



Assessment of body conformation traits and their relationship with production performance of Sahiwal cows

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ABSTRACT

Linear type scoring is key component in decision making process in the herd, as it focusses on the selection of animals with higher productive potential based on their body conformation/linear traits. The present study was carried out on 150 lactating Sahiwal cattle of first to fifth parity. Measurements on linear type traits were recorded 1 h before the evening milking at three different stages of lactation. The average score point of objective linear type traits was stature 5.77 ± 0.08 , chest width 4.59 ± 0.10 , body depth 5.24 ± 0.10 , rump width 5.56 ± 0.09 , rump angle 4.48 ± 0.08 , rear legs sets 4.81 ± 0.12 , foot angle 4.84 ± 0.10 , fore udder attachment 4.85 ± 0.11 , rear udder height 5.52 ± 0.10 , udder depth 5.31 ± 0.08 , rear udder width 4.27 ± 0.09 , central ligament 4.01 ± 0.09 , fore teat length 3.49 ± 0.10 , rear teat length 3.94 ± 0.09 , teat circumference 4.20 ± 0.11 , teat diameter 4.16 ± 0.10 and udder balance 5.25 ± 0.11 . On the other hand, average score point of subjective linear type traits (1-9 scale) was angularity 4.69 ± 0.09 , rear leg rear view 5.05 ± 0.06 , body condition score 6.53 ± 0.08 , locomotion 4.88 ± 0.06 , fore teat placement 4.41 ± 0.07 and rear teat placement 6.28 ± 0.08 . Most of the body conformation traits in Sahiwal cattle were falling under intermediate category and of desirable type. However, some traits like stature, chest width, body depth, rump width, angularity, central ligament, rear udder height, rear udder width and fore udder attachment expressed scope for further improvement.

Keywords: Body conformation, Linear traits, Production, Sahiwal cattle, Selection

Now-a-days, the dairy animals are reared under modern intensive systems for high milk production which exerts undue pressure on animals for maintaining their body under changing climatic conditions. Each individual animal is subjected to different types of selection criteria for improvement in its performance. Higher selection pressure for milk yield traits has been associated with occurrence of different metabolic diseases, decrease in the value of important conformation traits and harmful effects on health. Every year on a dairy farm, a significant portion of cows are culled from the herd for many other reasons rather than low production; hence, it is crucial to select cows that are physically fit to prevent such losses (Khan and Khan 2015). Selection for better conformation traits will increase strength, stamina and survival of dairy cows. Choosing better type traits may improve functionality and longevity of the animal for dairy production. Linear scoring is based on measurement of individual linear type traits instead of beliefs and judgments. In type scoring system, individual linear type traits are scored on 1-9 point scale considering the biological extremes of the traits, i.e. minimum to maximum degree. Moreover, type traits

have been used as indirect selection criteria for enhancing the life span of dairy cattle (Cruickshank *et al.* 2002). Normally, productive and reproductive data are recorded properly on a dairy farm but linear traits are not recorded in normal routine. The selection of cows is mainly done on the basis of lactation yield (Khan and Khan 2016) and bull calves are mainly selected based on their respective dam yield (Bhatti *et al.* 2007). In our country, the type traits are not normally included in selection indices, but various studies have reported that type traits like stature, chest width, body depth, angularity, rump width, rump angle, teat length, front teat placement, udder depth, have medium to high heritability. Inclusion of these type traits might be helpful for devising better breeding strategies for Sahiwal cows having ideal dairy conformation. Farmers also consider a cow with straight back, triangular shaped body and large capacious udder as the best producer (Belihu 2002). Relationship between type traits and production/reproduction performance is also well established by previous studies. Keeping in view above intricacies, the present study was conducted to assess the standard linear traits of Sahiwal cows and their correlation with milk production.

MATERIALS AND METHODS

For this study, 150 lactating Sahiwal cattle having first to fifth parity were selected from Livestock Research

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Centre of ICAR-NDRI, Karnal based on their previous lactation yield (>1500 kg). The study was conducted from 2020-22 and approved by the Institutional Animal Ethical Committee of NDRI.

Body measurements were recorded as per recommendation made by International Committee for Animal Recording (ICAR 2018). Measurements on type traits were recorded one hour before the evening milking at three stage of lactation (20-50 days, 90-130 days and 180-200 days). The measurement was taken to nearest centimeter with utmost precision. The animals within 15 days after parturition were not entitled for scoring to avoid influence of edematous swelling of udder. The milk production and reproduction data of lactating animals at the time of research work were collected from daily milk yield register maintained in the record room.

Production traits like monthly milk yield (kg), 305 days or less milk yield (kg), total milk yield (kg) were also recorded. The range for each trait was calculated by subtracting the minimum value from maximum. As the number of classes in which the animals were evaluated is 9, thus range was divided by 9 so as to get the unit score point. This 'unit score point' was added to that of minimum value to get the range for score 1. The subsequent score were obtained by adding unit score point to the highest unit of previous classes.

Statistical analysis: SPSS software was used for the statistical analysis. Descriptive analysis of type traits was carried out by using standard statistical procedure (Snedecor and Cochran 1994). Phenotypic correlation (r_p) between traits between type traits and production traits was computed by standard statistical procedure using Pearson's correlation coefficient.

RESULTS AND DISCUSSION

Measurement of linear traits in Sahiwal cattle:

Descriptive statistics and average score points (ASP) of all linear type traits have been given in Table 1 and 2. Frequency of different body, feet/legs type traits, udder type, teat type and visual scoring traits have been given in Supplementary Tables 1, 2, 3 and 4. The linear type scores for most of the traits followed normal distribution. The ASP score of stature, chest width, body depth, rump angle, rump width, rear legs set (angle), foot angle, fore udder attachment, rear udder height, rear udder width, udder depth, central ligament, udder balance were found to be under the intermediate category. Analogous finding were reported by Dubey *et al.* (2014), Khan and Khan (2015), Godara *et al.* (2015), Campos *et al.* (2015), Penev *et al.* (2017) and Deginal (2020). Stature represents vertical distance from ground to the highest point of hip bone. Taller stature is a preferable trait since it allows the animal to carry their udder higher, reducing the occurrence of mastitis. A cow with wider chest and broad shoulder shows better productive ability as dairy animal. Body depth indicates a larger body capacity, which is associated with consuming a large amount of feed and fodder to produce more milk. A rump with pin bone slightly lower than the hips, along with wider rump width was preferred because it decreases the cases of retained placenta, dystocia, better uterine discharge, greater longevity (Godara *et al.* 2015). Wider rump helps in proper uterine advancement and normal calving. Rump width is an important type trait, which indicated the good fertility in female dairy animals (Buranakarl *et al.* 2013). A rear legs set (angle) was measured from hock by visualizing the sickliness of hock joint. Foot angle in cattle represents the angle at the front of the rear hoof. The morphology of legs plays an important role in walking and important factor for involuntary culling. Health problem with feet lesions are not only problem to animal welfare but also cause prolongation of calving interval due to poor estrus detection (Sogstad *et al.* 2006). Fore udder attachment of

Table 1. Descriptive statistics of linear traits (measurements) in Sahiwal cattle

Type trait	Mean±SE	S.D	Sample Variance	Range	Minimum	Maximum
Stature (cm)	125.35±0.26	4.09	16.78	26.45	109.80	136.25
Chest width (cm)	25.96±0.15	2.36	5.58	12.90	20.10	33.00
Body depth (cm)	64.06±0.22	3.46	12.00	19.52	53.75	73.27
Rump width (cm)	16.92±0.11	1.73	2.99	10.34	11.20	21.54
Rump angle (cm)	12.94±0.22	3.50	12.31	24.04	0	24.04
Rear leg sets (degree)	159.78±0.43	6.89	47.52	32.03	143.97	176.00
Foot angle (degree)	43.47±0.31	4.89	23.92	28.00	30.00	58.00
Fore udder attachment (degree)	123.23±1.29	20.26	410.76	98.00	76.00	174.00
Rear udder height (cm)	17.55±0.24	3.84	14.81	22.04	7.96	30.00
Udder depth (cm)	6.80±0.29	4.64	21.58	34.00	-11.5	22.50
Rear udder width (cm)	8.39±0.13	2.06	4.26	12.32	3.20	15.52
Central ligament (cm)	3.21±0.07	1.12	1.26	7.01	0.50	7.51
Fore teat length (cm)	7.34±0.13	2.06	4.24	10.70	3.50	14.2
Rear teat length (cm)	6.47±0.12	1.91	3.65	11.33	2.20	13.53
Teat circumference (cm)	10.00±0.11	1.86	3.48	9.80	6.02	15.82
Teat diameter (cm)	3.18±0.03	0.59	0.35	3.14	1.92	5.06
Udder balance (cm)	-0.22±0.16	2.57	6.61	12.50	-6.00	6.50

Table 2. Average score points (ASP) of linear type traits under 1- 9 score system

Type trait	ASP	Interpretation	Desirable
Stature	5.77±0.08	Intermediate	Tall
Chest width	4.59±0.10	Intermediate	Wide
Body depth	5.24±0.10	Intermediate	Deep
Rump width	5.56±0.09	Intermediate	Wide
Rump angle	4.48±0.08	Intermediate	More slope
Angularity	4.69±0.09	Intermediate	Angular
Rear leg rear view	5.05±0.06	Intermediate	Intermediate
Rear leg sets	4.81±0.12	Intermediate	Intermediate
Foot angle	4.84±0.10	Intermediate	Intermediate
Body condition score	6.53±0.08	Grossly fat	Intermediate
Locomotion	4.88±0.06	Intermediate	Long stride
Fore udder attachment	4.85±0.11	Intermediate	Strong
Rear udder height	5.52±0.10	Intermediate	High
Udder depth	5.31±0.08	Intermediate	Intermediate
Rear udder width	4.27±0.09	Intermediate	Wide
Central ligament	4.01±0.09	Intermediate	Strong
Fore teat length	3.49±0.10	Short	Intermediate
Rear teat length	3.94±0.09	Intermediate	Intermediate
Teat circumference	4.20±0.11	Intermediate	Intermediate
Teat diameter	4.16±0.10	Intermediate	Intermediate
Udder balance	5.25±0.11	Intermediate	Intermediate
Fore teat placement	4.41±0.07	Intermediate	Intermediate
Rear teat placement	6.28±0.08	Intermediate	Intermediate

*, Correlation significant at 5%; **, Correlation significant at 1%.

an animal represents the strength of attachment of the fore udder to the abdominal wall by the lateral ligament. The rear udder height depicted the distance from the bottom of vulva and top of milk secreting tissue. Rear udder width represents the glandular capacity of udder in lactating dairy animal. Udder depth was evaluated as the relationship of the udder floor relative to the hock. Shallow udder had been related with less chance of infection, minor udder injury and greater longevity. Central ligament in form of a deep udder cleft is indicator of strong median suspensory ligament and dairy animal with strong ligament can easily bear the weight of udder in a better way. Udder balance mostly depends upon the attachment of suspensory ligament with udder. The ASP of fore and rear teat length were short and intermediate, respectively. Kumari (2019) reported similar teat length results. The intermediate teat length was preferred because long teats are predisposed to a higher incidence of mastitis. The ASP of teat thickness was intermediate. Patel and Trivedi (2018) reported similar trends for teat thickness in crossbred cow.

Linear traits on basis of visual classification: Linear traits like angularity, BCS, rear leg rear view, locomotion, fore teat placement and rear teat placement were given values on the basis of visual scoring (Table 2). Angularity is the important body trait used for assessing milking

ability of dairy animals. In present investigation, the ASP for angularity, rear legs rear view, locomotion, fore and rear teat placement was intermediate type which can be improved further. Similar results were also observed by Campos *et al.* (2015), Khan and Khan (2015) and Penev *et al.* (2017). Rear view was assessed as direction of the rear feet from back side of animal. Walking cows with toe out may experience increased stress on their feet and legs, as well as an increased risk of injury to rear udder. Locomotion has the potential to reduce the overall life time performance of dairy cows and more risk of involuntary culling (Huxley 2013). Position of teats determines the proper drainage of milk and visual appraisal of udder. The udder depth along with rear teats placement significantly influenced the herd life and functionality of dairy cows (Atkins and Shannon 2002). The ASP for BCS was coming under grossly fatty category. However, in Holstein cows Zink *et al.* (2014) had observed lower ASP for BCS in Holstein cows. This variation may be due to breed, feeding management practices and method of assessment.

Phenotypic correlation between body type linear and production traits: Phenotypic correlation between body type and production traits has been given in Table 3. Body depth was positively correlated with 305 DMY, TMY and monthly milk yield (MMY). Alphonsus *et al.* (2010) in Friesian × Bunaji cows and Dubey (2010) in Sahiwal cattle found similar results. The phenotypic correlation between body depth and milk yield in present study was higher than 0.15 (Zink *et al.* 2014), and 0.10 (Khan and Khan 2016). The positive correlation can be attributed to large body capacity in cows associated with more space for digestive and respiratory organs. The angularity was found to be positively correlated with MMY. Bohlouli *et al.* (2015) reported lower (0.10) while Dahiya and Rath (1997) reported higher (0.59) phenotypic correlation than current study between angularity and MY. Angularity of body is most important trait which is associated with milk production capacity of cattle (Dahiya and Rath 2002). The BCS was significantly and negatively correlated with 305 DMY and TMY. The correlation between BCS and MY in present study was higher than -0.15 (Zink *et al.* 2014) and lower than -0.37 (Alphonsus *et al.* 2010). It could be ascribed to tissue mobilization and energy balance. The association between feet, legs type traits and 305 days MY, total milk yield and monthly milk yield were generally weak and negative (Table 3). The week relationships indicated the existence of some degree of independence of production traits.

Phenotypic correlation between udder type and production traits: The udder depth was found to be negatively ($P \leq 0.05$) correlated with 305 days MY, MMY and TMY (Table 3). These finding were in agreement with Madrid and Echeverri (2014) who reported negative association (-0.21) between udder depth and MY. Khan and Khan (2016) and Sharma (2019) reported negative correlation between udder depth and MY. Various workers reported wide range of correlation (-0.20 to -0.48) between

Table 3. Phenotypic correlation between linear type and production traits

Trait	305 DMY	TMY	MMY
<i>Between body type and production traits</i>			
Stature	-0.07	-0.09	0.02
Chest width	-0.03	-0.01	0.11
Body depth	0.23*	0.29**	0.36**
Rump width	-0.09	-0.09	0.06
Rump angle	-0.03	-0.09	0.04
Angularity	0.14	0.15	0.22*
Body condition score	-0.21*	-0.23*	-0.07
<i>Between feet, legs type and production traits</i>			
Rear leg rear view	0.06	-0.01	-0.02
Rear legs set	-0.00	0.08	0.05
Foot angle	0.06	0.08	0.04
Locomotion	0.04	0.00	-0.06
<i>Between udder type and production traits</i>			
Fore udder attachment	0.10	0.05	-0.02
Rear udder height	0.00	0.03	0.00
Udder depth	-0.17*	-0.27**	-0.22*
Rear udder width	0.18*	0.24**	0.21*
Central ligament	0.23*	0.30**	0.21*
Udder balance	0.03	0.01	0.05
<i>Between teat type and production traits</i>			
Fore teat length	0.02	0.07	0.13
Rear teat length	0.10	0.11	0.15
Teat circumference	0.11	0.19*	0.03
Teat diameter	-0.03	-0.04	-0.00
Fore teat placement	-0.04	-0.04	0.02
Rear teat placement	0.13	0.13	0.16

udder depth and milk yield (Madrid and Echeverri 2014, Gibson 2015). Cows having deep udder might be more prone to mastitis and injury; hence, udder depth was negatively associated with milk production capacity. Rear udder width was positively correlated with 305 DMY, MMY and TMY. Khan and Khan (2016) and Kumari (2019) also found significant positive correlation between rear udder width and MY. Animals with wider rear udder width possess more surface area inside the udder for mammary tissue, which is known to synthesize milk, resulting in more milk production. The correlation between udder cleft, MY, MMY and TMY was significant and positive. Other studies by Dubey (2010), Khan and Khan (2016), Kumari (2019) and Deginal (2020) also found positive correlation of udder cleft and milk yield. High positive correlation with udder cleft suggested that cows having strong udder cleft have longer herd life, lesser chances of injury to udder due to elevated udder. The teat circumference had positive correlation with total milk yield (Table 3). Sharma (2019) and Kumari (2019) reported positive correlation between teat circumference with TDMY and MMY in Sahiwal cows.

Most of linear type traits in Sahiwal cattle were of intermediate and desirable type, except traits like stature, chest width, body depth, rump width, angularity, central

ligament, rear udder height, rear udder width and fore udder attachment, which indicated scope for further improvement by inclusion of these traits in selection programme for selection of elite dairy cows.

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