Research Article

Development of Linear Score System for Sahiwal Cows in Pakistan

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Abstract | Conformation is considered important to varying degree in different production indices besides milk. Linear scoring is the most recent method for describing a dairy cow in terms of conformation. The present study was designed with the objectives to develop linear score system for Sahiwal cattle. Body and udder measurements recorded on 310 Sahiwal cows were used for assigning linear score to each trait following the guidelines of International Committee on Animal Recording. The ASReml Version 2.0 was the statistical package used. The linear model included fixed effects of herd, parity, stage of lactation and the age of cow at classification as co-variable. The linear type score (mean±SD) were: stature 5.1±2.0, chest width 4.4±1.53, body depth 4.8±1.92, angularity 5.1±1.1, rump angle 5.2±1.56, rump width 4.7±1.46, rear legs set 4.9±1.71, rear legs rear view 4.3±1.77, foot angle 5.3±1.89, fore udder attachment 4.5±1.77, rear udder height 5.1±1.25, central ligament 3.8±1.55, udder depth 4.9±1.67, teat placement rear view 5.0±1.40, fore teat length 4.0±1.84, rear udder width 3.5±1.74, thurl width 4.9±1.37, naval length 4.7±1.43, dewlap width 4.5±1.29, dewlap surface area 4.4±1.71 and dewlap visual score 2.2±0.74. Means for most of the linear type traits fall in intermediate category. Presently animals could be selected for increase in height, chest width, body depth, rump width, thurl width, rear udder width and central ligament.

Keywords | Sahiwal cattle, Type traits, Linear scoring, Linear score means, Pakistan

INTRODUCTION

There are many characters that have been incorporated in selection indices in developed countries. Type is emphasized to varying degree in different type production indexes in different countries. Type is the word used literally to describe an animal in terms of conformation. Dairymen and livestock breeders usually try to seek best type cows and willing to pay more for these beautiful and functional animals (Hyatt et al., 1949; White, 1974).

Greater genetic progress can be attained by considering conformation and milk yield together while selecting for increased milk yield (Naidu, 1972). Selection for better type will increase strength, stamina and survival of dairy cows (Boettcher et al., 1993). Selection on linear type traits may improve functionally and longevity of the animal for dairy production (Harris et al., 1992). In an effort to breed

dairy cattle to with stand the stress of high production over several lactations; dairy producers have often selected bulls based on transmitting abilities for various conformation traits. Herd life studies suggested that mammary traits, particularly udder depth, fore udder attachment and teat placement should be emphasized while selecting animals (Funk, 1993). The reliability of evaluation for herd life for young bulls was enhanced by considering conformation information on correlated traits that can be measured early in the life of bulls. Conformation traits have been used as indirect selection criteria for herd life (Vukasinovic et al., 2002). High yielding Holstein heifers had deeper udders and were more angular in dairy character (Brotherstone, 1994). High producing heifers would be taller, larger and longer than low producing heifers (Lin et al., 1987). It becomes evident from preceding discussion that type is important selection criteria to be considered for breeding livestock.

The Royal Jersey Agricultural Society drew up the first score card ever developed for evaluating type of Jersey cattle in 1834 (Copeland, 1964). Type classification has under gone various changes from a single total score to the most recent uniform functional type traits (UFTT) program. A type committee appointed by the National Association of Animal Breeders (NAAB) in 1977 recommended this program. The new UFTT program that included 13 appraisal traits to supplement breeder association's traditional final score was implemented in January (1980) by the Ayrshire, Guernsey and Jersey breed associations, in January (1981) by the Milking Shorthorn and Red and White breed associations and in January (1982) by the Brown Swiss Association. Holstein Breed Association implemented a similar program in January (1983). National Association of Animal breeders (NAAB) proposed scoring 14 traits on a 50-point basis with each trait being scored from one biological extreme to the other (Norman et al., 1983). The topic has been reviewed extensively (Bowden, 1982; Burnside et al., 1984). The means for type traits on 9 point scale has been reported for Czech Holstein cattle (Nemcova et al., 2011). The linear score system has been developed for Nili Ravi Buffaloes (Javed et al., 2013). The Sahiwal cattle in India have been appraised for linear type traits on a 9 point scale (Dubey et al., 2014).

The linear type trait scoring on Sahiwal cattle breed in Pa-kistan has not been made in the past. The objectives of the study were to develop standards for linear type traits for Sahiwal cattle breed. Secondly to describe the Sahiwal cattle in terms of linear score that how Sahiwal cattle looks like.

MATERIALS AND METHODS

DATA COLLECTION

The study was started at three herds of Sahiwal cattle in the Punjab Province of Pakistan. Freshly calved cows were selected for linear scoring. Cows from lactation first to fifth were included in study. There were 310 lactating cows became available fulfilling said criterion. Measurements on body and udder traits were recorded at three stages of lactation (15 to 45 days, 90 to 120 days and 165 to 195 days after calving). The measurements were converted into class interval for assigning linear score. Each cow was assigned linear score thrice provided she remained in milk. Cows within 15 days after freshening were not entitled for scoring just to avoid error because of edematous swelling.

A specially designed proforma was used for recording measurements and for assigning linear score for traits scored visually. Major emphasis was laid on the 15 linear type traits approved as standard traits by the International Committee for Animal Recording (ICAR, 2002). The following were traits: 1) stature, 2) chest width, 3) body depth,

Table 1: Linear score assignment basis for Sahiwal cattle

Score	1	2	3	4	5	6	7	8	9
Stature (cm)	≤117	118-119	120-121	122-123	124-125	126-127	128-129	130-131	≥132
Chest width (cm)	≤22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	≥37
Body depth (cm)	≤61	62-63	64-65	66-67	68-69	70-71	72-73	74-75	≥76
Angularity				Visual score					
Rump angle (degree)	≤0	1-3	4-6	7-9	10-12	13-15	16-18	19-21	≥22
Rump width (cm)	≤12	13	14	15	16	17	18	19	≥20
Rear legs set (degree)	≤158	159-160	161-162	163-164	165-166	167-168	169-170	171-172	≥173
Rear legs rear view				Visual scoring					
Foot angle (degree)	≤36	37-39	40-42	43-45	46-48	49-51	52-54	55-57	≥58
Fore udder attachment				Visual scoring					
Rear udder height (cm)	≥30	28-29	26-27	24-25	22-23	20-21	18-19	16-17	≤15
Central ligament (cm)	≤1	1.5	2	2.5	3	4	5	6	≥7
Udder depth (cm)	≤2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	≥24
Teat placement rear view				Visual scoring					
Teat length (cm)	≤5	5	6	7	8	9	10	11	≥12
Rear udder width (cm)	≤6	7	8	9	10	11	12	13	≥14
Thurl width (cm)	≤35	36-37	38-39	40-41	42-43	44-45	46-47	48-49	≥50
Naval length (cm)	≤5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	≥20
Dewlap width (cm)	≤9	10-11	12-13	14-15	16-17	18-19	20-21	22	≥23
Dewlap surface area (cm)	≤395	401-475	476-550	551-625	626-700	701-775	776-850	851-921	≥922
Dewlap visual score				Visual scoring					

4) angularity, 5) rump angle, 6) rump width, 7) rear legs set, 8) rear legs rear view, 9) foot angle, 10) fore udder attachment, 11) rear udder height, 12) central ligament, 13) udder depth, 14) teat placement rear view, 15) fore teat length, 16) rear udder width and 17) thurl width, 18) naval length, 19) dewlap width, 20) dewlap surface area and 21) dewlap visual score. The traits including rear legs rear view, fore udder attachment and front teat placement were assigned objectively a linear score on a scale of 1-9 according to the procedures outlined for conformation recording by the International Committee for Animal Recording (ICAR, 2002). Dewlap of each cow was visually scored into three categories (dewlap with light skin folds, intermediate skin folds and heavy skin folds). However subjective measurements were recorded for all other traits with different tools like height gauge, callipers, vernier calliper, ruler, compass, protractor and cloth tape. Traits were recorded in nearest centimetres.

ASSIGNMENT OF LINEAR SCORE
Keeping in view, the biological extremes of measurement traits a class interval was constructed for each trait (Table 1). Traits were assigned linear score on a scale of 1-9 in the light of these class intervals.

STATISTICAL ANALYSIS
The ASReml (Version 2.0), was the statistical package used (Gilmour et al., 2007). The least square means for linear type traits were obtained after fitting fixed effect model. The linear model included fixed effects of herd, parity and stage of lactation at classification. The age of cow at classification was used as co-variable.

The reduced model assumed the following statistical expression after excluding linear and quadratic effect of age of cow at classification being non-significant in initial analysis:

$$Y_{ijkl} = \mu + H_i + P_j + T_k + e_{ijkl}$$

Where
μ= overall mean
H_i = effect of ith herd (1-3)
P_j = effect of jth parity (1-2)
T_k = effect of kth stage of lactation (1-3)
a_{ijkl} = age of cow at classification
e_{ijkl} = random error associated with each observation

RESULTS

DESCRIPTIVE STATISTICS OF LINEAR TYPE TRAITS
The means, minimum and maximum along with standard deviations are presented in Table 2. The linear score for most of the traits fall in intermediate range. The mean linear scores were for stature 5.1±2.0, chest width 4.4±1.53,

body depth 4.8±1.92, angularity 5.1±1.1, rump angle 5.2±1.56, rump width 4.7±1.46, rear legs set 4.9±1.71, rear legs rear view 4.3±1.77, foot angle 5.3±1.89, fore udder attachment 4.5±1.77, rear udder height 5.1±1.25, central ligament 3.8±1.55, udder depth 4.9±1.67, teat placement rear view 5.0±1.40, fore teat length 4.0±1.84, rear udder width 3.5±1.74, thurl width 4.9±1.37, naval length 4.7±1.43, dewlap width 4.5±1.29, dewlap surface area 4.4±1.71 and dewlap visual score 2.2±0.74, respectively.

Table 2: Descriptive statistics of linear type traits for Sahiwal cattle

Traits	Min	Mean	Max	Standard Deviation
Stature	1	5.1	9	2.00
Chest Width	1	4.4	9	1.53
Body Depth	1	4.8	9	1.92
Angularity	1	5.1	9	1.81
Rump Angle	1	5.2	9	1.56
Rump Width	1	4.7	9	1.46
Rear Leg Set	1	4.9	9	1.71
Rear Legs Rear View	1	4.3	9	1.77
Foot Angle	1	5.3	9	1.89
Fore Udder Attachment	1	4.5	9	1.77
Rear Udder Height	1	5.1	9	1.25
Central Ligament	1	3.8	9	1.55
Udder Depth	1	4.9	9	1.67
Teat placement rear view	1	5.0	9	1.40
Fore teat Length	1	4.0	9	1.84
Rear Udder Width	1	3.5	9	1.74
Thurl Width	1	4.9	9	1.37
Naval length	1	4.7	9	1.43
Dewlap width	1	4.5	9	1.29
Dewlap surface area	1	4.4	9	1.71
Dewlap visual score†	1	2.2	3	0.74

† Scored on a scale of 1-3

CLASSIFICATION OF SAHIWAL CATTLE FOR LINEAR TYPE TRAITS
How the Sahiwal cows included in present study look like is presented in Table 3. For most of the linear type traits, Sahiwal cows were classified in intermediate range. The cows were in intermediate category for stature, chest width, body depth, angularity, rump angle, rump width, rear legs set, rear legs rear view, foot angle and thurl width. The cows were possessing acceptable score for fore udder attachment, very low height at rear attachment, slight definition at central ligament, udder was set above hocks, rear udder was not very wide and teats of medium length were placed at middle of quarter.

Table 3: Classification of Sahiwal cattle for linear type traits

Traits	Mean±SD	Measurement (cm)	Description
Stature	5.1±2.0	124-125	Intermediate height at spine in between hooks
Chest Width	4.4±1.53	27-28	Intermediate neither wide nor narrow
Body Depth	4.82±1.92	67-68	Intermediate neither deep nor shallow
Angularity	5.1±1.81	-	Intermediate
Rump Angle	5.2±1.56	10-12*	Intermediate slope from hooks to pins
Rump Width	4.7±1.46	16	Intermediate
Rear Leg Set	4.9±1.71	165-166*	Intermediate neither sickled nor straight
Rear Legs Rear View	4.3±1.77	-	Intermediate toes slightly inclined to outward
Foot Angle	5.3±1.89	46-48*	Intermediate
Fore Udder Attachment	4.5±1.77	-	Intermediate/acceptable
Rear Udder Height	3.3±1.25	24-25	Very low
Central Ligament	3.8±1.55	2.5	Intermediate slight definition
Udder Depth	4.9±1.67	12.14	Intermediate set above hock
Teat placement rear view	5.0±1.40	-	Teats placed at middle of quarters
Fore teat length	4.0±1.84	7	Intermediate
Rear Udder Width	3.5±1.74	9	Not very wide
Thurl Width	4.9±1.37	42-43	Intermediate width at thurl position
Naval length	4.7±1.43	12-13	Intermediate
Dewlap width	4.5±1.29	15-16	Intermediate
Dewlap surface area	4.4±1.71	551-625	Intermediate
Dewlap visual score†	2.2±0.74	-	Intermediate

† Scored on a scale of 1-3; *= angle in degree

DISCUSSION

The linear type scores for most of the traits tended to follow normal distribution. Linear score for central ligament however deviated from normal distribution. As linear score was based on measurement of groove at the base of udder in between rear teats. Peculiar structure at base of teats of Sahiwal cattle was a source of disturbance for measurement. That might have affected accuracy of linear score assignment. The maximum cluster of animals for teat length and rear udder width at linear score 3 indicated that most of Sahiwal cows were not very wider at rear udder position and were possessing fore teats that were not very long. Most of the cows were found in category of narrow to intermediate for chest width. The linear score on 9 point scale for Indian Sahiwal were more or less same for most of linear type traits as for this study. The linear score for stature 6.88, chest width 5.30, rump width 5.09 and teat length 6.92 were slightly higher for Indian Sahiwal. Whereas the linear score for body depth 4.11, Rump Angle 4.27 for Indian Sahiwal were lower than current study findings (Dubey et al., 2014). Although the linear score for bone structure traits could not be compared across breeds because of breed differences. However the linear type traits score on 9 point scale for Czech Holstein were higher than

current study findings for most of traits. The mean linear score for central ligament 5.7, udder depth 5.8 and rear udder width 5.3 in Czech Holstein (Němcova et al., 2011) were very high as compared to current study finding. It means that Czech Holsteins possess strong central ligament, have deep udder and wide rear udder than Sahiwal cows included in current study. Several other studies have reported linear score for different breeds on a 50 point scale (50-99). Although 50 point scale has less logic to compare with 9 point scale, even though we could have some insight from such information. The linear score of stature 91.7 (score is on extreme side) for Tharparkar cattle (Vij et al., 1990) indicates that Tharparkar cows are taller than Sahiwal cows which is evident from the mean score of stature as 5.1. This score lies in between the biological extremes. However linear score of stature for Tharparkar cattle is on higher side of biological extreme. The mean score of stature 73.3 for Indian Sahiwal (Dahiya, 2005a) indicates that Indian Sahiwal were shorter in height at spine than Sahiwal cattle in current study. Because linear score for Indian Sahiwal is slightly less than midpoint of biological extremes, whereas score 5.1 for Sahiwal in current study is slightly higher than midpoint. The linear score for Hariana cows (Dahiya, 2005b) follow the same pattern as for Sahiwal in current study.

CONCLUSIONS

Means for most of the linear type traits fall in intermediate category. There is much scope for improvement of traits related to size. Presently animals can be selected for increase in height at spine, chest width, body depth, rump width, thurl width, rear udder width and central ligament.

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CONFLICT OF INTEREST

We want to make it clear that there is no conflict of interest with any of the financial organization regarding the material discussed in the current manuscript.

AUHTOR'S CONTRIBUTION

The present paper is part of Ph.D study of corresponding author (Musarrat Abbas Khan). Whereas the second author (Muhammad Sajjad Khan) worked as supervisor of Ph.D scholar.

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