With correlation coefficients between attachment of the udder front parts and dairy type (r = 0.401; P < 0.001), body (r = 0.298; P < 0.001), limbs (r = 0.125; P < 0.05), udder (r = 0.432; P < 0.001) and final score (r = 0.440; P < 0.001).

Height of udder attachment at the rear, performing a supporting function, is also an indicator of the cow potential to high productivity (Khmelnychyi, 2007). This statement substantiated by many studies on the evaluation of relationship between linear traits and milk production indicators. Thus, according to the study results of brown Swiss breed, a genetic correlation between the height of udder rear part and milk yield (r = 0.20) was established (Gibson & Dechow, 2018). It was reported (Du Toit et al., 2012) that height of udder attachment at the rear positively related to the functional life in herd of Jersey breed with correlation coefficients 0.28 for the first lactation, 0.54 for the second and 0.37 – for the third and real longevity of Czech Simmentals (r = 0.28) (Zavadilová et al., 2009).

According to our research results, the difference between a low grade for this trait (1 score) and the highest (9 scores) was 610 days (Fig. 2), with the highest duration use of cows with very high udder attachment – 2798 days, which was consistent with similar studies of Holstein cows of Canadian breeding (Samoré et al., 2010).

One of the most important breeding and functional udder traits in cows of dairy cattle – the central ligament. A connective tissue membrane, dividing the udder into left and right sides, forms it. Its main function is to support the udder at the appropriate height. The ease of milking and its prevention from the possibility of injury depends on the height of udder. An udder located very high, with a deep, strong, well-defined furrow, rising up close to the attachment place – the best prominence of the trait with a 9 score.

However, in addition to the main supporting function, a good prominence of the central ligament correlated with value of cows' milk yield, which confirmed by the results of experiments. The correlation between these traits in brown cows of different origin was within 0.108-209 (Ladyka & Khmelnychyi, 2017), Ukrainian Black-and-White (r = 0.109-212) (Khmelnychyi & Vechorka, 2015) Ukrainian Red-and-White dairy (r = 0.366) (Khmelnychyi, 2018) and Holstein (r = 0.311) (Khmelnychyi et al., 2018). The evaluation of central ligament also correlated with longevity (r = 0.11) (Zavadilová et al., 2009). The indicators of the diagram (Fig. 3) show that the average cows' lifespan depended significantly on the evaluation for this trait.

Animals (n = 53; 17.3%) with a score for the condition of udder central ligament lower than average (1-4 scores) are used from 2436 to 2156 days. While cows with the highest score of 9 have high longevity – 2786 days, exceeding cows with scores of 1-4 by 350-630 days (P<0.001).

In the system for evaluating udder descriptive traits, an important selection and technological trait is the udder depth, which evaluated by the distance between of bottom position relative to a conventional line drawn at the hock joint level. Since a deep, sagging udder causes a lot of inconvenience during machine milking, it is often injured and more favorable to the disease of mastitis.

A favorable genetic correlation was established between udder depth and number of somatic cells in milk

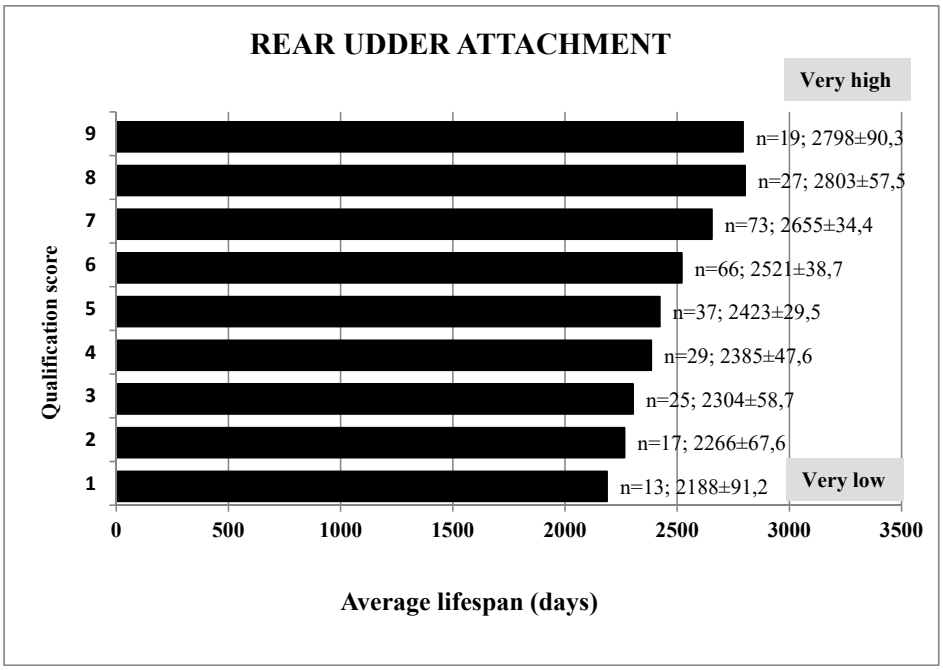

Fig. 2. Correlative variability of the 9-score evaluation of descriptive type trait "rear udder attachment" and cows' lifespan

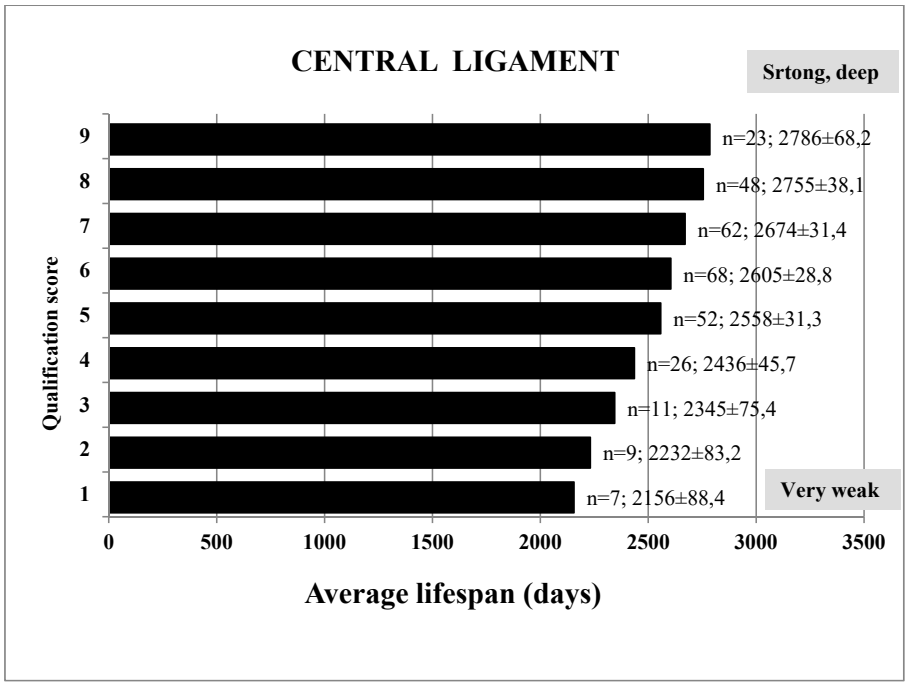

Fig. 3. Correlative variability of the 9-score evaluation of descriptive type trait "central ligament" and cows' lifespan

(r = -0.26) of brown Swiss cows of American breeding (Gibson & Dechow, 2018). Functional longevity had a strong positive genetic correlation with udder depth (r = 0.42) in Italian brown Swiss cows (Samoré et al., 2010) and Czech Simmentals (0.33) (Novotný et al., 2017). Furthermore, functional longevity had a strong positive genetic correlation with udder depth (0.42±0.10) in Italian brown Swiss dairy cattle (Samoré et al., 2010), with udder depth and longevity r = 0.28 (Zavadilová et al., 2009) in cows of Czech Simmental breed.

Expert bonitors in the classification process gave preference to animals with a higher udder placement. At the same time, considered traits that ensure its sufficient volume – the rear width and length of front part (Khmelnychyi. 2007). The indicators of diagram (Fig. 4) show that cows of Ukrainian brown dairy breed, in which udder is located high, are used much longer in the herds of controlled farms. In terms of lifespan, difference in favor of cows with the highest udder position relative to the hock, with a score of 8, compared to animals with the lowest udder placement, was 597 days (P<0.001).

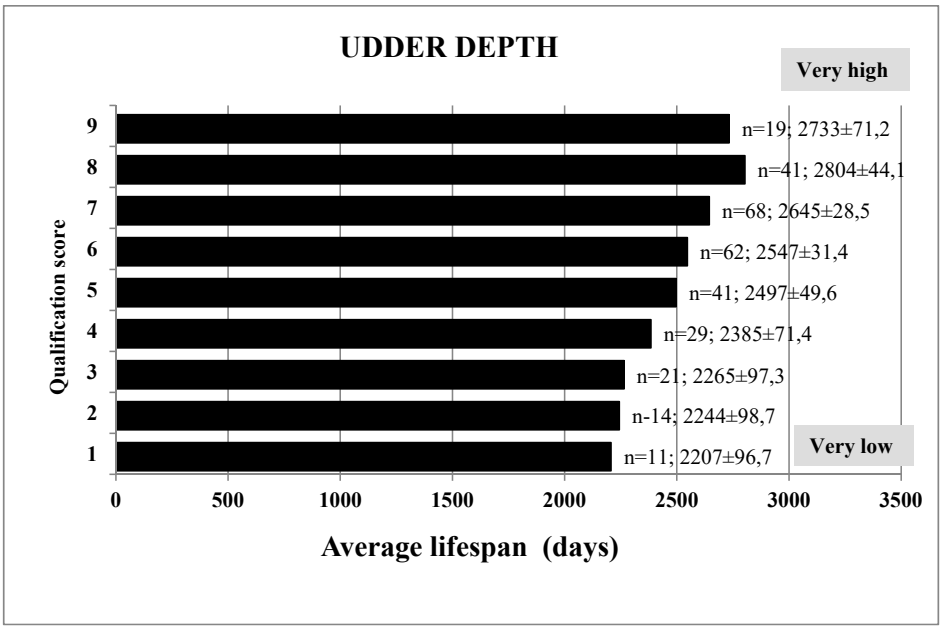

Fig. 4. Correlative variability of the 9-score evaluation of descriptive type trait "udder depth" and cows' lifespan

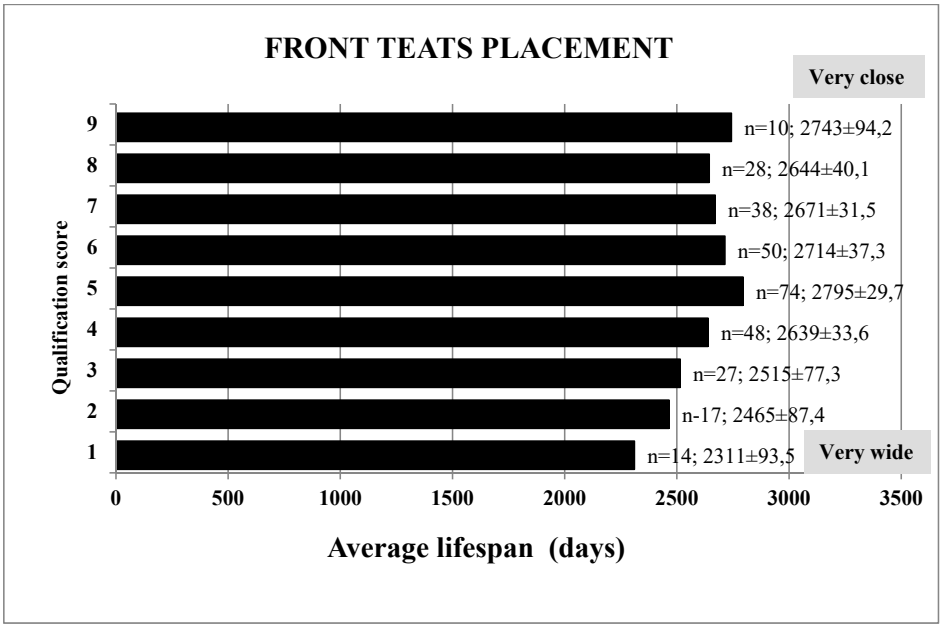

Fig. 5. Correlative variability of the 9-score evaluation of descriptive type trait "front teats placement" and cows' lifespan

The next linear udder trait – the front teats placement, which is quite important both from a selection and from technological point of view (Fig. 5). Teats that are located at the optimal distance from each other placed in the center of udder parts, vertically directed downwards, cylindrical or slightly conical in shape – are the desired development of the trait and best meet to technological requirements of machine milking. Very close or very wide placement both the front and rear teats is not the best development of conformation traits.

The diagram results show that cows with front teats placement scores of 5 to 9 were used the longest. A significant decrease by the index in cows' lifespan began with evaluation for this trait from 4 to 1 scores. Significantly, higher productivity was obtained from cows with placement of front and rear teats inside the quarter (linear scoring 6-9) in Holstein cattle of Latvia (Lāsma et al., 2016).

The difference in cows' lifespan rated at 5 compared to scores from 4 to 1 turned out to be highly reliable and amounted to 156-484 days (P<0.001).

Because of the search for longevity predictors of dairy cattle, many scientists from far abroad (Cruickshank et al., 2002; Du Toit et al., 2012; Forabosco et al., 2009; Jovanovac & Raguž, 2011; Kern et al., 2015; Sasaki, 2013) made an important conclusion that thanks to the use of linear type evaluation, the functional longevity of cows can be improved. This conclusion based on the existence of positive correlations between the evaluation of linear traits and lifespan, on their high heritability in contrast to the low heritability of lifespan indicators for cows of dairy breeds.

Conclusions. Based on the research results established that each of the evaluated linear udder traits had an impact on the cows' lifespan that distinguished by different relative variability of scores within each individual conformation trait. In order to increase cows' longevity of Ukrainian brown dairy breed, when selecting sires, it was necessary to consider their conformation profiles and degree of development indicators of linear evaluation of the morphological udder traits of their daughters, which will allow to increase the frequency of occurrence of desired development the morphological udder traits.

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Тривалість життя корів української бурої молочної породи залежно від рівня оцінки лінійних ознак вимені

Морфологічні ознаки вимені корів молочної худоби займають провідне місце в системі лінійної класифікації молочної худоби з найвищим ваговим коефіцієнтом 40%. Така значна увага до оцінки вимені пояснюється існуванням співвідносного зв'язку між описовими лінійними ознаками вимені та молочною продуктивністю та, особливо, з тривалістю функціонального життя корів молочних порід. У зв'язку з цим наведені результати досліджень у цій статті з вивчення впливу рівня оцінки лінійних ознак вимені на тривалість життя корів української бурої молочної породи є достатньо вмотивованими та актуальними. Оцінку корів-первісток за типом здійснювали у провідних господарствах Сумської області за методикою лінійної класифікації. Враховували результати оцінки описових ознак за 9-ти бальною шкалою. Досліджено п'ять описових ознак вимені, які включенні до системи лінійної класифікації: переднє прикріплення вимені, висота прикріплення вимені ззаду, центральна зв'язка, глибина вимені та розташування передніх дійок. Результати досліджень засвідчили існування достовірного співвідносного зв'язку між морфологічними ознаками вимені та тривалістю життя корів підконтрольних стад. Встановлено, що кожна із оцінюваних лінійних ознак справляє свій вплив на тривалість життя корів з різною співвідносною мінливістю оцінок у межах кожної оцінюваної ознаки. Оцінка переднього прикріплення вимені показала різницю між коровами, оціненими в один та дев'ять балів, становила 654 дені (P<0,001). Різниця між оцінкою за ознаку висоти прикріплення вимені ззаду в 1 бал та 9 балів склала 610 днів (P<0,001). Корови-первістки (17,3%) з оцінками за стан центральної зв'язки вимені нижчими за середню у бік зниження (1-4 бали) мали тривалість життя у межах 2436-2156 днів, тоді як ровесниці з найвищою оцінкою у 9 балів відрізнялися високим функціональним життям – 2786 днів. Перевага склала при цьому 350-630 днів (P<0,001). В оцінених корів з вим'ям, яке розташоване найвище відносно скакального суглоба, з оцінкою у вісім балів, різниця за тривалістю життя, у порівнянні з тваринами із максимально низько опущеним вим'ям, склала 597 днів (P<0,001). Корови-первістки з ознакою розташування передніх дійок з середньою оцінкою у п'ять балів, мали довше тривалість життя на 156-484 дні (P<0,001) у порівнянні з ровесницями з оцінками від чотирьох до одного балу.

Ключові слова: *українська бура молочна порода, корови-первістки, вим'я, лінійні ознаки типу, тривалість життя.*