

ORIGINAL ARTICLE

Identification of Priority Traits for Selection in Sahiwal Cattle Using Linear Type Scoring

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ABSTRACT

Linear type scoring is an important tool in herd decision-making, as it aids in selecting animals with superior productive potential based on body conformation. The present study was conducted on 150 lactating Sahiwal cattle, with measurements for linear type traits recorded before the evening milking at three different stages of lactation. The mean scores ($\pm$ SE, cm) for objective linear type traits were as follows: 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 . For subjective linear type traits (1–9 scale), the mean scores were 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 . Based on these findings, dairy cattle may be prioritized for selection with emphasis on improving rump height, body depth, chest width, rear udder width, fore udder attachment, and central ligament strength to enhance overall productivity and longevity.

KEYWORD

• Sahiwal cattle • Linear type traits • Body conformation • Dairy cattle selection • Udder morphology • Genetic improvement • Phenotypic assessment

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INTRODUCTION

Sahiwal is one of the most distinguished indigenous milch breeds of India, widely recognized for its high genetic potential for milk production and adaptability to tropical climates. Over the years, systematic selective breeding targeting milk yield traits has substantially enhanced productivity in this breed. However, increased selection pressure on milk yield has been linked to a higher incidence of metabolic disorders in high-producing cows. Moreover, prioritizing milk yield over other attributes can lead to undesirable changes in important conformation traits and adversely affect overall health and functional longevity. Previous reports indicate that approximately one-third of dairy cows are culled annually, with 42% removed due to low production, while the remaining are culled for reasons such as poor conformation, reproductive disorders, and disease (Murril, 1974).

Conformation refers to the externally visible and measurable variations in body size, proportions, and appearance that are functionally interrelated and influence the production performance of dairy animals (Dubey, 2010). Selection for desirable conformation traits has been associated with improved strength, stamina, and survivability in dairy cattle (Boettcher *et al.*, 1993). Furthermore, appropriate type traits have been shown to enhance functionality and longevity, thereby contributing to sustained dairy productivity (Harris *et al.*, 1992).

Linear type traits form the foundation of modern dairy cattle evaluation systems and are used to objectively assess the “dairyness” of an animal. Unlike subjective evaluations, linear scoring quantifies the degree of a trait rather than its desirability, covering a defined biological range in which variation can be consistently identified (International Committee for Animal Recording, 2018). Improvements in linear type traits have been reported to extend herd life without adversely affecting milk yield (Atkins & Shannon, 2002). In addition, type traits serve as indirect selection criteria for enhancing the lifespan of dairy cows (Cruickshank *et al.*, 2002).

Selection based on physical type traits not only promotes better health and milking efficiency but also facilitates ease of handling factors that can significantly

reduce involuntary culling. Incorporating conformation traits into breeding programs allows for the identification of animals with improved disease resistance and overall functional efficiency. Consequently, many countries have integrated type traits into dairy cattle selection indices (Miglior *et al.*, 2005). The accuracy of selection decisions can also be improved by incorporating conformation trait measurements (Atkins *et al.*, 2008). Given the growing emphasis on sustainable dairy production, it is imperative to balance selection for high milk yield with the improvement of conformation traits that support animal health, productivity, and longevity. In this context, linear type trait evaluation offers a valuable tool for enhancing breeding strategies and ensuring the long-term performance of dairy herds. The present study was undertaken to evaluate the linear type traits of lactating Sahiwal cattle at different stages of lactation and to examine their relationship with production and functional attributes. By generating objective data on these traits, this work aims to provide insights that can support more balanced selection strategies for improving both productivity and longevity in this important indigenous breed.

MATERIALS AND METHODS

The present study was conducted on 150 lactating Sahiwal cattle maintained at the Livestock Research Centre (LRC) of ICAR–National Dairy Research Institute, Karnal. During the study period, measurements of linear type traits were recorded one to two hours prior to the evening milking at three distinct stages of lactation: early (20–50 days), mid (90–130 days), and late (180–200 days). Each cow was scored at all three stages, provided she remained in milk throughout the respective intervals. All measurements were taken with the animal standing squarely on a level surface, ensuring proper weight distribution on all four limbs. The same evaluator conducted all measurements to minimize inter-observer variation. Animals were gently restrained in a standing position for accuracy, and measurements were taken to the nearest centimetre (cm) with maximum precision. Recording protocols followed the guidelines recommended by the International Committee for Animal Recording (ICAR, 2018).

Cows within 15 days postpartum were excluded from scoring to avoid potential bias caused by udder edema. The linear type traits evaluated in this study included: stature, chest width, body depth, rump width, rump angle, rear legs set, foot angle, fore udder attachment, rear udder height, udder depth, rear udder width, central ligament, fore teat length, rear teat length, teat circumference, teat diameter, udder balance, angularity, rear leg rear view, body condition score, locomotion, fore teat placement, and rear teat placement. Each trait was scored on a linear scale, representing a continuum from one biological extreme to the other, as per ICAR guidelines. Descriptive statistics, including means and standard errors, were calculated for all traits. Data analysis was carried out using standard statistical procedures as described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Objective linear type traits

The descriptive statistics for studied linear type traits have been presented in *table 1*. The mean stature of Sahiwal cows was 125.35 ± 0.26 cm, aligning closely with earlier reports by Dubey (2010). The average score point (ASP) for stature was 5.77 ± 0.08 , indicating an intermediate category, similar to findings in Tharparkar and Sahiwal cattle (Godara *et al.*, 2015; Khan & Khan, 2015).

Chest width averaged 25.96 ± 0.15 cm with an ASP of 4.59 ± 0.10 , consistent with previous reports in Sahiwal cattle (Khan & Khan, 2015). Wider chest width is associated with greater heart and lung capacity, contributing to better production potential. Body depth averaged 64.06 ± 0.22 cm (ASP = 5.24 ± 0.10), comparable to Dubey (2010), indicating intermediate body capacity for feed intake and milk production.

Rump traits showed an average rump angle of 12.94 ± 0.22 cm (ASP = 4.48 ± 0.08) and rump width of 16.92 ± 0.11 cm (ASP = 5.56 ± 0.09), both in the intermediate range and in agreement with earlier studies. Optimal rump conformation supports reproductive efficiency and udder capacity (Ramos, 2008).

Locomotion-related traits were also intermediate. Rear leg set averaged $159.78^\circ \pm 0.43$ (ASP = 4.81 ± 0.12), while foot angle averaged $43.47^\circ \pm 0.31$ (ASP = 4.84 ± 0.10), values comparable to those reported by Dubey (2010) and Khan & Khan (2015).

Udder traits showed fore udder attachment at $123.23^\circ \pm 1.29$ (ASP = 4.85 ± 0.11) and rear udder height of 17.55 ± 0.24 cm (ASP = 5.52 ± 0.10). Rear udder width averaged 8.39 ± 0.13 cm (ASP = 4.27 ± 0.09). Udder depth (6.80 ± 0.29 cm; ASP = 5.31 ± 0.08) was within the desirable intermediate range, minimizing mastitis risk. Central ligament depth averaged 3.21 ± 0.07 cm (ASP = 4.01 ± 0.09), suggesting moderate suspensory strength. Udder balance was close to zero (-0.22 ± 0.16 cm; ASP = 5.25 ± 0.11), indicating symmetry between fore and rear udders.

Teat traits showed intermediate values for teat circumference (ASP = 4.20 ± 0.11), fore teat length (7.34 ± 0.13 cm; ASP = 3.49 ± 0.10), rear teat length (6.47 ± 0.12 cm; ASP = 3.94 ± 0.09), and teat diameter (3.18 ± 0.03 cm; ASP = 4.16 ± 0.10). Moderate teat dimensions are preferable for ease of milking and reduced susceptibility to injury or mastitis (Van Drop *et al.*, 1998).

Traits such as rump height and body depth contribute to a larger body frame, enabling greater feed intake and improved reproductive efficiency. Chest width is closely associated with enhanced respiratory and digestive capacity, which in turn supports overall robustness and adaptability. Udder-related traits, including rear udder width and fore udder attachment, play a critical role in providing strong udder support, thereby extending productive life and reducing the risk of mastitis. Similarly, a well-developed central ligament helps maintain udder suspension and structural integrity, ensuring sustained functionality across multiple lactations. Together, these traits are essential for optimizing both the productivity and longevity of dairy cattle. In our study, majority of linear type traits in Sahiwal cattle fell within the intermediate range, suggesting balanced conformation that supports both productive and reproductive performance. These findings are consistent with earlier reports and provide updated baseline data for selection and breeding programs.

Subjective linear type traits

The average score point (ASP) for angularity was 4.69 ± 0.09 , indicating potential for further improvement toward the desirable range. Khan and Khan (2015) reported a slightly higher ASP (5.10 ± 1.81) in Sahiwal cattle. As angularity is assessed visually, scorer variation may influence results. The mean

Table 1: Descriptive statistics of linear type traits in Sahiwal cattle

Type traits	Mean± SE	Score point range			ASP± SE	Interpretation	Desirable
		1-3	4-6	7-9			
Stature (cm)	125.35±0.26	Short	Intermediate	Tall	5.77±0.08	Intermediate	Tall
Chest width (cm)	25.96±0.15	Narrow	Intermediate	Wide	4.59±0.10	Intermediate	Wide
Body depth (cm)	64.06±0.22	Shallow body	Intermediate	Deep body	5.24±0.10	Intermediate	Deep
Rump width (cm)	16.92±0.11	Narrow	Intermediate	Wide	5.56±0.09	Intermediate	Wide
Rump angle (cm)	12.94±0.22	High pins	Intermediate	Sloped	4.48±0.08	Intermediate	More slope
Rear leg sets (degree)	159.78±0.43	Straight	Intermediate	Extremely sickled	4.81±0.12	Intermediate	Intermediate
Foot angle (degree)	43.47±0.31	Extreme low angle	Intermediate	Extremely steep angle	4.84±0.10	Intermediate	Intermediate
Fore udder attachment (degree)	123.23±1.29	Weak and loose	Intermediate	Strong and tight	4.85±0.11	Intermediate	Strong
Rear udder height (cm)	17.55±0.24	Very low	Intermediate	High	5.52±0.10	Intermediate	High
Udder depth (cm)	6.80±0.29	Below hock	Intermediate	Shallow	5.31±0.08	Intermediate	Intermediate
Rear udder width (cm)	8.39±0.13	Narrow	Intermediate	Wide	4.27±0.09	Intermediate	Wide
Central ligament (cm)	3.21±0.07	Broken	Intermediate	High	4.01±0.09	Intermediate	Strong
Fore teat length (cm)	7.34±0.13	Short	Intermediate	Long	3.49±0.10	Short	Intermediate
Rear teat length (cm)	6.47±0.12	Short	Intermediate	Long	3.94±0.09	Intermediate	Intermediate
Teat circumference (cm)	10.00±0.11	Small	Intermediate	Large	4.20±0.11	Intermediate	Intermediate
Teat diameter (cm)	3.18±0.03	Thin	Intermediate	Thick	4.16±0.10	Intermediate	Intermediate
Udder balance (cm)	-0.22±0.16	Deep rear udder	Intermediate	Deep fore udder	5.25±0.11	Intermediate	Intermediate
Angularity	Visual scoring	Lack of angularity	Intermediate	Angular	4.69±0.09	Intermediate	Angular
Body condition score	Visual scoring	Poor	Intermediate	Grossly fat	6.53±0.08	Grossly fat	Intermediate
Rear leg rear view	Visual scoring	Toe out	Intermediate	Bow legged	5.05±0.06	Intermediate	Intermediate
Locomotion	Visual scoring	Severe abduction	Intermediate	No abduction	4.88±0.06	Intermediate	Long stride/ no abduction
Fore teat placement	Visual scoring	Wide	Intermediate	Close	4.41±0.07	Intermediate	Intermediate
Rear teat placement	Visual scoring	Wide	Intermediate	Close	6.28±0.08	Intermediate	Intermediate

body condition score (BCS) was 6.53 ± 0.08 on a 1–9 scale, which is higher than the 4.96 ± 1.25 reported for Holstein cows (Zink *et al.*, 2014), possibly due to breed-specific body reserves and management conditions.

Rear legs rear view averaged 5.05 ± 0.06 , indicating an intermediate positioning of hocks and feet, consistent with observations in Holstein cattle (Penev *et al.*, 2017). Proper leg conformation is associated with reduced locomotor stress and injury risk. Locomotion scored 4.88 ± 0.06 , aligning with findings in HF and Holstein cows (Berry *et al.*, 2004; Zink *et al.*, 2014). Impaired locomotion reduces lifetime

productivity and increases involuntary culling risk (Huxley, 2013).

Fore teat placement averaged 4.41 ± 0.07 , comparable to earlier reports in Sahiwal cattle (Dubey *et al.*, 2014). Both fore and rear teat placements at extreme positions increase susceptibility to culling (Berry, 2007). Rear teat placement had an ASP of 6.28 ± 0.08 , similar to findings in Sahiwal (6.37 ± 0.11) and Holstein (6.36 ± 1.15) cattle (Dubey *et al.*, 2014; Campos *et al.*, 2015). This trait, along with udder depth, significantly affects functional survival of dairy cows (Atkins & Shannon, 2002).

Traits with lower or moderate average scores are the focus for genetic and management improvement. Selecting breeding animals with higher scores in these specific traits will gradually shift the herd average upward in future generations.

CONCLUSION

The majority of conformation traits in Sahiwal cattle evaluated in this study fell within the intermediate range, with the exception of body condition score and fore teat length. While intermediate scores (4–6) are generally desirable, the observed average score points clustering around five indicate a balanced phenotype with scope for targeted improvement. These findings suggest that incorporating linear type traits into selection programmes could enhance the functional conformation of Sahiwal cattle, thereby improving their productivity and longevity, and progressively aligning their performance with that of high-yielding exotic breeds without compromising breed identity.

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