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RESEARCHES ON THE RELATIONSHIP BETWEEN LINEAR TYPE TRAITS AND PRODUCTIVE LONGEVITY OF COWS OF UKRAINIAN BROWN DAIRY BREED

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Abstract

The phenotypic relations between type traits and longevity indices in cows of Ukrainian Brown dairy breed in the Sumy region of Ukraine were analyzed. Linear estimation was performed according to ICAR recommendations (2014). In this study 18 traits of type are considered. The average lifetime of cows was 6.7 years, which corresponding to an average productive use of 4.67 years. Longevity yield for cows amounted to an average of 21,517 kg of milk, or 8.8 kg per one day of life, or 13.3 kg per day of productive use. Phenotypic correlations were between final assessment and lifetime (r=0.321), longevity milk yield (r=0.398) and milk fat (r=0.369). In general, phenotypic correlations between linear traits of type and longevity traits varied from -0.192 to 0.422. Sufficient levels of correlations indicated that indirect selection on the basis of height (r=0.122-0.209), body depth (r=0.209-0.268), angularity (r=0.318-0.422), rump width (r=0.226-362), front udder part attachment (r=0.275-0.396), rear udder part attachment (r=0.254-342), central ligament (r=0.245-371), udder depth (r=0.228-0.244) and body condition score (r=-0,192…-0,378) can lead to an effective improvement of cows longevity traits.

Key words: *Ukrainian Brown dairy breed, longevity, linear type traits, correlation*

INTRODUCTION

Longevity of cows, as a selective trait, significantly affected the profitability in dairy industry and allowed to reduce the number of selection traits [35]. The problem of longevity has been an urgent and strategic question in the breeding of animals, as evidenced by numerous studies of scientists all over the world. Therefore, longevity and productivity in dairy cows become the important traits among selection criteria, which closely related to economic efficiency of milk production [11, 12, 14, 25, 17].

From the viewpoint of breeding, productive longevity of cows is quite complex integrated trait that was determined significantly by genetic factors. Unfortunately, the achievement of rapid breeding progress by direct selection on the basis of longevity of dairy cattle has been limited due to the low heritability of longevity from 0.03 to 0.07 [45, 31, 44, 18 29] and time required to accumulate sufficient data for estimating breeding value of animals [39, 9, 22]. In this respect, it was necessary to find and use traits – predictors of longevity. This was especially important in the current conditions of intensive physiological loading on animals. In this aspect, the practice of breeding dairy cattle had proved that animals with a high score for conformation type, with desired dairy forms, strong legs, well-developed morphological udder traits were characterized not only by high performance, but also by strength, resistance to physiological loads, the ability to maximize their genetic productivity potential [40, 4, 2, 36]. Individual conformation traits can be used as predictors of longevity and productivity through their high and average heritability [8, 30, 10, 6, 26, 19].

This conclusion has been confirmed in many studies by genetic, phenotypic correlations among conformation traits and milk productivity, and duration of use cows of different breeds [24]. [33] found positive genetic correlations between longevity and udder traits, and angularity (from 0.22 to 0.48). [1] reported that genetic correlations between milk yield and body structure (except stature-ST and body depth-BD) were positive in the range from 0.188 (rump width-RW) to 0.823 (heart girth-HG) According to [37], genetic correlations among conformation traits and productivity indicated that higher-yielding cows had more angular forms, deeper udder, good rear teats placement, a high rear udder attachment, moderate body condition, strong central ligament and confident locomotion.

While studying the phenotypic and genetic relationships of three locomotion traits with profit, traits of productivity, longevity and fertility, [30] determined the importance of movement traits for production of dairy products. Feet and legs were the traits most genetically correlated to profit although a low value (0.10) was obtained, whereas RLS was the trait most correlated to milk production (0.12). Genetic correlations between LP, FA, RLS, and longevity traits (from –0.10 to 0.05) were low.

[10] found that rump width was positively correlated with milk productivity traits in Holstein and Red-and-White cattle, but was negative in cows of Brown Swiss breed. Therefore, they believed that conformation traits generally can be used as predictors for various purposes in dairy cattle breeding, but may require specific adaptation for each breed.

The purpose of this study was to evaluate the effect of linear type traits on the performance and longevity indicators of the Ukrainian Brown dairy cows breed in adaptation to the conditions of Sumy region of Ukraine.

MATERIALS AND METHODS

Research of relationship between indicators of longevity productivity and type traits was conducted using the data of linear assessment firstborn cows of the created Ukrainian Brown dairy breed (UBDB) in the five farms in Sumy region of Ukraine.

The dataset consisted of records about productive and linear type traits of 1,519 cows collected from January 1st 2006 to December 31st 2016.

The longevity of cows was calculated as the number of days between date of birth and date of withdrawal. Linear assessment was performed according to the recommendations made by [15].

Linear type traits were determined only in cows of the first lactation, classified from 15 to 150 days after calving.

In this study 18 linear type traits: stature (S), chest width (CW), body depth (BD), angularity (A), rump angle (RA), rump width (RW), rear legs side view (RLSV), rear legs rear view (RLRV), foot angle (FA), fore udder attachment (FUA), rear udder height (RUH), central ligament (CL), udder depth (UD), fore teats placement (FTP), rear teats placement (RTP), teats length (TL), locomotion (L), and body condition score (BCS) were considered. 18 linear type traits included in the analysis are given in Table 1. The minimum and maximum deviations of linear traits were estimated in absolute units of measurements on a specific 9 point-scale.

Some type traits, such as angularity, rump angle, rear legs set, locomotion and body condition score were estimated more subjectively, because classifiers took into account a number of appearance aspects when assigning scores to the cow.

Other traits were scored more objectively, because they have been defined as measurement indicators. Only classifiers with more than 30 estimated animals were considered in the experiment.

The true longevity of cows was calculated as the number of days between date of birth and date of culling.

Longevity milk yield was calculated as the sum of the cow milk yield for lactation used during productive use.

Longevity yield of milk fat was determined as the amount of milk fat for used lactation during the productive life of cows.

Table 1. Description of linear type traits using nine-point scoring range

Standard Traits	Score – min=1		Score – max=9	
Stature	Short	<128 cm	Tall	>150 cm
Chest Width	Narrow	<17 cm	Wide	>32 cm
Body Depth	Shallow body	<61 cm	Deep body	>81 cm
Angularity	Lacks angularity close ribs coarse bone		Very angular open ribbed flat bone	
Rump Angle	High pin bones		Sloped	
Rump Width	Narrow	<16 cm	Wide	>24 cm
Rear legs side view	Straight	>158°	Sickled	<136°
Rear Legs Rear View	Extreme toe-out		Parallel feet	
Foot Angle	Very low angle	<25°	Very steep	>61°
Fore Udder Attachment	Weak and loose	<90°	Extremely strong and tight	>161°
Rear Udder Height	Very low	<26 cm	High	>11 cm
Central Ligament	Convex to flat floor (flat)	0	Deep/strong definition	>6.5 cm
Udder Depth	Udder floor below hock	<-1-2 cm	Udder well above hock	>20 cm
Front Teat Position	Outside of quarter	>19cm	Inside	<4 cm
Rear Teat Position	Outside	>15 cm	Crossing	<0 cm
Teat Length	Short	<1 cm	Long	>9 cm
Locomotion	Severe Abduction/Short Stride		No Abduction/Long Stride	
Body condition score	All profiles extremely concave		All profiles extremely rounded	

Source: [21].

Basic statistical data of the linear type traits (calculated on a 9-point scale) in cows included an average value (x), standard error of linear traits (SE), standard deviation (SD), coefficient of variation (CV %), minimum (Min) and maximum (Max) deviation of economic and linear traits, correlation coefficient (r) between linear type traits and lifetime of cows, quantity of received milk and milk fat per life.

The coefficient of linear correlation was determined by formula of Pearson:

$$r_{xy} = \frac{\sum(x_i - \bar{x}) \times (y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \times \sum(y_i - \bar{y})^2}}$$

where:

x_i – value for variable X;

y_i – value for variable Y;

$\bar{x}$ – average value for X;

$\bar{y}$ – average value for Y.

RESULTS AND DISCUSSIONS

Ukrainian Brown dairy breed was created by interbreed crossing method between the cows of aboriginal Lebedyn cattle and Brown Swiss breed of German, American and Austrian breeding. The purpose of creation of Ukrainian Brown dairy breed was to transform Lebedyn cattle of a combined type (dual purpose breed) to a specialized dairy breed. The new created breed should be characterized by a high milk productivity and strong conformation type, and well adapted to the local feeding and technological conditions of housing. The definition of these important animal abilities of newly created breed was the aim of our research.

The conformation of cows, estimated using linear type traits, served as the basis for all modern type classification systems and foundation for systems of dairy cows description [15].

The data of average values and variability of estimated economic and linear type traits of firstborn cows Ukrainian Brown dairy breed have been presented in Table 2.

The average lifetime of experimental cows of Ukrainian Brown dairy breed was 6.7 years that corresponded to an average productive use of 4.67 years. Longevity milk yield of cows amounted to an average of 21,517 kg of milk, or 8.8 kg per day of life, or 13.3 kg per day of productive use. Longevity milk fat in cows was an average of 819.5 kg with moderate fat content of 3.81%.

Table 2. The average value and variability of cow linear type traits

Linear type traits	x ± S.E.	SD	Cv (%)	Min	Max
Lifetime, days	2,446±19.6	764	31.2	1,142	5,905
Longevity milk yield, kg	21,517±243.0	9,471	44.0	9,014	58,223
Longevity milk fat, kg	819.5±9.25	360	44.0	250.2	2,148.7
Stature (height at sacrum), cm	144.0±0.07	2.7	1.9	139	152
Stature	5.6±0.035	1.35	24.0	1	9
Chest Width	6.2±0.033	1.31	21.0	1	9
Body Depth	6.9±0.044	1.71	24.8	1	9
Angularity	6.7±0.039	1.51	22.7	2	9
Rump Angle	5.1±0.024	0.92	18.1	2	8
Rump Width	5.8±0.024	1.04	18.0	1	9
Rear legs side view	5.1±0.034	1.33	26.0	1	9
Rear Legs Rear View	6.1±0.039	1.52	24.8	1	9
Foot Angle	5.2±0.033	1.30	24.8	1	9
Fore Udder Attachment	6.1±0.033	1.30	21.3	2	9
Rear Udder Height	5.5±0.035	1.38	25.2	1	9
Central Ligament	6.2±0.038	1.50	24.2	1	9
Udder Depth	6.3±0.037	1.43	22.9	1	9
Front Teat Position	4.5±0.034	1.33	29.9	2	8
Rear Teat Position	5.1±0.032	1.24	24.2	2	9
Teat Length	5.5±0.031	1.20	22.0	3	9
Locomotion	6.1±0.043	1.69	27.5	1	9
Body condition score	5.8±0.029	1.14	19.6	2	9

Source: Own calculations.

Cows of Ukrainian Brown dairy breed by the trait height at sacrum 144.0 cm and 5.6 scores that characterize the overall animals development, sufficiently are developed at the age of the first lactation. Cow firstborn, according to the results of point score, were characterized by a good chest and body developmental, and assessment for angularity in 6.7 scores, indicated about cow development in dairy type direction. Rump slope angle and rear legs angle are optimally developed.

Assessment by udder morphological traits indicated about good front udder parts attachment, a well-defined central ligament and high placement. Coefficients of Pearson's phenotypic correlations between the final score, descriptive conformation traits and longevity indicators of cow's productivity have been given in Table 3. The high positive correlations obtained between final score and lifetime (r = 0.321), longevity milk yield (r = 0.398) and longevity yield of milk fat (r = 0.369).

The close correlation between the final assessment and traits of longevity productivity indicated that when selecting of sires to improve the conformation and performance of herd cows, the final score indicators should be taken into account. This conclusion was explained by the fact that focusing on the heritability of each descriptive trait, was sometimes problematic to find a bull with desired all body parts development.

The results obtained on the stock of UBDB cows were similar to those obtained by [8] and [34]. They observed a close linear relationship between final score and longevity in Holstein and Jersey cows, respectively, reducing the risk of culling of animals with a high final score. [13] believed that the final assessment deserved special attention because it was expressing the sum of scores for all group traits of cow conformation [13].

Stature characterizing the overall body structure development of UBDB cows positively correlated with lifetime (r = 0.122), longevity milk yield (r = 0.209) and longevity milk fat yield (r = 0.105), as presented in Table 3. A similar trend was found in studies of [32], who identified that higher cows had better survival chances than cows with lower scores. According to [20] genetic correlation in Canadian Holsteins between lifetime productivity and stature were low and moderate (from 0.14 to 0.25). However, [7] found that cows of the average height or lower than average height live longer.

[34] reported about an intermediate optimum for conformation linear traits and milk productivity. According to studies made by [5] and [8], stature did not have a strong relationship with functional ability to survive.

Table 3. Pearson correlation coefficients (r) between estimation of conformation traits and indicators of cow lifetime productivity

Standard Traits	Lifetime, days	Longevity milk yield, kg	Longevity milk fat, kg
Final score	0.321^{xxx}	0.398^{xxx}	0.369^{xxx}
Stature	0.122^{x}	0.209^{xxx}	0.105^{xxx}
Chest Width	-0.033	-0.054	-0.067
Body Depth	0.268^{xxx}	0.255^{xxx}	0.209^{xxx}
Angularity	0.318^{xxx}	0.422^{xxx}	0.389^{xxx}
Rump Angle	-0.021	-0.019	-0.011
Rump Width	0.226^{xxx}	0.362^{xxx}	0.296^{xxx}
Rear legs Side View	0.183^{xx}	0.125^{x}	0.129^{x}
Rear Legs Rear View	-0.024	-0.017	-0.022
Foot Angle	-0.016	-0.025	-0.015
Fore Udder Attachment	0.275^{xxx}	0.361^{xxx}	0.396^{xxx}
Rear Udder Height	0.254^{xxx}	0.311^{xxx}	0.342^{xxx}
Central Ligament	0.245^{xx}	0.371^{xxx}	0.347^{xxx}
Udder Depth	0.244^{xxx}	0.233^{xxx}	0.228^{xxx}
Front Teat Position	-0.088	-0.037	-0.062
Rear Teat Position	-0.039	-0.021	-0.011
Teat Length	-0.018	-0.081	-0.014
Locomotion	0.137^{x}	0.148^{x}	0.122^{xxx}
Body condition score	-0.192^{xx}	-0.378^{xx}	-0.357^{xxx}

^{x} significant in P <0,05; ^{xxx} significant in P <0,01; ^{xxx} significant in P <0,001
Source: Own calculations.

Whereas, according to [18] height had negative genotypic and phenotypic correlations with longevity indicators.

[43] believed that such different results could be due to differences in the breed or in the definition of traits.

Chest width, one of the type linear traits associated with longevity of cows [28]. But according to [27], between functional longevity and chest width the correlation was negative.

Research data (Table 3) corresponded to results of [27], correlations between the chest width and longevity traits were low and negative (from –0.033 to –0.067).

Depth of body was rather an important linear trait of the conformation for dairy cattle that characterize the digestive tract development depending on the age and period of lactation. Cow with a deep body, are able to process a large amount of coarse fodder, converting it into appropriate productivity. A positive correlation of UBDB cows between body depth and the lifetime of cows (Table 3) was 0.268, with longevity milk yield of 0.255 and longevity milk fat yield of 0.209.

[16] and [27] also reported about positive effect of cows body depth on the duration of life. However, evaluating the genetic correlations between longevity and linear type traits, [33] obtained noticeable negative correlations between longevity and body depth (–0.15).

The angularity was affected positively on the longevity traits of Ukrainian Brown dairy cows with moderate correlation between the angularity and lifetime of 0.318, longevity milk yield of 0.322 and longevity fat of 0.219 (Table 3). [20] also found a strong genetic correlation between lifetime productivity and angularity in Canadian Holsteins (0.44-0.55). According to studies made by [33], genetic correlations between the longevity traits and angularity were moderate, high, and positive (0.22 to 0.48).

The relationship between the trait of rump angle and longevity traits UBDB cows was absent (from –0.011 to –0.021) (Table 3). Similarly, no relationship was found between the rump angle (position) and longevity of American Holstein and Jersey cows in studies of [8]. About the influence on functional survival of Czech Simmental cows especially in extreme classes was reported by [45]. According to their research, cows with a very high or extremely slope rumps were more ready to culling than those who had the best score of 5. Furthermore, cows with extremely raised sacrum were 2.54 times more likely to withdrawal as compared with cows with extremely oblique sacrum. Similar data were obtained by [15], [32] and [7]. According to the studies of [44], the rump angle in Czech Holstein cows was positively associated with longevity traits, with genetic correlations from 0.15 (length of productive life as the functional longevity) to 0.21 (number of lactations initiated).

The rump width of cows had a positive effect on longevity indicators with correlation coefficients on the duration of life (0.226), longevity milk yield (0.362) and longevity milk fat (0.296) (Table 3). According to various scientific studies, rump width was correlated with longevity traits in the positive [43] and negative direction [38, 3, 45].

Scientific research and practice of cattle keeping proved that duration of life and longevity productivity of cows in industrial complexes to a large extent depended on the traits characterizing the legs condition. According to research cows UBDB the rear legs angle was positively correlated with lifetime (r=0.183), longevity milk yield (r=0.125) and milk fat yield (r=0.129), whereas the rear legs set and foot angle had weak negative correlations with longevity indicators. [30] reported that genetic correlations among feet and legs (FL), foot angle (FA), rear legs set (RLS), and longevity traits (from –0.10 to 0.05) also were low. According to these authors, higher scores for FL, FA and RLS were positively related to production and functional traits. The cows that were scored the highest for feet and legs remained in the herd for 307 functional days longer than cows scoring the lowest.

[20] obtained a low genetic correlations between longevity productivity and legs set (from 0.10 to 0.16) and negative for rear heel (–0.16 to –0.27). A negative genetic correlations between rear legs set (side view) and traits of longevity (–0.11 to –0.24) were revealed by [44] in Czech Holstein cows.

The udder of a dairy cow was estimated by the sum of morphological traits, its structure and texture. The using in a system of linear classification cows udder morphological traits, based on the fact that each of them could have predicted effect on the udder health. From the traits of udder structure, the greatest influence on udder health had the udder depth. High-lying udder was less disease-prone. Low location of the udder due to the penetration of bacteria was more favorable to mechanical damage. Good udder technological features required for efficient automatic milking. Breeding cows by udder structure positively influenced (directly or indirectly) on the duration of their economic use [15]. The strong attachment of the front udder was closely related to its shape, size, proportional development, and did not allow the udder to fall below the hock joints with age. The function of the rear udder attachment and the central ligament were similar. According to UBDB cow estimates, fore udder attachment, rear udder attachment, and the central ligament correlated positively with longevity traits, with variability from 0.245 (central ligament - lifetime) to 0.396 (front udder attachment - longevity milk fat). The UBDB cow's udder depth positively correlated with lifetime (0.244), longevity milk yield (0.233) and longevity milk fat (0.228).

The functional longevity of Holstein cows has been studied in 9 geographic regions of the United States by [8], who found that, depending on the udder morphological traits assessment, udder depth, front udder attachment, and central ligament are successively associated with functional longevity, regardless on the region. Genetic correlations were low and moderate between lifetime productivity and udder texture (0.19 to 0.26), rear udder attachment (0.19 to 0.25), and rear attachment (0.10 to 0.22). About sufficiently high genetic correlations between productive life and milk yield, fat, dairy form, and udder traits ranged from +0.22 to +0.46 in Holstein cows of the United States was reported by [42]. The obvious influence of udder depth on the length of productive life of the French Holstein was observed by [23]. Similarly, according to studies of [31], the functional longevity in Italian Brown Swiss dairy cattle had a strong positive genetic correlation with udder depth (0.42 ± 0.10) and at the same time insignificant with fore udder attachment (0.10 ± 0.11), central ligament (0.08 ± 0.12) and slightly negative with rear udder width (–0.10 ± 0.11). When were studied correlations of linear and composite type traits with direct longevity, [38] found a positive correlation with udder depth (0.29), fore udder parts attachment (0.18), and height of rear udder parts attachment (0.14).

The correlations between front and rear teats position and teats length, and lifetime indicators and productive longevity of UBDB cows had a weak negative directionality from –0.011 to –0.088 (Table 3). In the scientific research of other authors, similar correlations had different directions. Negative genetic correlations among longevity and front teats length (–0.07) were obtained by [33]. The strongest correlation was found for rear teats placement (–0.28) and the weakest for teats length (–0.03) [44].

Phenotypic correlations between linear type traits and longevity in Brazilian Holstein cows were insignificant by the traits of teats placement (–0.01) and teats length (0.01) [18].

When assessing the trait of locomotion, the intensity of the animal’s movement, fixation of the support phase and transfer of limbs were taken into account. The score decreased for weak movement and if the lameness was present. Firm, confident movement, correct posture of limbs, strength hooves and pasterns increased the level of linear assessment.

Between the locomotion of UBDB cows and longevity traits was determined insignificant but positive correlation, from 0.122 by the trait of longevity milk fat, to 0.148 - by the trait of longevity milk yield. In general, the movement of cows was a quite important in the technological sense linear trait of the conformation, that depending on three other traits that affecting it - angle and posture of pelvic limbs and foot angle [8, 30, 38]. Disadvantages of the traits, angle and posture of pelvic limbs lead to the hooves erosion and erasing its rear wall.

[44] found low genetic correlations between longevity traits and locomotion were for the length of productive life (0.06), number of lactations (0.07), length of productive life as the functional longevity (0.10) and number of lactations initiated as the functional longevity (0.09).

Body condition score of UBDB cows has a negative and reliable relationship with lifetime (r = –0.192), longevity milk yield (r = –0.278) and longevity milk fat (r = –0.357). Similar results were obtained by [41] who found a negative relationship between body condition score and longevity in Brown Swiss cattle. As a consequence, for more well-fed types of animals the period of stay in the herd was reduced.

[16] revealed that cows having higher scores for fatness had higher risk of culling than cows with lower scores. On the contrary, [44] found strong positive genetic correlation between fatness and functional longevity in Czech Holstein cows (0.30).

CONCLUSIONS

Some researchers have evaluated the use of linear type traits as alternative indirect breeding traits of longevity through favorable genetic and phenotypic correlations.

Excellent conformation by final type estimation is an effective factor influencing on the indicators of cows longevity, because actual dairy cows' longevity improved through genetic selection

Phenotypic correlations indicated that indirect selection based on traits of stature, body depth, angularity, rump width, fore udder parts attachment, rear udder parts attachment, central ligament and udder depth can lead to the effective development of longevity traits in cows of Ukrainian Brown dairy breed.

REFERENCES

[1]Alphonsus, C., Akpa, G. N., Oni, O. O., Rekwot, P. I., Barje, P. P., Yashim, S. M., 2010, Relationship of Linear Conformation Traits with Bodyweight, Body Condition Score and Milk yield in Friesian × Bunaji Cows. Journal of Applied Animal Research, 38 (1): 97-100. https://doi.org/10.1080/09712119.2010.9707164, Accessed on 19.06.2021.

[2]Atkins, G., Shannon, J., Muir, B., 2008, Using Conformational Anatomy to Identify Functionality & Economics of Dairy Cows. WCDS Advances in Dairy Technology, 20: 279-295.

[3]Bouska, J., Vacek, M., Štípková, M., Němec, A., 2006, The relationship between linear type traits and stayability of Czech Fleckvieh cows. Czech Journal of Animal Science, 51 (7): 299-304.

[4]Brum, E. W., Ludwick, T. M., 1999, Heritabilities of Certain Immature and Mature Body Measurements and Their Correlations with First Lactation Production of Holstein Cows. Journal of Dairy Science, 52: 52-85.

[5]Buenger, A., Ducrocq, V., Swalve, H. H., 2001, Analysis of survival in dairy cows with supplementary data on type scores and housing systems from a region of Northwest Germany. Journal of Dairy Science, 84: 1531-1541.

[6]Campos, R. V., Cobuci, J. A., Costa, C. N., Neto, J. B., 2012, Genetic parameters for type traits in Holstein cows in Brazil. Revista Brasileira de Zootecnia, 41: 2150-2161.

[7]Canji, V., Strapak, P., Strapakova, E. Juhas, P., 2008, Effect of conformation traits on longevity of cows of Slovak Simmental breed. Slovak Journal of Animal Science, 41: 83-90.

[8]Caraviello, D.Z., Weigel, K. A., Gianola, D., 2004, Analysis of the Relationship between type traits and functional survival in US Holstein cattle using a Weibull proportional Hazards model. Journal of Dairy Science, 87 (8): 2677-2686, Elsevier Inc. All rights reserved. 10.3168/jds.S0022-0302 (04) 73394-9, Accessed on 21.06.2021.

[9]Daliri, Z., Hafezian, S. H., Shad Parvar, A., Rahimi, G., 2008, Genetic relationships among longevity, milk production and linear type traits in Iranian Holstein Cattle. Journal of Animal and Veterinary Advances, 7: 512-515.

[10]De Haas, Y., Janss, L. L., Kadarmideen, H. N., 2007, Genetic and phenotypic parameters for conformation and yield traits in three Swiss dairy cattle breeds. Journal of Animal Breeding and Genetics, 124(1): 12-19. 10.1111/j.1439-0388.2007.00630.x, Accessed on 21.06.2021.

[11]Dekkers, J. C. M., Jairath, L. K., Lawrence, B. H., 1994, Relationships between sire genetic evaluations for conformation and functional herd life of daughters. Journal of Dairy Science, 77: 844-854.

[12]Duru, S., Kumlu, S., Tuncel, E., 2012, Estimation of variance components and genetic parameters for type traits and milk yield in Holstein cattle. Turkish Journal of Veterinary & Animal Sciences, 36(6): 585-591. 10.3906/vet-1012-660, Accessed on 27.06.2021.

[13]Esteves, A. M., Bergmann, J. A. G., Duraes, M. C., Costa, C. N., Silva, H. M., 2004, Genetic and phenotypic correlations between type traits and milk production in Holstein cattle. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 56: 529-535.

[14]Gutierrez, J.P., Goyache, F., 2002, Estimation of genetic parameters of type traits in Austriana de los Valles beef cattle. Journal of Animal Breeding and Genetics, 119: 93-100.

[15]ICAR Recording Guidelines approved by the General Assembly held in Berlin, Germany, on May – Copyright: 2014, ICAR. 618 p.

[16]Jovanovac, S., Raguz, N., 2011, Analysis of the relationships between type traits and longevity in Croatian Simmental cattle using survival analysis. Agriculturae Conspectus Scientificus, 76 (30): 249-253.

[17]Jovanovac, S., Raguz, N., Solkner, J., Mészáros, G., 2013, Genetic evaluation for longevity of Croatian Simmental bulls using a piecewise Weibull model. Arch Tierzucht, 56: 89-101.

[18]Kern, E. L., Cobuci, J. A., Costa, C. N., McManus, C. M., Campos, G. S., Almeida, T. P., Campos, R. V., 2014, Genetic association between herd survival and linear type traits in Holstein cows under tropical conditions. Italian Journal of Animal Science, 13 (3419): 665-672. 10.4081/ijas.2014.3419, Accessed on 24.06.2021.

[19]Khan M. A., Khan, M. S., 2016, The heritability estimates of linear type traits in Sahiwal cows. The Journal of Animal & Plant Sciences, 26(1): 25-33.

[20]Klassen, D. J., Monardes, H. G., Jairath, L., Cue, R. I., Hayes, J. F., 1992, Genetic correlations between lifetime production and linearized type in Canadian Holsteins. Journal Dairy Science, 75 (8): 2272-2282.

[21]Ladyka V. I., Hmelnychyi L. M., Hmelnychyi S. L., 2019, Influence of the development of linear conformation traits characterizing the body state, on the viability of cows ukrainian brown dairy breed. Animal Breeding and Genetics, 58: 130-136.

[22]Lagrotta, M. R., Euclydes, R. F., Verneque, R. S., Santana, M. L., Pereira, R. J., de Almeida Tores, R., 2010, Relationship between morphological traits and milk yield in Gir breed cows. Pesquisa Agropecuária Brasileira, 45: 423-429.

[23]Larroque, H., Ducrocq, V., 2001, Relationship between type and longevity in the Holstein Breed. Genetics Selection Evolution, 33: 39-59.

[24]Liu, S., Tan, H., Yang, L., Yi, J., 2014, Genetic parameter estimates for selected type traits and milk production traits of Holstein cattle in southern China. Turkish Journal of Veterinary & Animal Sciences, 38: 552-556. doi:10.3906/vet-1107-37, Accessed on 01.07.2021.

[25]Meszaros, G., Fuerst, C. H., Fuerst-Waltl, B., Kadlecik, O., Kasarda, R., Solkner, J., 2008, Genetic Evaluation for Length of Productive Life in Slovak Pinzgau Cattle. Archives of Animal Breeding/Archiv Tierzucht-Index, 5: 438-448.

[26]Mirza, R. H., Javed, K., Abdullah, M., Pasha, T.N., Akhtar, M., 2015, Heritability estimates of some linear type traits in nili ravi buffaloes. The Journal of Animal & Plant Sciences, 25(1): 23-28.

[27]Morek-Kopec, M., Zarnecki, A., 2012, Relationship between conformation traits and longevity in Polish Holstein Friesian cattle. Livestock Science, 149: 53-61. 10.1016/j.livsci.2012.06.022, Accessed on 02.07.2021.

[28]Neuenschwander, T., Kadarmideen, H. N., Wegmann, S., de Haas, Y., 2005, Genetics of parity – dependent production increase and its relationship with health, fertility longevity, and conformation in Swiss Holsteins. Journal of Dairy Science, 88: 1540-1551.

[29]Novotny, L., Frelich, J., Beran, J., Zavadilova, L., 2017, Genetic relationship between type traits, number of lactations initiated, and lifetime milk performance in Czech Fleckvieh cattle. Czech Journal of Dairy Science, 62: 501-510. 10.17221/60/2017-CJAS, Accessed on 03.07.2021.

[30]Perez-Cabal, M. A., Garcia, C., Gonzalez-Recio, O., Alenda, R., 2006, Genetic and phenotypic relationships among locomotion type traits, profit, production, longevity, and fertility in Spanish dairy cows. Journal of Dairy Science, 89: 1776-1783.

[31]Samore, A. B., Rizzi, R., Rossoni, A., Bagnato, A., 2010, Genetic Parameters for Functional Longevity, Type Traits, Somatic Cell Scores, Milk Flow and Production in the Italian Brown Swiss. Italian Journal of Animal Science, 9 (28): 145-152. 10.4081/ijas.2010.e28, Accessed on 29.06.2021.

[32]Schneider, M. D., Durr, J. W., Cue, R. I., Monardes, H. G., 2003, Impact of type traits on functional herd life of Quebec Holsteins assessed by survival analysis. Journal of Dairy Science, 86: 4083-4089.

[33]Setati, M. M., Norris, D., Banga, C. B., Benyi, K., 2004, Relationships between longevity and linear type traits in Holstein cattle population of Southern Africa. Tropical Animal Health and Production, 36 (8): 807-814.

[34]Sewalem, A., Kistemaker, G. J., Miglior, F., Van Doormaal, B. J., 2004, Analysis of the relationship between type traits and functional survival in Canadian Holsteins using a Weibull Proportional Hazards Model. Journal of Dairy Science, 87: 3938-3946.

[35]Sewalem, A., Miglior, F., Kistemaker, G. J., 2010, Analysis of the relationship between workability traits and functional longevity in Canadian dairy breeds. Journal of Dairy Science, 93: 4359-4365.

[36]Sondergaard, E., Sorensen, M. K., Mao, I. L., Jensen, J., 2002, Genetic Parameters of Production Feed Intake, B Weight, Body Composition, and Udder Health in Lactating Dairy Cows. Livestock Production Science, 77: 23-34.

[37]Tapki, I., Ziya, G. Y., 2013, Genetic and phenotypic correlations between linear type traits and milk production yields of Turkish Holstein dairy cows. Greener Journal of Agricultural Sciences, 3 (11): 755-761.

[38]Vanderick, S., Croquet, C., Mayeres, P., Soyeurt, H., Gengler, N., 2006, Correlations of longevity evaluation with type traits in walloon region. Belo Horizonte, MG, Brasil. 8th World Congress on Genetics Applied to Livestock Production, August 13-18.
https://www.researchgate.net/publication/268327679, Accessed on 02.07.2021.

[39]Vollema, A. R., Groen, A. F., 1996, Genetic parameters of longevity traits of an upgrading dairy cattle population. Journal of Dairy Science, 79: 2261-2267.

[40]Vukasinovic, N., Moll, J., Kunzi, N., 1995, Genetic Relationships among Longevity, Milk Production and Type traits in Swiss Brown Cattle. Livestock Production Science, 41: 11-18.

[41]Vukasinovic, N., Moll, J., Kunzi, N., 1997, Analysis of productive life in Swiss Brown cattle. Journal of Dairy Science, 80: 2572-2579.

[42]Weigel, K. A., Lawlor, T. J., Vanraden, Jr. P. M., Wiggans, G. R., 1998, Use of linear type and production data to supplement early predicted transmitting abilities for productive life. Journal of Dairy Science, 81 (7): 2040-2044.
[43]Zavadilova, L., Nemcova, E., Stipkova, M., Bouska, J., 2009, Relationships between longevity and conformation traits in Czech Fleckvieh cows. Czech Journal of Dairy Science, 54 (9): 387-394.
[44]Zavadilova, L., Stipkova, M., 2012, Genetic correlations between longevity and conformation traits in the Czech Holstein population. Czech Journal of Dairy Science, 57 (3): 125-136.
[45]Zavadilova, L., Stipkova, M., Nemcova, E., Bouska, J., Matejickova, J., 2009, Analysis of the phenotypic relationships between type traits and functional survival in Czech Fleckvieh cows. Czech Journal of Dairy Science, 54 (12): 521-531.