

Effect of linear traits in dairy cows on herd disposal

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No other branch of social production is as closely concerned with the use of natural resources as agriculture - animal husbandry in general and dairy farming in particular. The intensification of the dairy industry causes constant changes of the priority principles of selection of animals on breeding grounds. The minimum percentage of cows leaving the main herd has been established with the indicators of linear estimator: udder depth of 6 points, the attachment of the anterior lobes of the udder at 5 points, the placement of front teats at 6 points. The probable ($p < 0.01$) effect of anterior teat placement on the number of somatic cells in cow's milk has been found in both tied housing ($\eta^2 = 12.0\%$) and free-stall housing ($\eta^2 = 3.6\%$). In order to effectively assess the condition of the udder of high-yielding cows during their selection for machine milking at modern dairy complexes, a method has been developed to classify the suitability of cows for industrial use into three categories.

Keywords: Cow; Dairy herd; Linear trait; Udder; Somatic cells; Score; Productive longevity

Introduction

The success of the rational use of natural animal resources depends on the genotype, the adopted technology, the level of cattle feeding and the training of specialists and service personnel (Alekseev et al., 2018; Paliy et al., 2019a). Each of these factors matters to a certain degree in the process of forming a highly productive dairy herd.

Productive qualities of animals are the result of the interaction of genotype and environment. Since it is not the ready trait that is inherited, but the level of genotype response to environmental conditions, the manifestation of economically useful traits is largely determined by the environment in which the animals are raised and kept. The realization of genetic potential of cows, which indicates the maximum capabilities of animals, is an indicator of a high level of their adaptability (Yurchenko et al., 2018).

Productive longevity of cows is a rather complex integral trait, which is determined by both genetic and paratypic factors. The difficulty of selection on the basis of longevity is that the assessment of the actual indicators of these characteristics is possible only after the cows leave the herd, and, consequently, from the selection process (Efimova et al., 2017; Paliy et al., 2020). Long-term use of high-yielding cows contributes to the accelerated improvement of the herd due to the minimum annual culling of animals (Effa et al., 2013; Milostiviy et al., 2017). In addition, it has been found that a high economic effect is obtained when using cows during 6-8 lactations (Khmelnichy & Vecherka, 2016).

On a farm of almost any size there is always the culling of animals. This is a very important aspect of animal husbandry, which largely determines the profitability and efficiency of animal husbandry. As noted (Paliy, 2016), the correct and timely selection of animals allows the most rational use of livestock.

Every year in the country, dairy farm specialists sort out 35-40% of cows, a similar average reading worldwide being 35.8%. Most often, cows are culled due to problems associated with severe calving and reproductive dysfunction. Also, the reasons include too low milk productivity, non-compliance with breed standards, etc.

Cow udder diseases are one of the main reasons for the culling of cows (Jankovska et al., 2014; Paliy et al., 2018). The studies (Gussmann et al., 2019), carried out in the aspect of determining the relationship between the assessment of linear udder traits and life expectancy of dairy cows, found that cows with higher scores on the development of morphological traits of the udder have a significant advantage in life expectancy.

Thus, the culling of cattle is an integral, extremely important process in animal husbandry. It is necessary to exercise the selection of animals with all responsibility, to control the percentage of selection and to look for the reason when it increases.

The practice of dairy cattle breeding has shown (Bademkiran et al., 2007; Salau et al., 2018) that most of the morphological traits of the udder are the most important and reliable exterior indicators of high yields and efficiency of cows. Therefore, conducting in-depth and comprehensive research on the functioning of the mammary glands and their individual parts in cows acquires in special scientific and practical importance when deepening the understanding of the issues of the theory of lactation. Thus, taking into account the selection importance of the udder in determining the breeding value of animals, the aim of the study was to establish the influence of linear traits of the udder of dairy cows on their disposal from the herd.

This will contribute to the development of theoretical foundations and improvement of practical approaches to cow milking, increase the efficiency of dairy production and breeding work in dairy farming.

Materials and Methods

The percentage of disposal of cows was calculated as the ratio of the number of animals that left the herd during lactation to the number of cows that calved. Depending on the results of the scoring of linear traits of the udder the animals were divided into groups. The productivity of cows on experimental farms was at the level of 5.000-6.000 kg per lactation. To establish the patterns of influence of exterior indicators, a linear assessment of the udder of animals was performed according to the method of the International Livestock Association 'ICAR' (ICAR Guidelines approved by the General Assembly held in Kuopio, 2006). Thus, according to the method for linear assessment, each trait has an independent value and was evaluated on a scale from 1 to 9 points, points 1 and 9 being extreme values of traits.

The attachment the front lobes of the udder: the angle of connection of the front lobes of the udder with the abdomen of the animal was estimated. If the assessment of the trait on the left and right sides differed, the worst assessment was taken into account. The udder depth: the distance between the lower point of the bottom of the udder and the imaginary horizontal line, which is drawn at the level of the middle of the hocks, was estimated. If the bottom of the udder was located at the level of the middle of the hocks, score =2. The height of the posterior lobes of the udder: the distance between the lower edge of the vulva and the upper secretory part of the udder was estimated. Central ligament: the depth of the sulcus formed by the central supporting ligament between the posterior lobes of the udder was estimated.

The location of anterior teats: the location of the anterior teats with respect to the middle of the corresponding udder lobe was assessed. 5 points were given if the teats were located in the center of each anterior lobe of the udder. When examining the cows from behind, the location of the posterior teats with respect to the middle of the corresponding udder lobe was determined. 5 points were given if the teats were located in the center of each posterior lobe of the udder. To determine the quality of milk the 'Ekomilk Scan' device (Bulgaria), a viscometric analyzer of somatic cells in milk, was used. The principle of operation of the device corresponds to the method of determining somatic cells in milk using a viscometer according to GOST 23453-90.

The main results were processed by the method of variation statistics (Plohinskij, 1969) with application of computer technologies and using the computer program Microsoft Excel with built-in statistical functions and Statistica 7.0. Significance of differences between traits was determined by comparison with the Student's criterion. The experimental data were processed according to the main statistical methods (correlation and analysis of variance).

Results and Discussion

The indicators of the udder are the important features of the exterior, on which the productivity of animals as well as the duration of their use depend. In Figures 1 and 2 the ratio of disposal of cows with different estimates of udder attachment are shown.

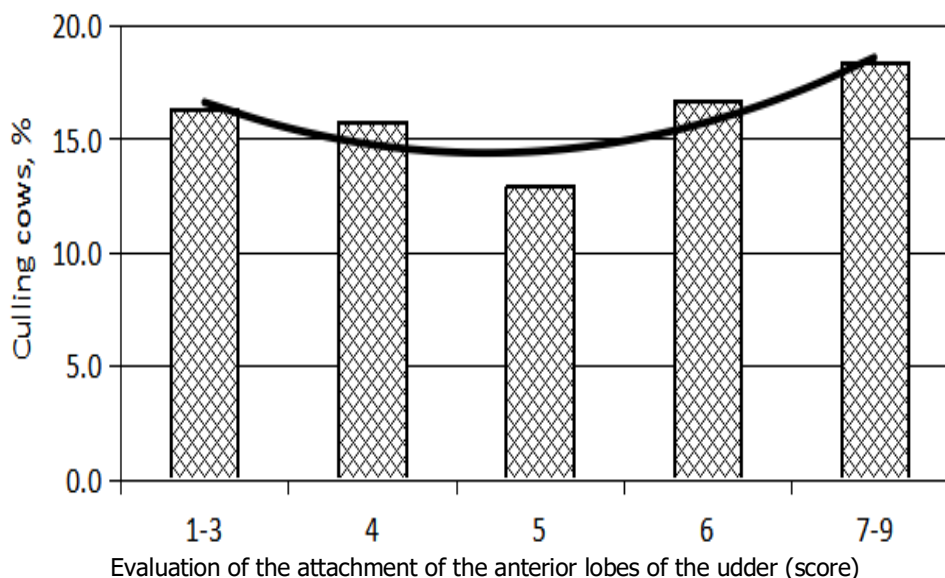


Figure 1. Disposal of cows according to the attachment of the anterior lobes of the udder.

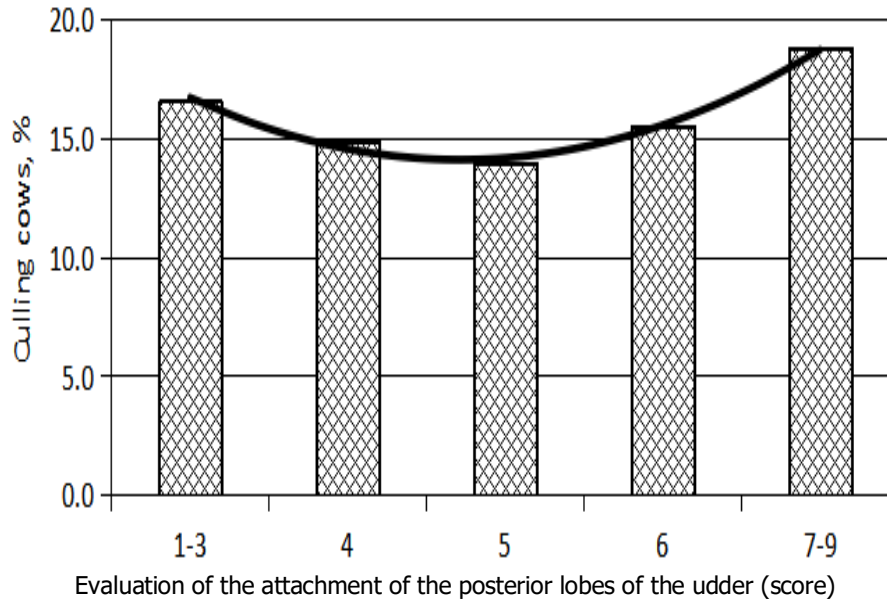


Figure 2. Disposal of cows according to the attachment of the posterior lobes of the udder.

The minimum number of animals that left the herd ($13.0 \pm 2.3\%$) was in the group with an assessment of the attachment of the anterior lobes of the udder at 5 points. Animals with a poor udder attachment (the score of 1-3 points) dropped out more often ($16.3 \pm 2.6\%$). The differences in the 3.3% disposal rate between these groups were improbable. At the same time, a group of cows with a score of 7-9 points ($p < 0.05$) was characterized by the highest percentage of disposal ($18.4 \pm 2.1\%$).

This is due to the fact that cows with closely attached anterior lobes of the udder had lower productivity both on the 80-90th day of lactation and during 305 days of lactation. Similar results were obtained when determining the percentage of cows with different estimates of the height of attachment of the posterior lobes of the udder ($p > 0.1$). There is a similar trend in the change in the ratio of disposal of the cows depending on the expressiveness of the central ligament of the udder (Figure 3). The difference in the percentage of disposal of the cows between the groups of animals with different estimates of the central udder ligament was also improbable ($p > 0.1$).

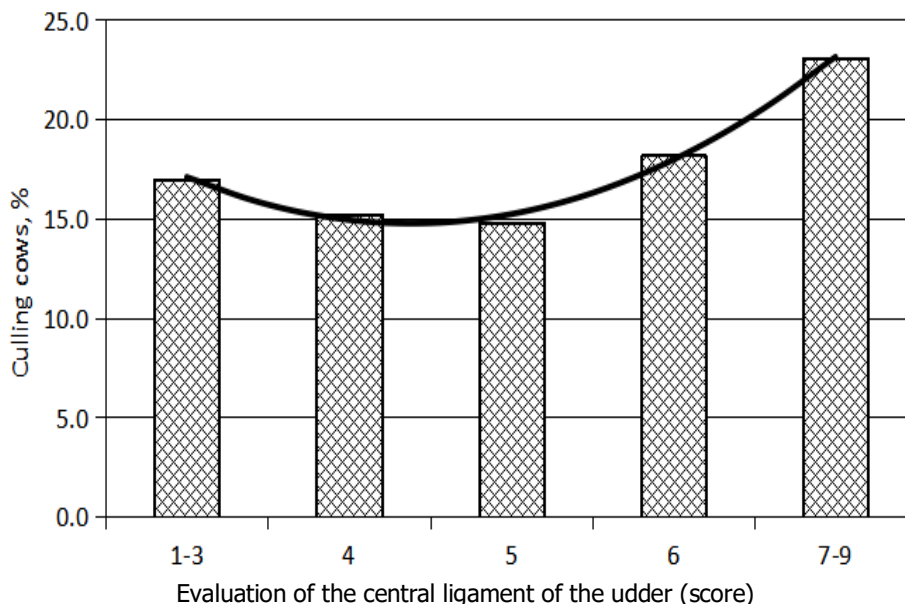


Figure 3. The disposal of the cows according to the expressiveness of the central ligament of their udder.

The correlation of cows leaving the herd with the depth of their udder was determined (Figure 4). The lowest percentage of the disposal ($10.6 \pm 2.5\%$) was in the cows with a score of 6 points.

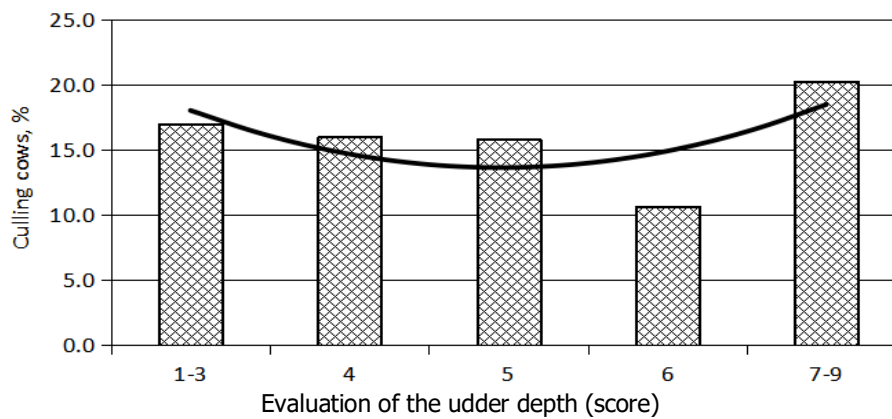


Figure 4. The disposal of the cows according to their udder depth.

This is due to the negative correlation between this trait of the exterior and daily milk yield. That is, the disposal of cows is largely determined by their productivity, and it, in turn, has to do with the depth of the udder.

The disposal of cows significantly depended on the location of the anterior teats (Figure 5).

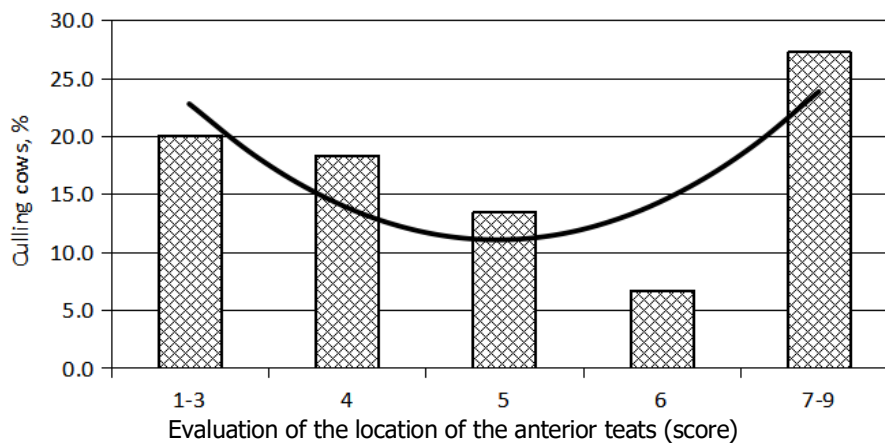


Figure 5. The disposal of cows according to the location of the anterior teats.

Thus, $20.1 \pm 2.8\%$ of cows with widely located anterior teats dropped out of the main herd (the score of 1-3 points). As teats were located closer, the percentage of animals initially gradually decreased; and, with an estimate of the placement of the anterior teats of 6 points, only $6.7 \pm 3.7\%$ of cows dropped out. In the group of animals with very closely located teats (the score of 7-9 points), the percentage of disposal increased to $27.3 \pm 9.5\%$ ($p < 0.01$). The largest number of cows who left the herd had widely and closely located teats because milking such animals is inconvenient. As for other indicators of the exterior of the cow udder, namely the location of the posterior teats (Figure 6) and the length of the teats (Figure 7), the percentage of the disposal of cows with such characteristics in terms of groups of animals with different scores was improbable ($p > 0.1$).

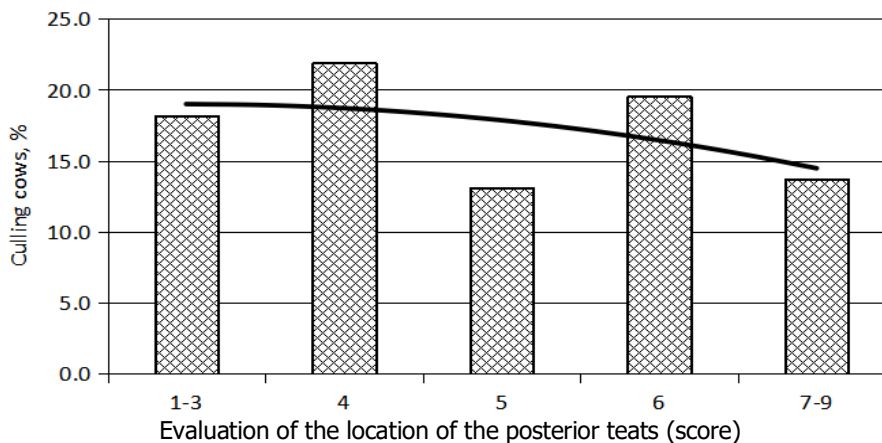


Figure 6. Disposal of cows according to the location of the posterior teats.

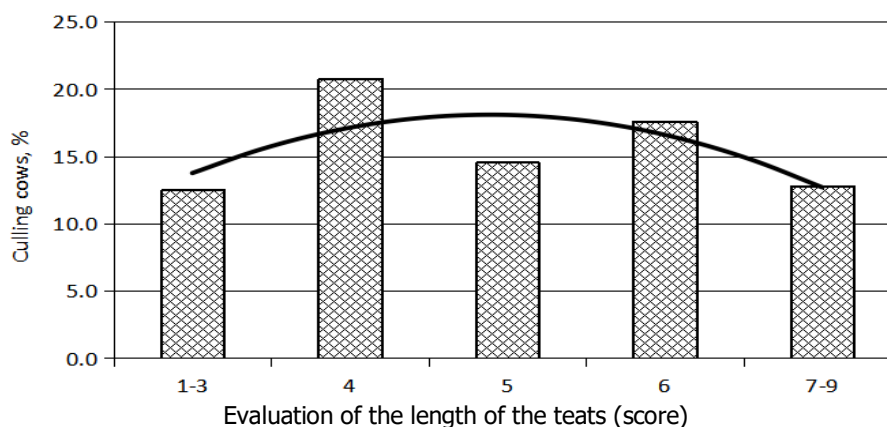


Figure 7. Disposal of cows according to the length of their teats.

The studies have established a probable ($p < 0.01$) effect of the placement of the anterior teats on the number of somatic cells in the milk of cows with both tied ($\eta^2 = 2.0\%$) and free-stall housing ($\eta^2 = 3.6\%$) (Table 1).

Table 1. The dependence of the milk quality on the location of anterior teats when milking cows in the stall box and in the milking parlor, ($M \pm m$).

Location of the anterior teats (score)	Number of somatic cells, thous./mm ³	
	Cows in the stall box	Cows in the milking parlor
1-3 points	516.4 \pm 68.2	924.7 \pm 325.9
4-6 points	917.0 \pm 77.3	1069.3 \pm 157.3
7-9 points	722.0 \pm 20.0	893.2 \pm 238.2

The mechanism of this influence doesn't consist in the technology of milking, but is determined by the contamination of the anterior teats, estimated at 4-6 points.

In order to effectively assess the condition of the udders of high-yielding cows in their selection for machine milking in modern dairy complexes, a method was developed that is as follows: after the arrival of high-yielding cows on the dairy complex, the diameter and length of udders are measured by means of a caliper. To do this, the measuring device (caliper) is placed on the teat of the cow's udder so that the sponges of the tool for external measurement are on its base.

At the next stage, the measuring device (ruler) is placed vertically to the udder so that the end of the tool with the reference scale is on its base. All teats of the udder of animals are similarly subjected to the specified measurement. The interpretation of the obtained data is carried out according to Table 2.

Table 2. Evaluation of the suitability of high-yielding cows for machine milking according to the condition of their teats.

Category	Measurements of the cow teats, mm		Suitability of cows for machine milking
	Teat diameter	Teat length	
I	<18	<60	Not suitable
II	18-36	60-80	Suitable
III	>36	>80	Not suitable

Therefore, the classification of the evaluation of the teats of high-yielding cows during their selection for machine milking is carried out as follows: Category I (not suitable) - the diameter of the teats is less than 18 mm, their length is less than 60 mm; Category II (suitable) - the diameter and length of the udder teats are in the range of 18-36 mm and 60-80 mm, respectively; Category III (not suitable) - the diameter of teats is more than 36 mm, length is more than 80 mm.

The organization of machine milking on the farm must be decided taking into account the health of dairy animals. First of all, it is necessary to identify cows with a latent form of mastitis (Paliy et al., 2015). In addition, for mechanical milking it is necessary to select cows that are homogeneous in milk productivity, with the correct shape of the udder and teats. Ignoring these rules results in incomplete milking and breast irritation and mastitis (Paliy et al., 2020; Rees et al., 2017). On farms that do not pay due attention to the selection of cows for machine milking, slipping of milking cups from the udder and the suction of manure and litter often takes place. This further increases the contamination of milk with microflora (Paliy et al., 2019b; Shkromada et al., 2019).

The main task of selection and breeding work is to obtain a highly productive livestock. In dairy farming, much attention is paid to the productive qualities of animals, as well as the exterior, longevity and lifelong milk yield, as one of the ways to increase the profitability of the industry is to increase the production time of high-yielding cows. This is consistent with the opinion of a number of scientists (Imbayarwo-Chikosi et al., 2015; Osipenko et al., 2018; Trukhachev et al., 2016). The assessment of the exterior and constitution has always been a necessary element of a comprehensive assessment of dairy cattle. In terms of selection, a dairy cow is preferable, when along with high milk productivity it maintains normal fertility, good health and a strong constitution.

The data obtained are consistent with the results of other authors (Johansson & Korkman, 2010; Kern et al., 2015), who report that the disposal of animals from the main herd is based on linear evaluation of their udder. Currently, in domestic and foreign breeding, the factor of efficiency of economic use of dairy cattle is becoming increasingly important (Camara et al., 2019). Prolonged productive use indicates the compliance of the animal's genotype with environmental conditions, good reproductive ability, resistance to disease, the normal course of physiological and biochemical processes in the body. The reduction of productive longevity negatively affects the effect of selection: the rate of qualitative improvement of the herd and the intensity of selection of

the best cows in the selection group are sharply delayed (Jenko et al., 2013). Therefore, the extension of the economic use of dairy cattle directly determines the economic efficiency of breeding and commercial livestock.

Productive longevity of cows is especially important in the selection and breeding work, as it is closely related to the rate of replacement of the herd and the intensity of selection (DeVries, 2017; Hutchison et al., 2017; Jenko et al., 2013). Premature disposal of dairy cows not only reduces the breeding resources of breeds, but also causes economic damage to the industry as a whole, causing large economic losses that do not always pay off due to high animal productivity (Nayeri et al., 2016). This led to the relevance of research to establish the influence of linear traits of the udder of dairy cows on their disposal from the herd (Kozyr et al., 2017; VandeHaar et al., 2016). Nowadays, dairy farming is accompanied by a number of negative consequences: deterioration of milk quality, reduced immune status of animals and fertility as well as shortening the period of economic use of cows in herds (Denholm et al., 2017; Charfeddine & Pérez-Cabal, 2016; Palii & Palii, 2019). Some (Abdalla et al., 2016; Banos et al., 2017; Compton et al., 2016; Domingues et al., 2019) report that the short duration of economic use of high-yielding cows is associated with higher metabolic processes in their body, because in difficult conditions they are more prone to diseases and disorders of reproductive function than animals with average productivity, not excepting the influence of genetic factors.

Reducing the time of productive use of animals in terms of industrial technology should serve as an incentive for in-depth study and search for solutions to this issue. In the years to come, a significant increase in the number of dairy herd will not happen; it will take decades to restore the dairy industry. Therefore, it is necessary to solve the issue of milk production by intensifying the industry, the basis of which is determined by the high level of specialization and continuous route of production. This, in turn, requires a certain standardization of animals in live weight, productivity, anatomical and physiological characteristics; and, first of all, according to the adaptation of cows to machine milking and persistence to diseases.

The obtained experimental results can be used to create competitive herds in the conditions of intensive milk production technology and used in the development of long-term programs and long-term plans of breeding work with herds of Ukrainian black-spotted dairy breed. Further research in this direction will increase the interest among domestic livestock breeders, owners of genetic material and large manufacturers of technological equipment for dairy farming.

Conclusion

The lowest percentage of disposal from the main herd was detected among the cows with such linear evaluation indicators: udder depth of 6 points ($10.6 \pm 2.5\%$), the attachment of the anterior lobes of the udder at 5 points ($13.0 \pm 2.3\%$), the placement of anterior teats at 6 points ($6.7 \pm 3.7\%$). The probable ($p < 0.01$) influence of placement of anterior teats on the number of somatic cells in the milk of cows of both tied ($\eta^2 = 12.0\%$) and free housing ($\eta^2 = 3.6\%$) was determined. In order to effectively assess the condition of the udders of high-yielding cows during their selection for machine milking at modern dairy complexes, a method has been developed which provides for the classification into categories: Category I (not suitable); II category (suitable); Category III (not suitable).


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