



## Impact of housing modification on locomotion and feeding behaviour in lactating Sahiwal cows during summer stress

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### ABSTRACT

The present study evaluated the effect of selected shelter and flooring modifications on lameness and feeding behaviour of Sahiwal cows in early lactation under subtropical field conditions. Twenty four clinically healthy cows (1–3 months in milk) were randomly allotted to four equal groups for 150 days (June–November 2018): G1 (control, concrete floor, no modification), G2 (rubber mat over concrete), G3 (concrete plus microclimate modification: fans and twicedaily water sprinkling at 11:00 and 15:00 h), and G4 (rubber mat plus microclimate modification as in G3). All cows received identical diets (green and dry fodder plus 2.5 kg concentrate; additional concentrate adjusted postcalving for milk yield) and were hand milked twice daily. Lameness was assessed fortnightly using a fivepoint locomotion scoring system (1= sound; 5= severely lame). Mean locomotion scores differed significantly ( $P<0.05$ ): G1  $2.04 \pm 0.12$ , G2  $1.35 \pm 0.10$ , G3  $1.81 \pm 0.09$ , G4  $1.23 \pm 0.14$ , indicating lower lameness on rubber flooring with or without microclimate modification. Feeding time (minutes/day) increased with environmental improvements. Combining rubber mats and cooling (G4) produced the most favourable welfare indicators. Practical adoption of these modifications may reduce lameness risk and support sustained feed intake in Sahiwal cows.

**Key words:** Behavioural pattern, Heat stress, Locomotion score, Rubber mat, Welfare

There is growing consumer interest in food production and in recent years, the dairy industry has been a subject to increasing public scrutiny. Consumers frequently highlight the welfare of dairy cows as an issue of concern (Wolf 2016; Jackson 2022), management practices and conditions that adversely affect animal welfare may negatively influence public perception of the industry and undermine consumer trust. Scientific literature frequently documents the significance of lameness in dairy cows resulting from welfare and economic concerns (Ventura 2015; Passos 2017).

Lameness is an important animal welfare and economic issue on dairy farms (Weigele 2018). Poor cow comfort increases the risk of lameness. It negatively impacts

lifespan, milk production, and reproductive efficacy (Oehm 2020).

Lameness has been demonstrated to influence various behavioural traits, including reduced daily feed intake, diminished eating duration, decreased rumination time, and elevated feeding rate (Thorup 2016). Locomotion scoring systems, which are typically based on a five-point system, are extensively employed to quantify the degree of lameness in dairy cattle. The degree of impairment can be classified in a range from one point (no lameness) to five points (severe lameness) in reference to the movement of dairy cattle (Kang 2020). Given these factors, it is crucial to create an early, efficient, and rapid detection method to assist in managing this welfare concern on dairy farms.

Animal comfort can be indicated by behavior of the animal under a given set of environmental conditions. The time spent by the animal in eating are important behavioral indicators and thus were included in the present study. Therefore, the proposed study was initiated to see the effect of improved shelter management on the lameness and behavioural pattern in lactating Sahiwal cows.

### MATERIALS AND METHODS

The present study was conducted at the Livestock Research Station (L.R.S.), Kodamdesar, Bikaner, Rajasthan, India. Twenty-four Sahiwal milch cattle in early lactation (1–3 months) were selected and randomly

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Table 1 . Proximate composition of feed and fodders (on dry matter basis) fed to experimental animals.

Nutrients %	Wheat straw	Ground nut chara	Concentrate mixture (Saras Gold)
DM	95.30	94.89	89
CP	4.52	8.45	22
CF	29.82	25.56	10
EE	0.75	2.61	1.9
Ash	12.31	11.81	9.15

Table 1(b): Lameness scoring chart

Score	Description of the score	Locomotion score/ Lameness score
1	Cow stands & walks with level-back, gait normal	Normal
2	Cow stands level-back, walks with arched-back, gait normal	Mildly lame
3	Stands & walks with arched-back, short striding gait with one or more limbs	Moderately lame
4	Always with arched-back, gait with deliberate step at a time.	Lame
5	Inability or extreme reluctance to bear weight on one or more limbs	Severely lame

divided into four groups of six animals each. Group I (G1), which served as the control, was reared without any shelter modification and housed on a pucca floor made of cement concrete blocks in a covered area.

The experimental cows in group-II were reared on rubber mat bedding over pucca floor in covered area (G2).

Group III (G3) animals were reared on pucca floors as G2 in a covered area, with physical additional modifications in the shelter environment. Group IV (G4) animals were housed on rubber mat flooring (dimensions: 4 feet wide, 7 feet long, 25 mm thick; sourced from Sumanglam Dairy Farm Solution Pvt. Ltd., Ghaziabad) in a covered area, along with shelter modifications as in G3.

The physical modifications for both G3 and G4 included the provision of fans and body surface water sprinkling twice daily, at 11:00 AM and 3:00 PM.

Data for various observations were recorded over a 150-day period, from June to November 2018. The feed offered across all treatment groups was kept consistent throughout the experimental period. Each cow was offered green and dry fodder, along with 2.5 kg of concentrate mixture daily (Table 1). After calving, 1 kg extra concentrate mixture was given for every 2.5 kg milk production. Milking of

cows was mainly done by manually twice a day at 5.00 AM and 4.00 PM at milking parlour. Quantification of lameness was done using locomotion scoring accordance with 5 points locomotion scoring system (Flower and Weary, 2006) to get the prevalence of lameness in a dairy herd using visually analyzed locomotion scores (Table 1b).

All the behavior parameters like eating and rumination behavior in the groups of cattle was recorded through constant personal observation and CCTV footage for 24 hours from 60th day to 75th day in hot humid season (June to August) in covered area during the experimental period (150 days). The data collected, scored, compiled and tabulated were subjected to statistical analysis by appropriate method of analysis as per Snedecor and Cochran (1994) for analysis of variance and Duncan's multiple range tests was conducted to test the significance of difference between means ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

Locomotion scoring is a widely accepted, non-invasive tool to assess lameness and cow mobility, with a score of 1 indicating optimal gait and absence of discomfort, and increasing scores reflecting varying degrees of pain

Table 2. Mean ( $\pm$ SE) of Locomotion score in Sahiwal cows in different sheds

Locomotion Score (Days)	G-1	G-2	G-3	G-4
0	1 $\pm$ 0.12	1.34 $\pm$ 0.21	1.17 $\pm$ 0.17	1.34 $\pm$ 0.21
15	1.17 $\pm$ 0.17	1.5 $\pm$ 0.22	1.17 $\pm$ 0.17	1.34 $\pm$ 0.21
30	1.67 $\pm$ 0.21	1.5 $\pm$ 0.22	1.17 $\pm$ 0.17	1.34 $\pm$ 0.21
45	2.17 $\pm$ 0.17	1.84 $\pm$ 0.31	1.67 $\pm$ 0.21	1.34 $\pm$ 0.21
60	2 $\pm$ 0.07	1.67 $\pm$ 0.21	1.67 $\pm$ 0.21	1.34 $\pm$ 0.21
75	2.34 $\pm$ 0.21	1.34 $\pm$ 0.21	2.17 $\pm$ 0.17	1.34 $\pm$ 0.21
90	2.34 $\pm$ 0.21	1.34 $\pm$ 0.21	1.84 $\pm$ 0.17	1.17 $\pm$ 0.17
105	2.34 $\pm$ 0.21	1.17 $\pm$ 0.17	1.84 $\pm$ 0.17	1 $\pm$ 0.13
120	2.17 $\pm$ 0.31	1.17 $\pm$ 0.17	2 $\pm$ 0.26	1.17 $\pm$ 0.17
135	2.5 $\pm$ 0.22	1 $\pm$ 0.09	2.5 $\pm$ 0.22	1.17 $\pm$ 0.17
150	2.67 $\pm$ 0.21	1 $\pm$ 0.08	2.67 $\pm$ 0.21	1 $\pm$ 0.09
Overall mean	2.04b $\pm$ 0.12	1.35a $\pm$ 0.1	1.81b $\pm$ 0.09	1.23a $\pm$ 0.14

Mean bearing different superscripts in a row differ significantly ( $p < 0.05$ )

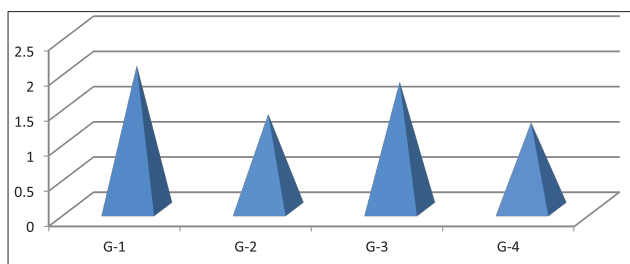


Fig. 1 Mean of Locomotion Score in different groups

Table 3. Analysis of variance of Locomotion Score in Sahiwal cattle of different sheds

	DF	Sum Square	Mean Square	F(calculated)
Group	3	16.66667	5.555556**	41.66667
Error	20	2.666667	0.133333	
Total	23			

Significant at 5% level of significance (P<0.05)

and mobility impairment (Flower & Weary, 2006). Mean locomotion score for Sahiwal cows kept under different groups are presented in Table 2, 3 and Figure 1. In the present study, Sahiwal cows housed under G-4 (1.23±0.14) and G-2 (1.35±0.1) conditions recorded lowest mean locomotion scores, indicating minimal gait abnormalities and enhanced comfort. These groups were housed on rubber mat flooring-with G-4 receiving additional environmental enrichment through mechanical fans and twice-daily water sprinkling-suggesting a synergistic benefit of combined flooring and microclimate management strategies.

The highest locomotion score was observed in G-1 (2.04±0.12), which lacked any shelter modifications and was housed on a hard concrete floor. This score corresponds to mild to moderate lameness, which was likely to be due to increased pressure on hoof and joint surfaces and higher susceptibility to claw lesions and abrasions associated with unyielding flooring (Cook & Nordlund, 2009). These findings suggest that hard floor surfaces without climate control elements may lead to subclinical lameness, even in indigenous breeds like Sahiwal, which are otherwise resilient to tropical conditions. These results aligned with earlier findings by Rushen and de Passillé (2006), who reported that rubber flooring enhances cow gait and comfort compared to concrete. Vanegas (2006) and Boyle (2005) also reported that the incidence of clinical lameness was highest in herds managed on unpadded concrete surfaces. The cushioning effect of rubber mats reduces the mechanical load on hooves, especially during transitions like lying down, standing up, and walking, which are frequently implicated in the etiology of lameness.

However, studies such as O’Driscoll (2009) and Eicher (2013) did not observe consistent benefits of rubber flooring over concrete, possibly due to confounding factors like floor hygiene, slope, traffic density, or inadequate drainage, which can lead to increased bacterial load and digital dermatitis. Thus, the efficacy of rubber flooring is context-

dependent, and requires good management practices to realize its full potential. Recent evidence reinforces the value of flooring modifications. Leach (2021) reported a significant reduction in lameness prevalence in tie-stall barns following the installation of rubber mats. Chapinal (2020) emphasized that flooring alone is not sufficient; it must be coupled with adequate lying time, stall comfort, and air circulation to reduce lameness-related stressors. In the current study, G-4’s low locomotion score can be attributed not just to rubber flooring, but also to the integrated provision of heat abatement strategies, which are known to reduce standing time and increase resting, thereby mitigating limb fatigue (Solano 2016; Tucker 2021).

Moreover, prolonged standing on hard surfaces under heat stress may predispose cows to sole hemorrhages, white line disease, and claw horn disruption—conditions which can be attenuated by interventions that reduce ambient heat load and provide ergonomic flooring (Randall 2015). Therefore, the superior results in G-4 highlighted the importance of addressing both mechanical and thermal stress simultaneously, a model that aligns well with contemporary welfare frameworks that advocate holistic interventions (von Keyserlingk and Weary, 2017)..

Behavioral parameters such as eating time, rumination, lying duration, and feeding temperament are considered non-invasive and sensitive indicators of animal welfare. (Haley 2001). The animal behavior viz. eating in the different groups of Sahiwal cattle due to microclimate alteration were represented in Tables 4-7.

These behaviors are influenced by several environmental, physical, and physiological factors, and are increasingly used to assess the well-being of dairy animals under different housing conditions (Haley 2001; Tucker 2021).

In the present study, eating time was significantly higher in G-3 and G-4 cows, particularly in G-4 during the autumn season (351.5 ± 2.51 minutes), which suggested that housing modifications, such as the use of rubber mat flooring and the provision of cooling systems (fans and sprinklers), played a critical role in improving animal comfort and reducing thermal stress. Such comfort enables cows to engage more naturally in feeding behavior, potentially improving dry matter intake (DMI) and milk productivity, which is consistent with the thermal-neutral zone concept in dairy cattle (West, 2003; Black 2020). These findings are in agreement with Chanpongsang (2010) and Shiao (2011), who reported prolonged feeding durations and improved welfare in dairy cows housed under evaporative or tunnel-ventilated barns. Madke (2010) also noted that rubber and sand bedding encouraged longer feeding and lying time in Karan Fries crossbred cows compared to concrete flooring. This implies that softer, thermally insulated floor surfaces contribute to reduced strain on the limbs, better hoof health, and improved behavioral expression. However, Rushen (2007) found no significant differences in feeding time between cows on concrete and rubber surfaces, highlighting that behavioral patterns can be modulated by

Table 4. Mean± SE of Eating Time in different groups (Hot Humid)

Eating Time-hot humid (Days)	G-1	G-2	G-3	G-4
1	317.67±2.35	315.5± 1.73	328.34±3.25	334.5±1.82
2	313.34±1.56	319.17±2.1	329.17±4.14	329.5±3.01
3	321±2.83	323.34±1.31	327.84±3.11	337±2.27
4	319.34±2.09	324.84±1.83	333.34±2.36	334±2.25
5	316.34±3.13	318.17±4.81	321.17±3.22	334.84±2.7
6	316±4.28	323.34±3.46	326.17±2.87	342.17±2.02
7	321.17±3.42	317.34±3.65	316.17±5.92	330.67±3.38
8	322.67±2.23	314.84±4.03	328.67±3.87	329.34±2.2
9	315.5±3.02	331±2.73	326.67±3.87	333±2.73
10	318.5±2.95	320.34± 2.8	325.84±4.65	335.84±2.97
11	321.5±0.99	317.5±1.98	331.84 ±2.63	325.67±1.63
12	322.34±2.03	309.5±3.43	325.34±3.1	332.84±1.96
13	307.34±2.58	311.84±2.23	320.84±3.87	322.67±2.79
14	310.5±2.64	320.84±3.22	320.67±4.06	336.84±216
15	323.34±2.62	319±1.15	325.84±2.27	338.17±2.3
Overall Mean	317.77a ±0.73	319.1ab±1.57	325.86bc±2.37	329c±3.76

Mean bearing different superscripts in a row differ significantly (P<0.05)

multiple factors such as barn design, stocking density, space availability, feed quality, and animal hierarchy. Thus, while the flooring type is important, it is only one component of a comprehensive welfare strategy. Increased eating

time under modified housing conditions may also suggest a more relaxed feeding posture and fewer competitive

Table 5: Analysis of variance of eating time in Sahiwal cattle in different shed (Hot Humid)

	DF	Sum Square	Mean Square	F (calculated)
Group	3	520.3961	173.4654**	5.084515
Error	20	682.3281	34.11641	
Total	23			

Significant at 5% level of significance (P<0.05)

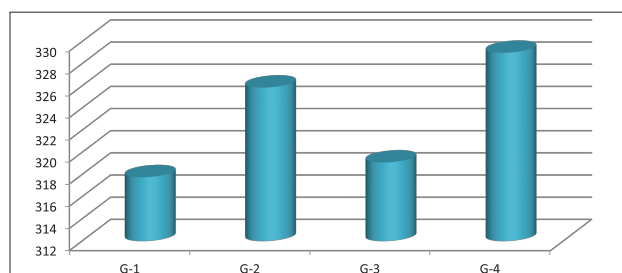


Fig. 2- Mean of Eating Time in different groups (HOT HUMID)

Table 6. Mean± SE of Eating Time in different groups (Autumn)

EATING TIME- AUTUMN (DAYS)	G-1	G-2	G-3	G-4
1	310±1.39	328.67±0.84	335.5±2.35	346.17±2.06
2	312.17±1.3	280.67±50.44	336±2.65	351.34±1.69
3	312.17±1.72	311.5±3.16	334.17±2.3	353.84±1.35
4	304.84±2.56	326.34±2.46	335±2.35	352.67± 2.35
5	309.84±1.96	329.67±2.84	330±1.15	339.67±2.93
6	315.34±1.84	321.5±1.41	327.67±1.09	350.17±3.68
7	309±1.59	322.67±3.98	327.17±2.76	352.84±2.68
8	303.5±2.43	337.17±2.24	323.17±3.48	354.17±4.11
9	318.84±0.95	332.84±1.99	320.5±2.1	343.17±2.52
10	315±1.95	333.17±2.01	333.34±3.45	354.67±2.87
11	312.34±1.94	334.17±2.12	332.5±4.65	355.84±2.98
12	312.67±3.25	328.67±3.11	334.5±4.65	332b±2.11
13	315.34±2.68	326.5±4.86	334±4.6	337.17±2.26
14	313±1.95	332.84±2.1	338.67±2.38	357.5±1.61
15	323.34±2.89	336.67±2.67	339±3.18	391.34±3.45
Overall Mean	312.49a ±0.29	325.54b ±3.31	332.08c ±2.02	351.5d ±2.51

Mean bearing different superscripts in a row differ significantly (P<0.05)

Table 7. Analysis of variance of eating time in Sahiwal cattle in different shed

	DF	Sum Square	Mean Square	F (calculated)
Group	3	4755.104	1585.035**	49.30441
Error	20	642.9585	32.14793	
Total	23			

Significant at 5% level of significance ( $P < 0.05$ )

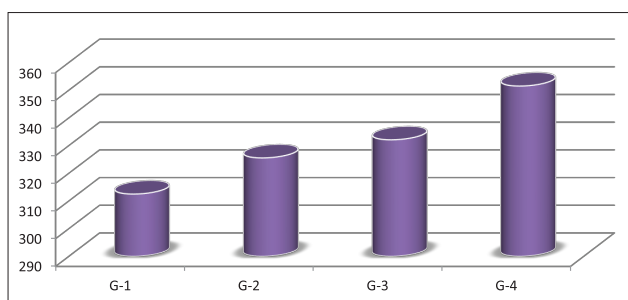


Fig. 3 Mean of eating time in different groups (AUTUMN)

interactions around feed bunks, as softer flooring and cooler microenvironments may reduce standing fatigue and promote voluntary feed approach. Longer eating time is often correlated with better rumination activity, which plays a crucial role in buffering rumen pH and supporting optimal digestive health (Schirrmann 2012).

While behavior is a valuable welfare indicator, it must be interpreted within the larger framework of physiological and environmental variables. Animal behavior is not always conclusive unless validated with physiological biomarkers such as serum cortisol, epinephrine, norepinephrine, rectal temperature, and heart rate variability (von Keyserlingk and Weary, 2017; Neave 2022). In this context, inclusion of endocrine and biochemical parameters in future trials is recommended to give a more holistically assessment of the impact of housing on cow welfare. It is important to note that the current study was conducted under a semi-intensive management system, which means the animals had limited access to open areas and were primarily housed indoors with consistent feeding and milking routines. This housing type emphasizes the critical role of internal shed environment in shaping animal welfare outcomes. Improved ventilation, floor comfort, and temperature regulation become even more vital under such confined systems to prevent subclinical heat stress and behavioral abnormalities. The findings of the present study clearly demonstrate that housing interventions such as rubber mat flooring and microclimate modifications (fans and water sprinkling) significantly improve animal comfort, reduce the incidence of lameness, and enhance feeding behavior in lactating Sahiwal cows. Cows housed on rubber mats (G2 and G4) exhibited lower locomotion scores, indicating better hoof and limb health compared to those on concrete flooring. Additionally, cows in shelters with cooling provisions showed increased eating time, reflecting improved welfare and thermal comfort. These results underscore the importance of optimizing shelter design and

flooring material in dairy production systems to promote animal welfare and sustain productive performance under intensive management conditions.

#### AUTHORS' CONTRIBUTIONS

RA carried out the research work and finalized the manuscript, SG conceptualized the study, SA helped in manuscript drafting, and ML helped with data analysis, visualization and manuscript preparation. All authors approved the manuscript.

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#### ETHICS APPROVAL

All the work was conducted after approval from institutional animal ethics committee.

#### CONFLICTS OF INTEREST/ COMPETING INTERESTS

The authors have no conflict of interest to declare.

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