



## Does floor surface affect locomotion behaviour of crossbred cows under loose housing system?

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### ABSTRACT

Present study was conducted to evaluate the effect of floor surface on lameness score and walking speed of crossbred cows under loose housing system. Crossbred cows (24) were selected and randomly assigned into one of the four groups (6 in each group) having different combination of flooring surface viz. T<sub>0</sub>-Concrete floor (in covered feeding area) + Brick paved (in open area), T<sub>1</sub>-Concrete (in covered feeding area) + Sand bed (in open area), T<sub>2</sub>- Rubber mat (in covered feeding area) + Sand bed (in open area) and T<sub>3</sub>- Rubber mat (in covered feeding area) + Brick paved (in open area). All experimental animals were scored for lameness using “Visual Lameness Scoring” (VLS) system on 1–5 scale. Walking speed of cows was also observed during experimental period. Lameness scores were significantly different between the groups. Lameness score were greater for cow housed in T<sub>3</sub> and T<sub>0</sub> group. However, lameness score were lower in cows housed in T<sub>1</sub> and T<sub>2</sub> group. Walking speed differed significantly between treatments and was greater in T<sub>2</sub> and T<sub>1</sub> than T<sub>3</sub> and T<sub>0</sub>. Cow housed in T<sub>0</sub> and T<sub>3</sub> group walked slower compared to T<sub>1</sub> and T<sub>2</sub> group. Further, proportionally greater numbers of cows with higher lameness score were found in T<sub>0</sub> and T<sub>3</sub> group. It can be concluded that equipping open area with sand bed with either concrete or rubber mat in covered area improved animal welfare in term of decreasing lameness. While providing rubber mat alone with brick was comparable to concrete and brick.

**Key words:** Behaviour, Floor, Lameness, Rubber mat, Sand bed, Walking speed

Floor of livestock house is a deciding factor for walking and lying comfort of the animal (Sonck *et al.* 1999). However, concrete floor is a far away from the ideal walking and standing surface for cow (Phillips and Morris 2000). It is because of its abrasive and hard nature (Camara and Gravert 1971). Another serious objection includes slipperiness. It doesn't provide enough friction for natural locomotary movements. It has been reported that coefficient of friction in concrete is lower (0.35) than required (0.4–0.7) by cow for normal locomotion (Telezhenko and Bergsten 2005, Rushen and de Passille 2006). Inadequate floor surface predisposes dairy cattle to several health related issues prominent among which is lameness. Worldwide approximately 20% of intensively managed cows are lame at any one time (Cook 2003, Espejo *et al.* 2006). Studies concerned with prevalence of lameness are very scanty in India. The prevalence of lameness has been reported from 8–30.5% (Chawla *et al.* 1991, Singh *et*

*al.* 1999, Randhawa 2006, Sood and Nanda 2013). Lameness is world-widely reported as 3<sup>rd</sup> most economically important disease next to infertility and mastitis (Enting *et al.* 1997). Further, pain caused in this problem makes it most serious animal welfare issue (Webster 1986, Why *et al.* 1997). Hard floor surface adversely affects hoof health and comfort, predisposes animal to pain and lameness and ultimately affect productivity. Providing soft rubber floor for covered area and sand bedding in open area of loose housing system will be favourable for cow comfort, health, hygiene and milk production. It may probably reduce occurrence of lameness and mastitis in organized dairy farm. With the increased awareness for animal welfare, provision of cushioned flooring in the resting and feeding area of animal house is gaining popularity. Under Indian condition, available literature on research work exploring effect of the cushioned flooring is very rare. Keeping in mind above mentioned facts, the present study was undertaken to evaluate the effect of floor surface on lameness score and walking speed of crossbred cows under loose housing system.

### MATERIALS AND METHODS

The present study was conducted at Cattle and Buffalo farm, LPM section, Indian Veterinary Research Institute

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(IVRI), Bareilly, Uttar Pradesh. The farm is located at an altitude of 169.2 m above the mean sea level, at latitude of 28° 22' north and at longitude of 79° 24' east. Generally, it has humid subtropical climate with high variation between summer and winter temperatures. The annual mean temperature is 25°C, and the average annual rainfall is 1714 mm, most of which is during the monsoons in July and August.

Cross breed cows (HF/Jersey/BS × Haryana, named as *Vrindavani*) being maintained at Cattle and Buffalo farm, were used for the experiment. All the experimental animals were housed in loose housing system where they were provided with covered (shaded) area with feeding manger at one side and open resting area. Roof was made up of asbestos with long axis oriented to East-West direction. Water troughs were provided at one side of open area. All the experimental cows were milked in the milking parlour located at the distance of 200 m from experimental shed. Green fodder (maize/berseem/oat) was provided *ad lib.* and dry fodder (wheat straw) was also made available all the time. The animals were fed concentrate ration as per their milk yield twice a day at the time of milking.

A total of 24 crossbred cows, from different parities (ranging 1 to 3) and below 45 days in milk were selected initially for experiment and randomly assigned into one of the four treatment groups (6 in each group). Four experimental sheds were prepared using different combination of flooring surface in covered and open area of loose house viz. Control group ( $T_0$ ), Concrete floor (in covered feeding area) + Brick paved (in open area) (CB); Treatment group 1 ( $T_1$ ), Concrete (in covered feeding area) + Sand bed (in open area) (CS); Treatment group 2 ( $T_2$ ), Rubber mat (in covered feeding area) + Sand bed (in open area) (RS) and Treatment group 3 ( $T_3$ ), Rubber mat (in covered feeding area) + Brick paved (in open area) (RB). In this way, floor in covered feeding area had either concrete floor with grooved surface or with rubber mat (6 × 4 feet per sheet, channeled surface and made up of virgin rubber), having 20 mm thickness, over the existing concrete floor. Floor provided in open area was made up either of brick paved floor or sand bed (fine river sand, average depth 80 mm) over the existing brick paved floor.

In sand bedded open area, manure and wet spots were removed twice daily. Further, new sand was added as and when required to maintain proper depth. Rubber and concrete floor surface in the covered area were cleaned using forced water after removing solid dung manually. Space for animal in both covered and open area was provided as per BIS norms.

All experimental animals were scored for lameness using "Visual Lameness Scoring" (VLS) system on 1–5 scale, as per Flower and Weary (2006). Score allotted were viz. 1, smooth and fluid movement; 2, imperfect locomotion but ability to move freely not diminished; 3, capable of locomotion but ability to move freely is compromised; 4, ability to move freely is obviously diminished and 5, ability to move is severely restricted and animal must be vigorously

encouraged to move. Lameness scoring was performed on 1<sup>st</sup> day thereafter repeated every 30 day. Animals were scored after morning milking session while walking through a 14 m long and 1.25 m wide passage in a consistent manner. Before making actual scoring, all the cows were made familiar with the passage by passing through it several times. While standing on right side of passage observer assigned visual lameness score to moving cows. Each cow was also video recorded using colour digital camera placed 6 m away, which was later used for re-scoring purpose. Lameness scoring was performed 7 times during the study period for 24 animals belonging to different treatment groups. Each lameness video record was viewed three times meticulously by the same observer (who visually scored for lameness) and rescored was done. Finally these score were considered for analysis. Same video recording as used for lameness scoring was analyzed for walking speed (m/sec) determination also. Cows were observed when released individually and walked freely along the 14 m long and 1.25 m wide concrete passage way.

The information collected by data sheet was pooled and analyzed as per standard statistical procedure (Snedecor and Cochran 1994). Repeated measure ANOVA and multiple comparisons were used for continuous variables. Tukey test was used for the multiple comparisons. For Lameness scores, non-parametric techniques were used to investigate treatment effects and relationships between scores. Multiple comparisons for score data were done by using K-W test using SAS 9.2 software. JMP 8.0 software was also utilized for analyzing the data.

## RESULTS AND DISCUSSION

Mean lameness score, walking speed (m/sec) and walking time (sec) in crossbred cows kept under different flooring conditions is presented in Table 1. Overall lameness score for group  $T_0$ ,  $T_1$ ,  $T_2$  and  $T_3$  was  $1.60 \pm 0.11$ ,  $1.26 \pm 0.05$ ,  $1.32 \pm 0.10$  and  $1.71 \pm 0.11$ , respectively. Lameness scores were significantly ( $P < 0.05$ ) different between the groups. Lameness score were greater for cow housed in Rubber mat + Brick paved ( $T_3$ ) and Concrete + Brick paved ( $T_0$ ) floor. However, lameness score were lower in cows housed in Concrete + Sand ( $T_1$ ) and Rubber mat + Sand floor ( $T_2$ ). Lameness scores were found higher in cows housed in brick floor with either concrete or rubber in covered area. Thus rubber mat was not found beneficial over concrete with respect to lameness score. Contrary to our finding, Rushen and de Passillé (2006) found that rubber flooring improved locomotion in cows compared with those on concrete flooring. Beneficial effect of rubber mat in  $T_3$  group might have been diluted in our study by uneven and harder surface of brick paved floor. Earlier reports also suggest that increased total standing times on hard surface have negative effects on lameness (Singh *et al.* 1993). However, cows housed with sand in open area showed lower lameness score. Provision of sand was found advantageous than brick paving in open area for lameness score. Espejo *et al.* (2006) also found that cow using sand stall had lower lameness

Table 1. Mean ( $\pm$ SE) lameness score, walking speed (m/sec) and walking time of crossbred cows housed under different floors

Group	Month 0	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Total
<i>Lameness Score (1 to 5 scale)</i>								
T <sub>0</sub> (CB)	1.25 $\pm$ 0.25 <sup>ab</sup>	1.42 $\pm$ 0.24	1.33 $\pm$ 0.25	1.83 $\pm$ 0.33	1.67 $\pm$ 0.31	1.92 $\pm$ 0.30	1.75 $\pm$ 0.36	1.60 $\pm$ 0.11 <sup>ab</sup>
T <sub>1</sub> (CS)	1.00 $\pm$ 0.00 <sup>b</sup>	1.17 $\pm$ 0.11	1.17 $\pm$ 0.11	1.33 $\pm$ 0.17	1.42 $\pm$ 0.15	1.58 $\pm$ 0.15	1.17 $\pm$ 0.11	1.26 $\pm$ 0.05 <sup>b</sup>
T <sub>2</sub> (RS)	1.00 $\pm$ 0.00 <sup>b</sup>	1.17 $\pm$ 0.17	1.58 $\pm$ 0.49	1.50 $\pm$ 0.41	1.25 $\pm$ 0.17	1.25 $\pm$ 0.25	1.50 $\pm$ 0.22	1.32 $\pm$ 0.10 <sup>b</sup>
T <sub>3</sub> (RB)	1.67 $\pm$ 0.31 <sup>a</sup>	1.58 $\pm$ 0.24	1.58 $\pm$ 0.27	1.92 $\pm$ 0.27	1.83 $\pm$ 0.38	1.83 $\pm$ 0.36	1.58 $\pm$ 0.20	1.71 $\pm$ 0.11 <sup>a</sup>
<i>Walking speed (m/sec)</i>								
T <sub>0</sub> (CB)	0.91 $\pm$ 0.04	0.91 $\pm$ 0.03	1.00 $\pm$ 0.04	0.86 $\pm$ 0.05 <sup>b</sup>	1.01 $\pm$ 0.06	0.92 $\pm$ 0.04	0.91 $\pm$ 0.02 <sup>b</sup>	0.93 $\pm$ 0.02 <sup>a</sup>
T <sub>1</sub> (CS)	1.01 $\pm$ 0.02	0.99 $\pm$ 0.03	1.07 $\pm$ 0.04	0.92 $\pm$ 0.03 <sup>ab</sup>	1.01 $\pm$ 0.06	0.91 $\pm$ 0.05	1.10 $\pm$ 0.05 <sup>a</sup>	1.00 $\pm$ 0.02 <sup>b</sup>
T <sub>2</sub> (RS)	1.00 $\pm$ 0.06	1.00 $\pm$ 0.04	1.01 $\pm$ 0.06	1.03 $\pm$ 0.06 <sup>a</sup>	1.06 $\pm$ 0.07	0.94 $\pm$ 0.09	1.09 $\pm$ 0.07 <sup>a</sup>	1.02 $\pm$ 0.02 <sup>b</sup>
T <sub>3</sub> (RB)	0.98 $\pm$ 0.02	0.89 $\pm$ 0.05	1.00 $\pm$ 0.06	0.91 $\pm$ 0.02 <sup>ab</sup>	0.96 $\pm$ 0.03	0.86 $\pm$ 0.06	0.95 $\pm$ 0.02 <sup>a</sup>	0.93 $\pm$ 0.02 <sup>a</sup>
<i>Walking time (sec)</i>								
T <sub>0</sub> (CB)	10.45 $\pm$ 0.40	10.33 $\pm$ 0.28	9.43 $\pm$ 0.34	11.08 $\pm$ 0.60 <sup>a</sup>	9.42 $\pm$ 0.50	10.33 $\pm$ 0.54	10.30 $\pm$ 0.21	10.19 $\pm$ 0.17 <sup>a</sup>
T <sub>1</sub> (CS)	9.28 $\pm$ 0.16	9.53 $\pm$ 0.28	8.82 $\pm$ 0.35	10.25 $\pm$ 0.27 <sup>ab</sup>	9.45 $\pm$ 0.55	10.55 $\pm$ 0.62	8.67 $\pm$ 0.41	9.51 $\pm$ 0.17 <sup>b</sup>
T <sub>2</sub> (RS)	9.60 $\pm$ 0.61	9.47 $\pm$ 0.48	9.47 $\pm$ 0.64	9.38 $\pm$ 0.73 <sup>b</sup>	9.08 $\pm$ 0.59	10.57 $\pm$ 1.18	8.82 $\pm$ 0.71	9.48 $\pm$ 0.27 <sup>b</sup>
T <sub>3</sub> (RB)	9.66 $\pm$ 0.24	10.72 $\pm$ 0.65	9.57 $\pm$ 0.55	10.42 $\pm$ 0.27 <sup>ab</sup>	9.85 $\pm$ 0.26	11.23 $\pm$ 0.99	9.97 $\pm$ 0.24	10.20 $\pm$ 0.20 <sup>a</sup>

Means bearing different superscripts (a, b) differ significantly ( $P < 0.05$ ) within the column.

prevalence than cow using rubber mattress. This might be due to motivation of cow to lie down more time when sand bed was available to them. Furthermore, there was no extra benefit of providing rubber mat in covered area with sand in open area for lameness score. It could be due to the preference of cow for lying in sand over standing in rubber mat. Wagner-Storch *et al.* (2003) found that when dairy cows are given a choice between deep loosely bedded stalls or concrete stalls covered with mats, they choose mostly to lie down in deep bedded stall. Cook and Nordlund (2009) also suggested that sand bedded stalls are useful in reducing new cases of lameness as they permit lame cow to maintain adequate rest. Improvement in gait score is likely a direct consequence of improved biomechanics of weight distribution with the claw (Bicalho and Oikonomou 2013). Our results are in agreement with Vockey *et al.* (2001) who found that cumulative incidence of clinical lameness was highest for concrete than other softer floor surface. In several studies, concrete floor has been found involved in the development of lameness (Vanegas *et al.* 2006, Cook and Nordland 2009). Rubber floor in place of concrete was not favourable for locomotion score of cows (O'Driscoll *et al.* 2009, Eicher *et al.* 2013). Odds of becoming lame over time and the proportion of cows requiring therapeutic hoof trimming was reported to be higher for cows on concrete (Vanegas *et al.* 2006). It is important to note that in general mean lameness score for all treatment groups were in acceptable range in the present study.

Mean walking speed differed significantly ( $P < 0.05$ ) on month 3 and month 6 between treatments. Overall mean walking speed for group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 0.93 $\pm$ 0.02, 1.00 $\pm$ 0.02, 1.02 $\pm$ 0.02 and 0.93 $\pm$ 0.02 m/sec, respectively. Walking speed differed significantly ( $P < 0.05$ ) between treatments and was greater in T<sub>2</sub> and T<sub>1</sub> than T<sub>3</sub> and T<sub>0</sub>. Cows housed in T<sub>0</sub> and T<sub>3</sub> group walked significantly slower compared to T<sub>1</sub> and T<sub>2</sub> group. This trend persisted throughout the study period. Walking time differed significantly ( $P < 0.05$ ) between treatments. Walking time

also followed the similar trend with that of walking speed.

There was a significant negative correlation ( $r_s = -0.468$ ) between lameness score and walking speed. In the present study, the groups having comparatively lower lameness score (T<sub>1</sub>, T<sub>2</sub>) walked faster than the groups having higher lameness score (T<sub>0</sub>, T<sub>3</sub>). Higher values for locomotion scores and lower values for cow speed indicate poorer mobility. Our findings are in agreement with Telezhenko and Bergsten (2005) who reported that the cow with normal gait had higher walking speed (1.11 $\pm$ 0.01 m/s) than moderately lame cow (0.99 $\pm$ 0.03 m/s). Hassall *et al.* (1993) noted that lame cows were often the slowest to enter the parlour. However, O'Driscoll *et al.* (2009) found no effect of concrete or rubber floor on cow speed.

Cows having maximum lameness score of 1 at least once (smooth and fluid movement) for whole experiments were 16.7% of all animal in Group T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub>. Cows with maximum lameness score of 2 (imperfect locomotion but moving freely) at least once in group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 33.3, 83.3, 66.7 and 66.7%, respectively. Cows with maximum score of more than 2 at least once were highest in T<sub>0</sub> (50%) followed by T<sub>3</sub> (33.3%), T<sub>2</sub> (16.7%) and T<sub>1</sub> (0%). In general, no cow in any group was scored with more than 4 lameness score. Proportionally greater number of cows with higher lameness score in T<sub>0</sub> group might be due to the fact that exposure to harder (concrete) and uneven (brick paving) surface resulted into constant strain on hooves. Conversely, in other groups due to availability of softer surface (rubber or sand) at least in some area of loose house might have provided respite from the strain and improved lameness score. Boyle *et al.* (2005) also reported that cows prefer to stand on cushioned flooring than on bare concrete.

In conclusion, lameness scores differed significantly among the groups. Lameness scores were found higher in cows housed in brick floor with either concrete or rubber in covered area (T<sub>0</sub>, T<sub>3</sub>). Provision of sand was found advantageous than brick paving in open area for lameness

score. Cow housed in T<sub>0</sub> (Concrete + Brick) and T<sub>3</sub> (Rubber + Brick) group walked slower compared to T<sub>1</sub> (Concrete + Sand) and T<sub>2</sub> (Rubber + Sand) group. This trend persisted throughout the study period. There was a significant negative correlation ( $r = -0.468$ ) between lameness score and walking speed.

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