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RELATIONSHIP OF THE CULLING OF FIRST-BORN COWS FROM THE HERD WITH THE SCORE OF LINEAR TYPE TRAITS UNDER VARIOUS HOUSING

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The results obtained in breeding plants indicate the influence of the technology of housing primiparous cows on their score of linear type traits. The influence of this factor ranged from 0.4% ($p < 0.01$) to 2.9% ($p < 0.001$). It was found that when stall housing, animals with a high assessment of body depth, angularity, and rear legs had a lower percentage of abandonment from the herd compared to animals with an average and low assessment of these traits ($p < 0.05$). The results obtained when determining the percentage of abandonment of cows with different score of fore udder attachment indicate a greater stayability of first-born cows with a high assessment of this trait, which was 7.5-11% higher compared to animals with a lower score. The assessment of the central ligament of the udder (1.3%; $p < 0.05$) and the depth of the udder (1.3%; $p < 0.05$) had a probable impact on the abandonment of first-born cows from the herd. The number of animals that left the herd during the study period with a low assessment of the central udder ligament was higher by 0.7-13% compared to animals with a high and average assessment. A similar relationship between the loss of animals was established with the assessment of the depth of the udder (by 8.8-17.1%). The culling of first-born cows depending on the assessment of body structure traits in free housing, according to our data, probably depended only on one factor - the slope of the sacrum. The strength of the impact of the assessment of this trait was 2.9%. It is important to note that the percentage of animals leaving the herd with an average assessment of the slope of the sacrum was the lowest. When comparing the trends in the influence of the body structure traits of first-born cows on the level of their loss from herds under different methods of maintenance, it was found that, unlike tied housing, under free housing, there was a tendency to increase the percentage of culling first-born cows with a high growth assessment. Also, cows with a wide chest and a deep body had the highest risk of culling compared to the group of animals with average linear score indicators. There was a slight decrease in the percentage of culling of first-born cows with an increase in the score for the dairy type in both housing methods, animals with the desired posture of the hind limbs and a high score of the central ligament of the udder and body condition.

Keywords: dairy cattle, housing technology, body type traits, survival, culling.



ЗВ'ЯЗОК ВИБУТТЯ КОРІВ-ПЕРВІСТОК ІЗ ЛІНІЙНОЮ ОЦІНКОЮ ТИПУ БУДОВИ ЇХ ТІЛА ЗА РІЗНИХ ТЕХНОЛОГІЙ УТРИМАННЯ

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Отримані у племінних заводах результати вказують на наявність впливу технології утримання корів-первісток на будову їх тіла. Сила впливу цього чинника коливалась від 0,4 % ($p < 0,01$) до 2,9 % ($p < 0,001$).

Встановлено, що за прив'язного утримання тварини з високою оцінкою глибини тулуба, кутастості, постави задніх кінцівок мали менший відсоток вибуття зі стада у порівнянні з тваринами із середньою та низькою оцінкою цих ознак ($p < 0,05$). Результати отримані при визначенні відсотка вибуття корів із різною оцінкою висоти прикріплення задніх часток вимені вказують на більшу збереженість первісток із високою оцінкою даної ознаки, яка була на 7,5-11 % вищою у порівнянні з тваринами, які мали нижчу оцінку. Вірогідний вплив на вибуття первісток зі стада мала оцінка центральної зв'язки вимені (1,3 %; $p < 0,05$) та глибини вимені (1,3 %; $p < 0,05$). Кількість тварин, які вибули зі стада в досліджуваній період, із низькою оцінкою центральної зв'язки вимені була вищою на 0,7-13 % у порівнянні з тваринами з високою та середньою оцінкою. Аналогічний зв'язок вибуття тварин встановлено з оцінкою глибини вимені (на 8,8-17,1 %). Вибуття первісток залежно від оцінки ознак будови тіла за безприв'язного утримання за нашими даними вірогідно залежало лише від однієї статі – нахилу крижів. Сила впливу оцінки цієї ознаки становила 2,9 %. Важливо відзначити, що відсоток вибуття тварин зі стада з середньою оцінкою нахилу крижів був найменший.

При порівнянні тенденцій впливу ознак будови тіла первісток на рівень їх вибуття зі стад за різних способів утримання встановлено, що на відміну від прив'язного за безприв'язного утримання спостерігалась тенденція збільшення відсотка вибракування первісток із високою оцінкою росту. Також найвищий ризик вибуття мали корови з широкою грудною клітиною та глибоким тулубом порівняно з групою тварин із середніми показниками лінійної оцінки. Спостерігалось незначне зменшення відсотка виракування первісток із підвищенням оцінки за молочний тип за обох способів утримання, тварин із бажаною поставою задніх кінцівок та високою оцінкою центральної зв'язки вимені та вгодованості.

Ключові слова: молочна худоба, технологія утримання, ознаки типу будови тіла, збереженість, вибуття.

Introduction. The practice of using cattle has convincingly shown that the economic efficiency of milk production largely depends on the duration of its productive longevity (Pidpala T. and Zaitsev Ye., 2018). Intensification of dairy cattle breeding leads to a significant reduction in the life span of cows, as a result of which the average term of their use on dairy farms is limited to only 3-4 lactations (Karatieieva O. I., 2019). Therefore, the modern approach to improving dairy cattle is shifting from milk production traits to functional traits, such as longevity and body type traits (Tapki I. and Guzey, Y. Z. 2013; Stanojević D. et al., 2018). Although body type traits have low to medium



heritability (Bohlouli M. et al., 2015; Susanto A. et al., 2018), they are registered in a single database, which makes them reliable and relatively inexpensive for inclusion in national cattle breeding programs (Němcová E. et al., 2011). Therefore, the selection of animals by exterior type is of leading importance in the aspect of genetic improvement of herd productivity and longevity of cows (Camara Y. et al., 2019; Rodriguez-Bermudez R. et al., 2019). Only animals with good health, adapted to the harsh conditions of use in industrial complexes, can guarantee high lifetime productivity and longevity (Berry D. P. 2018; Kern E. L. et al., 2015). Improved lifespan of dairy cows is associated with increased profitability due to reduced need for replacement heifers to maintain herd size, higher average herd productivity (Williams M. et al., 2022) and greater opportunity for selective culling (van Pelt M. L., et al., 2015). In studies by foreign scientists, it was reported that the location of the front teats, udder depth, front udder attachment and location of the rear teats had a greater impact on cow culling compared to other linear type traits (Imbayarwo-Chikosi V. E. et al., 2016). Other researchers have estimated a higher risk factor for animals with deep udders and weak and loose anterior and posterior attachments. The relationship between the stature of the posterior udder attachment and longevity (Zavadilová L. and Štipková M., 2012) and between the anterior udder attachment and longevity (Dube B. et al., 2009) has also been confirmed by other authors.

Limb and hoof problems, as well as other musculoskeletal problems, are the third most common problem and cause of culling of dairy cows after reproductive problems and mastitis (Sulayeman M. and Fromsa A., 2012; Kerslake J. I. et al., 2018). In numerical terms, losses due to lameness were associated with a decrease in milk yields of affected cows, which accounted for 40% of total losses, 34% of treatment costs and a decrease in conception rate – 26% (Olechnowicz J. and Jaskowski J. M., 2011). Extremely saber-shaped legs and low hoof angle also increased culling (Morek-Kopec M. and Zarnecki A., 2012).

Since scientists have established a high positive correlation between linear traits and longevity traits (Novotný L. et al., 2017), studying the relationship between traits of the body type of animals and their duration of economic use is a relevant task.

In this regard, the aim of the work was to study the dependence of the culling of first-born cows on the traits of their body type under different housing technologies.

Materials and methods of research. The work was carried out at the State Enterprises of the State Farm "Kutuzivka" and "Hontarivka" of the Kharkiv region and the State Enterprises of the State Farm "Stepne" and the Decembrists of the Poltava region. The first three enterprises are breeding plants for the Ukrainian black-and-white dairy breed, the fourth is the Ayrshire. The milk yield for one cow in the specified period was more than 6000 kg of milk. At the dairy complex of the State Farm "Kutuzivka" the first-born cows are kept free on long-term straw bedding. At the farms of the State Farm "Hontarivka", "Stepne" and the Decembrists of the State Farm "Agroprogress" they are kept tied.

To determine the patterns of influence of body type traits, a linear assessment of animals was carried out using the ICAR scale (Khmelnychyi L. M. et al., 2008). According to the linear assessment method, each of the traits had its own value and was evaluated with scores from 1 to 9. Scores 1 and 9 are the extreme values of the traits. The assessment was carried out visually. In the period 2013-2021, 569 first-born cows were assessed for tethered maintenance and 501 for free-range maintenance. Depending on the results of the assessment of individual linear features of the body structure type of animals, they were divided into 3 groups: low score - 1-3 points, average score - 4-6 points and high score - 7-9 points.



The percentage of cows leaving the herd was calculated as the ratio of the number of animals that left the herd in the period from the assessment of the body structure type of animals to their second calving. Analysis of variance was used to process the experimental data.

Research results. At the beginning of the research, differences in the assessment of first-born cows by the characteristics of the body structure type of animals under different technologies of their maintenance were considered (Table 1).

Table 1

Evaluation of first-borns by linear type traits and their culling rate under different housing ($\bar{x}\pm SE$), points

Indicators	Housing		Total	Effect size, %
	stall	free		
Stature	6,30±0,05	6,71±0,05	6,49±0,04	2,9***
Chest width	5,31±0,04	5,16±0,05	5,24±0,03	0,5**
Body depth	5,61±0,05	5,41±0,06	5,52±0,04	0,7**
Angularity	5,91±0,04	5,69±0,05	5,81±0,03	1,2***
Rump angle	5,09±0,04	5,37±0,04	5,22±0,03	2,2***
Rump width	5,23±0,04	5,36±0,05	5,29±0,03	0,4**
Rear legs	5,57±0,04	5,91±0,06	5,73±0,04	2,0***
Legs rear view	5,11±0,05	4,74±0,06	4,94±0,04	1,8***
Foot angle	3,99±0,04	4,25±0,05	4,11±0,03	1,5***
Fore udder attachment	4,92±0,07	5,38±0,08	5,14±0,05	1,8***
Rear udder height	5,06±0,05	4,69±0,05	4,88±0,04	2,6***
Central ligament of the udder	4,96±0,07	4,54±0,07	4,76±0,05	1,6***
Udder depth	5,78±0,06	5,44±0,06	5,62±0,04	1,6***
Front teat position	4,27±0,04	4,07±0,05	4,18±0,03	1,0***
Rear teat position	5,77±0,05	6,13±0,06	5,94±0,04	2,0***
Teat length	4,37±0,04	4,57±0,04	4,46±0,03	1,2***
Body condition	4,84±0,04	4,78±0,04	4,81±0,03	0,1
Number of cows that were eliminated before the second calving, %	0,23±0,02	0,15±0,02	0,19±0,01	1,0***

Note: ** $p < 0.01$; *** $p < 0.001$

According to the results of the analysis of variance, only for the assessment of body condition, insignificant differences were observed in the score of the characteristics of animals kept using tethered and untethered technologies. For all other indicators of linear assessment of the exterior, the differences were significant ($p < 0.05$). The influence of the method of keeping on these indicators of body structure ranged from **0.4% to 2.9%**.

First-born heifers that were kept on a leash had a higher score: for chest width by 0.15 points, body depth by 0.2 points, angularity by 0.22 points, pelvic limb posture by 0.37 points, posterior udder attachment by 0.37 points, central udder ligament by 0.42 points, udder depth by 0.34 points, and anterior teat placement by 0.2 points. Animals in free-range housing had a higher score on the linear scale: stature by 0.4 points, sacral slope by 0.28 points, sacral width by 0.13 points, pelvic limb



angle by 0.34 points, anterior udder attachment by 0.46 points, posterior teat placement by 0.36 points, and teat length by 0.2 points.

Next, it was examined how the culling of first-born cows depended on the assessment of linear features of their body structure in tethered housing (Table 2).

Table 2

Culling of first-born cows from the herd with different assessments of body structure indicators in stall housing ($x \pm SE$), %

Indicators	Score of linear type traits			Effect size, %
	1-3	4-6	7-9	
Stature	-	23,3±1,0	23,2±1,2	0,3
Chest width	16,7±5,7	23,3±0,8	21,7±2,2	0
Body depth	50,0±10,2	24,7±0,9	15,7±1,2	1,2*
Angularity	-	24,2±0,9	20,5±1,2	0,1
Rump angle	20,8±3,4	23,2±0,8	22,5±2,8	0
Rump width	18,2±3,2	23,4±0,8	22,0±2,4	0,1
Rear legs	55,6±8,2	22,7±0,8	21,9±1,6	0,9
Legs rear view	35,5±2,9	21,2±0,8	22,8±1,7	0,8
Foot angle	25,1±1,5	22,3±0,9	14,3±4,6	0,1
Fore udder attachment	28,1±1,7	20,7±1,0	23,1±1,6	0,5
Rear udder height	20,8±2,4	25,3±0,9	13,3±1,2	1,1*
Central ligament of the udder	26,0±2,0	25,3±1,0	13,0±1,1	1,3*
Udder depth	34,3±3,8	25,5±1,0	17,2±1,0	1,3*
Front teat position	23,6±1,6	23,1±0,8	-	0,2
Rear teat position	18,8±3,8	23,5±0,9	22,1±1,5	0,1
Teat length	23,2±1,8	22,7±0,8	36,4±7,0	0
Body condition	37,2±3,6	22,3±0,8	7,1±1,8	1,3*

Note: * $p < 0.05$

The results of the study showed that the number of animals that dropped out of the herd did not depend on the assessment of their stature and chest width. However, animals with a high assessment of body depth (7-9 points) had a lower percentage of dropping out of the herd by 9% and 34.3% (respectively) compared to the average (4-6 points) and low (1-3 points) assessment. Differences in the dropping out of animals with different body structure assessments for this factor were significant ($p < 0.05$), and the influence of the factor "keeping method" was 1.2%. Differences in the number of cows that dropped out of the herd with different angularity assessments were insignificant. A slight decrease in the percentage of dropping out was observed with an increase in the assessment of angularity, which characterizes the dairy type of animals. The dependence of the dropping out of cows on the assessment of the slope and width of the sacrum was not determined.

Animals with an average and high assessment of the posture of the hind limbs had somewhat better survival. However, the differences between the groups were not significant. The influence of the factor "pelvic limb angle" was 0.9%, and the factor "pelvic limb posture" was 0.8% ($p > 0.05$).

Important signs of the type of body structure, on which the milk productivity of animals depends, as well as the duration of their use, are the signs of the udder. A greater number of animals were removed from the herd with weak anterior attachment of the



udder (1–3 points), but the differences in the percentage of removal of 5-7.4% between these groups were not significant. The results obtained when determining the percentage of removal of cows with different assessments of the stature of attachment of the hind udder lobes indicate a greater survival of first-born cows with a high assessment of this sign. It was 7.5-11% higher compared to animals with an average and low assessment. The influence of this factor was 1.1% ($p < 0.05$).

The highest influence on the withdrawal of first-born heifers from the herd was the central ligament of the udder (1.3%; $p < 0.05$) and the depth of the udder (1.3%; $p < 0.05$). The number of first-born heifers that were withdrawn from the herd during the studied period with a low assessment of the central ligament of the udder was higher by 0.7-13% than in animals with a low and medium assessment. A similar relationship between the withdrawal of animals was established with the assessment of the depth of the udder (by 8.8-17.1%).

The withdrawal of first-born heifers did not significantly depend on the assessment of the placement of the front and rear teats, as well as their length.

The percentage of animals that were withdrawn from groups with a low assessment of body condition was significantly higher than in first-born heifers with a medium and high assessment (by 14.9-20.1%). The influence of the body condition assessment was 1.3% ($p < 0.05$).

The results of the first-born calves culling with different assessments of the linear indicators of their body type under free housing are given in Table 3.

Table 3

First-born calves culling from the herd with different assessments of body structure traits under free housing ($\bar{x} \pm SE$), %

Indicators	Score of linear type traits			Effect size, %
	1-3	4-6	7-9	
Stature	-	13,8±0,8	15,9±0,8	0,1
Chest width	16,7±3,3	14,6±0,6	17,0±1,9	0,1
Body depth	13,3±3,0	14,2±0,6	17,8±1,4	0,2
Angularity	14,3±4,6	15,3±0,7	13,8±1,0	0
Rump angle	33,3±6,4	12,4±0,5	28,6±2,6	2,9***
Rump width	22,2±5,8	14,7±0,6	15,7±1,6	0,1
Rear legs	11,8±2,5	15,1±0,7	15,1±0,9	0
Legs rear view	17,0±1,4	14,3±0,7	15,3±1,7	0,1
Foot angle	13,2±1,0	16,2±0,7	-	0,7
Fore udder attachment	13,3±1,3	17,9±0,9	10,3±0,8	0,9
Rear udder height	16,9±1,8	14,6±0,6	16,7±2,8	0,1
Central ligament of the udder	17,7±1,5	14,4±0,6	13,0±2,4	0,1
Udder depth	11,9±1,6	15,2±0,7	15,2±1,2	0,1
Front teat position	15,3±1,1	14,6±0,7	50,0±17,7	0,4
Rear teat position	14,3±4,6	13,2±0,6	18,1±1,1	0,4
Teat length	13,0±1,4	14,7±0,6	29,4±5,0	0
Body condition	18,9±2,5	14,8±0,6	11,1±2,3	0,1

Note: *** $p < 0.001$



According to the results of the analysis of variance of the firstborn's mortality depending on the assessment of body structure traits in free housing, a probable influence of only one factor was established - the slope of the sacrum. The strength of the influence of this trait was 2.9%. It is important to note that the percentage of animals leaving the herd with an average assessment of the slope of the sacrum was the lowest. With a low assessment of this trait, 19.9% more animals were left, and with a high assessment by 16.2%.

The impact of the assessment of other traits on the mortality of firstborns was unlikely. Therefore, we will further compare the trends in the impact of body structure traits of firstborns on the level of their mortality in free housing and compare them with the results obtained in tied housing.

Unlike tied housing, a tendency was observed to increase the percentage of culling of firstborns with a high growth assessment in free housing. Cows with a wide rib cage and a deep body had the highest risk of culling compared to the group of animals with average linear scores. In this case, the cows had an optimal body weight, and this combination had a greater impact on the joints and hooves, since a heavier body puts more pressure on the foot, which is an unfavorable factor for the preservation of livestock. Since the concrete stall floor is part of the typical housing system on Ukrainian farms with loose housing, animals with a higher body weight were more likely to be culled from the herd.

A slight decrease in the percentage of culling was observed with an increase in the score for the dairy type for both housing methods. Also, animals with the desired hindlimb posture were better preserved for both technologies. In loose housing, as in tied housing, there is a tendency to reduce the number of animals that were culled from the herd with a high score for the central ligament.

Regardless of the housing technology, the percentage of animals that were culled with a high score for body condition was lower compared to first-borns that had low and medium body condition.

Discussion. The housing technology has a significant impact on the longevity and survival of dairy cattle. The most important type traits for animal longevity were those that described body size and udder. According to our data, it was found that first-borns with a high score for body depth had a lower percentage of culling from the herd when tied. In contrast to tied, when free-ranged, there was a tendency for the risk of culling first-borns with a high score for growth, a wide chest and a deep body, which is associated with the conditions of animal housing. Our data are consistent with (Morek-Kopec M. and Zarnecki A., 2012), as they also reported a longer productive life of cows with a smaller body depth and chest width. Our studies found a slight decrease in the percentage of animals being culled with an increase in the score for the milk type. Foreign scientists found that the most angular cows had a shorter lifespan (Zavadilová L. and Němcová E. 2011). They were more sensitive to environmental conditions, which led to a shorter productive life. Despite this, cows with good angularity had better milk productivity for different populations of the Holstein breed, as was found by other researchers (Campos R. V. et al., 2015; Battagin M. et al., 2013). In contrast to tethered housing, there was a tendency for the percentage of first-born cows with a high growth score to be culled. This fact has been confirmed by other studies (Pali A. P. et al., 2020).

It was found that animals that had an average and high score for the posture of the hind limbs were more adapted to the harsh conditions of industrial complexes. This pattern is confirmed by numerous authors (Morek-Kopec M. and Zarnecki A., 2012; Kerlake J. I. et al., 2018; Sulayeman M. and Fromsa A., 2012). Our studies revealed a higher percentage of withdrawal from the herd of first-born cows with weak anterior



udder attachment and better survival of animals with a higher score for the stature of the attachment of the hind udder lobes and a well-pronounced central ligament. Other researchers also emphasize that cows with weak and poorly attached udders, as well as deep udders, had an increased risk of culling compared to cows that had average scores for these traits (Török E. et al., 2021; Zavadilová L. and Štipková M., 2012; Dube B. et al., 2009).

Conclusions:

1. It was established that the percentage of first-born cows leaving the herd depends on the characteristics of their body type, as well as the technology of housing.

2. When stall housing, animals with a high body depth score had a lower percentage of leaving the herd by 9% and 34.3% than animals with an average and low score. The stayability of first-born cows with a high score of the stature of attachment of the posterior lobes of the udder was 7.5-11% higher compared to lower scores of this trait. The number of animals that left the herd with a low score of the central ligament of the udder was 0.7-13% higher compared to animals with a low and average score. A similar relationship between the loss of animals was established with the score of the udder depth (by 8.8-17.1%). The percentage of animals that dropped out of groups with a low score for body condition was significantly higher than in first-born heifers with an average and high score (by 14.9-20.1%).

3. According to our data, only the score of the rump angle (2.9%) significantly influenced the dropout of first-born cows in free housing. The percentage of culling cows from the herd with an average score of the rump angle was 19.9% lower than in animals with a low score of this trait and 16.2% lower than in animals with a high score.

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