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Study of association of type traits with lifetime milk traits in Frieswal cattle

M M CHOPADE[1]✉, SHRINIVAS JAHAGEERDAR[2], B S KATKADE[1], R S DESHMUKH[3] and M P SAWANE[3]

Maharashtra Animal and Fishery Sciences University, Nagpur, Maharashtra 440 001 India

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India's 70% rural households rely on agriculture, which generated 20% of GDP in 2020–21. Animal Husbandry, the allied sector of agriculture employs 8.8% of the population and supports two-thirds of rural households. The local market's demand for milk is always expanding, necessitating early selection of high-yielding cows. Type traits such as body measurement and udder traits are easy to measure and highly heritable allowing for indirect prediction of lifetime milk yield traits. This helps breeders to accelerate breeding, allocate resources effectively and increase farm business profitability. The study investigated the relationship between type traits and lifetime milk yield traits in Frieswal cattle. Data from 9094 lactation records from 3425 cows born to 239 sires were collected from Military Dairy Farm Pimpri, Pune. The study focused on body conformation and udder traits excluding cows with disease, debilitation or death before the first three lactations. The data was standardized and divided into two groups based on lactation completion: first three (LTMY3) and first five (LTMY5). Analysis was performed using SAS 9.13.

The overall mean for lifetime milk yield up to three lactations was observed as 10491.52±248.42 kg. The mean values for body length, body depth, wither height and chest girth was 82.12±0.40 cm, 127.89±0.58 cm, 112.92±0.60 cm and 184.83±0.86 cm, respectively (Table 1). However, value of udder parameters like udder length, fore udder height, rear udder height, fore udder width, rear udder width, fore udder depth and rear udder depth were 34.70±0.59 cm, 45.27 ±0.96 cm, 44.80±0.84 cm, 44.80±0.84 cm, 30.72±0.71 cm, 25.84 ±0.57 cm and 24.71±0.44 cm, respectively. Vacek *et al.* (2006) observed chest width, body depth and udder depth as 30.80±0.067 cm, 30.56±0.070 cm and 30.30±0.070 cm in Holstein Friesian cow, respectively. Whereas Cyprian *et al.* (2012) reported the overall mean for body depth, height at withers, heart girth, body length, rear udder height, rear udder width and udder depth as 100.65±0.31 cm, 124.20±0.65 cm, 172.34±0.75 cm, 120.13±0.19 cm, 18.48±0.17 cm, 18.83±0.13 cm and 15.09±0.15 cm, respectively in Friesian × Bunaji cows.

As per Table 2, the overall correlation between body measurement parameters and lifetime milk yield was low. The highest correlation (0.193) was observed between body depth with lifetime milk yield. However, the lowest correlation (0.044) was observed between body length and lifetime milk yield. The correlation between udder parameters with lifetime milk yield up to three lactations ranged from 0.002 (rear udder width with lifetime milk yield) to 0.217 (fore udder depth with lifetime milk yield). The low estimates of correlation between the body measurement traits and udder parameters traits with lifetime milk yield indicated that the selection of cow based on body measurement traits needs the additional source of information on animals for final selection. Hence the other criteria of selection may also be considered while the selection of the cows. Haas *et al.* (2007) reported the correlation between heart girth and body depth with 305 milk yield as 0.17 and 0.56 in Holstein cattle, 0.08 and 0.18 in Brown Swiss and 0.08 and 0.17 in Red and White cattle, respectively. Lifetime milk yield was most strongly related to the fore udder depth (r=0.217), followed by body depth (0.193) and rear udder depth (r=0.181). Sawa *et al.* (2013) observed that the correlation between body depth, chest width and udder width with three lactation milk yield as 0.09, 0.09 and 0.19, respectively in Holstein-Friesian breed. Ahmed *et al.* (2023) reported that the genetic correlations of udder width with total milk yield and persistency were strongly positive (0.86 and 0.93, respectively). However, strong negative genetic correlations were found between udder width with peak milk yield and lactation length (–0.92 and –0.80, respectively).

As per Table 2, the overall mean for length of productive life up to three lactations was observed as 898.83±10.47 days. The results obtained showed weak to low relationships between individual conformation traits and lifetime production efficiency in the cows which was slightly higher for milk yield than for length of productive life. The significant correlation was observed between fore

Present address: [1]College of Veterinary and Animal Sciences, Parbhani, Maharashtra. [2]Central Institute of Fisheries Education, Mumbai. [3]Mumbai Veterinary College, Parel, Mumbai. ✉Corresponding author email: drmmchopade@gmail.com

Table 1. Descriptive analysis for body measurement and udder traits up to three and five lactations

Trait	Up to three lactations		Up to five lactations	
	Mean±SE	C.V (%)	Mean±SE	C.V (%)
B_LEN	82.12±0.40	4.41	84.64±0.68	5.24
B_DPT	127.89±0.58	4.18	129.39±0.86	4.33
W_HT	112.92±0.60	4.84	113.35±0.80	4.61
CG	184.43±0.86	4.27	187.13±1.29	4.51
U_LEN	34.70±0.59	15.58	34.85±0.85	16.05
F_UD_HT	45.27±0.96	19.52	46.40±1.39	19.59
R_UD_HT	44.80±0.84	17.28	44.14±1.26	18.68
F_UD_WD	44.80±0.84	17.28	44.14±1.26	18.68
R_UD_WD	30.72±0.71	21.24	31.78±1.10	22.64
F_UD_DPT	25.84±0.57	20.12	25.68±0.58	14.88
R_UD_DPT	24.71±0.44	16.24	24.89±0.55	14.44
LTMY	10491.52±248.42	2.36	12235.33±515.38	27.62
LPL	898.83±10.47	1.65	1492.86±4.03	7.62

B_LEN, body length; B_DPT, body depth; W_HT, Wither Height; CG, chest girth; U_LEN, Udder length; F_UD_HT, Fore udder height; R_UD_HT, Rear udder height; F_UD_WD, Fore udder width; R_UD_WD, Rear udder width; F_UD_DPT, Fore udder depth; R_UD_DPT, Rear udder depth; LTMY5, Lifetime milk yield up to five lactations; LPL5, Length of productive life up to five lactations.

udder depth and lifetime milk yield up to three lactations. The moderate and significant correlation of udder depth (0.217) with lifetime milk yield indicated that it can be the important indicator for selection of animals for high lifetime milk yield up to three lactations. Whereas, the low estimates of the other body measurement traits and udder parameters in the present study showed limited importance of these traits in the breeding program, therefore it indicates that these traits to be supported with the other ways of selection. The estimates of correlation between udder parameters with length of productive life up to three lactations ranged from 0.027 (body depth with length of productive life) to 0.172 (wither height with length of productive life). The estimates of correlation between udder parameters with length of productive life up to three lactations ranged from to 0.002 (fore udder depth with length of productive life) to 0.098 (udder length with length of productive life) The low relationship between the body measurement traits and udder parameters traits with length of productive life indicated that while selecting the cows for better performance on the basis of these traits some other criteria of selection may also be considered to make the selection effective. Mrode and Swamson (1994) also reported the low correlation between the udder parameters and milk yield in Ayreshire heifers. Similarly, Vacek *et al*. (2006) also reported low correlations between udder traits with productive life (ranging from 0.071 to 0.1) in Holstein cows. Dadpasand *et al.* (2008) studied impact of conformation traits on functional longevity of Holstein cattle and reported strongest relationship between length of productive life and type traits were found for fore udder attachment, udder depth, udder cleft angularity and loin strength. Sawa *et al.* (2013) observed that the correlation between body depth, chest width and udder

Table 2. Correlation between body measurement traits and udder parameter traits with lifetime traits up to three and five lactations

Trait	Lifetime traits up to three lactations		Lifetime traits up to five lactations	
	Lifetime milk yield (r)	Length of productive life (r)	Lifetime milk yield (r)	Length of productive life (r)
Body measurement trait				
Body length	0.044	0.116	0.052	-0.079
Body depth	0.193	0.027	-0.133	0.071
Wither height	0.103	0.172	0.049	0.217
Chest girth	0.100	0.094	0.119	-0.072
Udder parameter trait				
Udder length	0.029	0.098	0.172	0.202
Fore udder height	0.028	0.013	0.082	0.085
Rear udder height	0.075	0.050	0.102	0.038
Fore udder width	0.075	0.050	0.102	0.038
Rear udder width	0.002	0.022	0.282	0.209
Fore udder depth	0.217*	0.002	0.297	0.264*
Rear udder depth	0.181	0.095	0.366*	0.168

*Correlation is significant at the 0.05 level (2-tailed).

width with length of productive life –0.05, –0.07 and –0.01, respectively in Holstein-Friesian. On the contrary, Setati *et al.* (2004) reported that udder traits may be useful tools in improving the longevity of dairy cows and further imply that these traits are economically important to the dairy producers.

As per the data presented in Table 1, the overall mean for lifetime milk yield up to five lactations was observed as 12235.33±515.38 kg. The average mean of body length, body depth, wither height and chest girth were observed as 84.64±0.68, 129.39±0.86, 113.35±0.80, and 187.13±1.29 cm, respectively. However, udder parameters, i.e. udder length, fore udder height, rear udder height, fore udder width, rear udder width, fore udder depth and rear udder depth were observed as 34.85±0.85, 46.40±1.39, 44.14±1.26, 44.14±1.26, 31.78±1.10, 25.68±0.58 and 24.89±0.55 cm, respectively.

The moderate and significant correlation was observed between rear udder depth and lifetime milk yield up to five lactations (Table 2). It was found that the overall correlations between body measurement parameters and lifetime milk yield were low. The highest correlation (0.119) was observed between chest girth with lifetime milk yield up to five lactations. However, the lowest correlation (–0.133) was observed between body depth and lifetime milk yield up to five lactations. The correlation between udder parameters with lifetime milk yield up to five lactations ranged from 0.082 (fore udder height with lifetime milk yield up to five lactations) to 0.366 (rear udder depth with lifetime milk yield up to five lactations). The high and significant (0.366) correlation of udder depth with lifetime milk yield up to five lactations indicated its importance in selection program along with other main criteria of selection. Whereas, the low estimates of the other body measurement traits and udder parameters in the present study showed their limited importance in the breeding program.

Haas *et al.* (2007) reported the low correlation between confirmation traits and milk production in Holstein (–0.35 to 075), Brown Swiss (–0.08 to 0.19) and Red and White heifers (–0.15 to 0.19). Soni *et al.* (2020), reported positive association of milk yield with stature (r=0.369), chest width (r=0.338) and rear udder height (r=0.069). Similarly Bohlouli *et al.* (2015) also reported the negative to low correlations (ranging from –0.01 to 0.13) of type traits with milk yield in Holstein dairy cattle.

The overall mean for length of productive life up to five lactations was observed as 1492.86±4.03days (Table 1). The estimated correlation between different body measurement and udder parameters with length of productive life up to five lactations has been shown in Table 2. It was found that the overall correlation between body measurement traits and length of productive life was low indicating that the direct selection of the cows for length of productive life based on the body measurement traits will result in slow genetic progress. The estimates of correlation between udder parameters with length of productive life up to five lactations ranged from –0.079 (body length with length of productive life up to five lactations) to 0.217 (wither height with length of productive life up to five lactations). The estimates of correlation between udder parameters with length of productive life up to five lactations ranged from 0.038 (rear udder height and fore udder width with length of productive life up to five lactations) to 0.264 (fore udder depth with length of productive life up to five lactations). The low correlation of body measurement traits with length of productive life was also reported by Vukasinovic *et al.* (1995) in Swiss Brown cattle. However, the positive and moderate correlation was reported between udder parameters and productive life. Setati *et al.* (2004) reported that the phenotypic correlation between all type traits and longevity traits were less than 0.1. Vacek *et al.* (2006) reported that productive life had positive correlations with most linear type traits excluding, rear leg set-side view, rump angle udder depth and teat length which were negative.

SUMMARY

Most of the type traits have positive correlated response with lifetime traits. Therefore, these traits are important for selection of animals for high milk yield. Moreover, the udder depth can be used as a good indicator for predicting lifetime milk yield and length of productive life. Lastly, the selection may be supported with the detected QTLs, significant SNPs and candidate genes which are the potential tools to improve the lifetime traits.

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