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# Insights into the effect of shelter modification on key production aspects of Sahiwal zebu cows reared in hot arid ambience

**R Arora, SC Goswami, ML Chaudhary and G Gujar**

**Abstract**
This study was undertaken to evaluate the effect of shelter modifications in the form of floor alteration and heat stress amelioration aids on the biochemical aspects and productive performance of Sahiwal zebu cows. 24 healthy Sahiwal cows in their second or third parity were randomly assigned to four groups (G1, G2, G3, and G4) having 6 cows each and were studied for duration of 150 days from June to November. G1 acted as control without any shelter modification, while G2 cows were housed in stalls with rubber mat covered floors, G3 cows were provided with cooling fans along with water sprinkling twice a day, and G4 cows were housed in stalls combining rubber mat floors with cooling fans and water sprinkling twice a day. This study revealed a significant ($p<0.05$) effect of shelter modification on milk yield, though no significant effect on milk composition was found. The use of heat amelioration aids with, and without rubber mat floors positively influenced the productive aspects of Sahiwal cows. Such strategies can be utilized to reduce stress on animals and help in maintaining their production.

**Keywords:** Sahiwal, dairy cows, flooring, shelter, rubber mat, milk yield, production performance

## Introduction
India is home to an assortment of livestock species, ranging from large bovids like cattle, buffalo, and yaks, to smaller species like goats, sheep, and pigs. The country alone accounts for 37.28 %of global cattle, 21.23 %of global buffalo, 26.40 %of global goat and 12.17 %of global sheep population (FAOSTAT, 2020) [6]. This livestock richness is one of the key reasons of the nation emerging as a global giant in milk production. However, the majority of animals are still reared in unorganized set up, which translates into low productivity per animal compared to the developed country counterparts. Livestock rearing still holds the key to livelihood security of a large rural mass, especially in the state like Rajasthan which has got substantial area under the Great Thar desert that massively constraints agriculture (Department of animal husbandry, Rajasthan). The nation is going through a phase of climate change resulting in increased episodes of heat stress in northern India (Shukla 2003) [10], this poses a serious challenge to the sustainability of livestock rearing. Climate change coupled with the ever-increasing demand for animal source food owing to changing food habits warrants significant transformation in the livestock sector to meet these challenges.

The recent past has seen a shift in the dairy production systems of the country from the traditional extensive set up to a largely industrial set up characterized by intensification. However, the intensification of dairy production systems comes with its own set of challenges. Studies from countries across globe, over the years, have highlighted the issues associated with intensive production, especially with regards to animal comfort and subsequent welfare (Chikwanda and Muchenje 2017; Brscic *et al*. 2015) [4, 3]. The type of intensification and housing systems are defined by the prevailing agroclimatic conditions and availability of construction materials. In Indian set up, mostly tie stalls or loose housing systems are prevalent in dairy production owing to the small herd size. Even in loose housing systems, the resting paddocks and key buildings like milking and feeding areas have largely concrete floor. Concrete floor being hard and abrasive, has been associated with discomfort of cows often predisposing to lameness, and mastitis (Islam *et al*. 2020; Upadhyay *et al*. 2015) [7, 14]. Both lameness and mastitis are known adversaries of productivity of cows.

The earlier stated facts warrant a closer look at the various dairy production systems prevalent in the country, which will throw crucial insights into the advantages and limitations of different systems.

This will help to devise production systems in the form of housing and its aspects best suited to a particular agroclimatic set up. Furthermore, studies delineating the effects of varied flooring and heat stress amelioration strategies is significantly lacking in the animals of hot arid region of Bikaner. The study area falls in the great Thar Desert, which is characterized by wide diurnal fluctuations in ambient temperature, which makes the animals reared in this set up the model candidates for heat stress studies. Taking cognizance of all these facts, the present study investigated the effects of concrete floor and modifications to the floor, with and without heat stress amelioration strategies on the productive parameters of Sahiwal zebu cows reared in hot arid ambience.

## Materials and Methods

### 1. Experimental design

Twenty-four lactating Sahiwal cows, in their second or third parity, free from any anatomical or pathological conditions were selected from the cattle yard of Livestock research station (LRS), Kodamdesar, Bikaner, India. The cows were randomly assigned to four experimental groups: G1, G2, G3, and G4, with six cows per group, averaging similar cumulative milk yield at the start of the experiment. The G1 group acted as control and reared on concrete floor without any shelter modification, while the rest three groups were assigned to treatments as outlined in table 1. The milk samples were collected fortnightly for analysis of production parameters.

### 2. Recording of microclimatic variables inside shed

The meteorological variables, temperature, and relative humidity were recorded twice daily at morning and afternoon time points every fortnight in all four sheds. The THI was calculated from these variables as per the formula:

$THI = (1.8 \times Tdb + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times Tdb - 26)]$ (NRC, 1971)

Where, Tdb- dry bulb temperature in °C and RH is relative humidity (%).

### 3. Estimation of production parameters

The milk yield per group was recorded daily and averaged for a fortnight combining yields of all the individuals of every treatment group. The milk samples collected every fortnight during the study period were subjected to estimation of milk fat, protein, lactose, solids not fat (SNF), and total solids, in an automated milk analyser, Foss Milkoscan FT120.

### Statistical analysis

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

### Prevailing microclimate

The mean THI was found to be 78.81 ± 0.49 and 82.87 ± 0.12, 78.56 ± 0.19 and 82.66 ± 0.19, 76.81 ± 0.17 and 79.23 ± 0.17, and 76.78 ± 0.50 and 79.18 ± 0.11 during morning and afternoon periods for G1, G2, G3, and G4 shed, respectively. THI values were significantly higher ($p<0.05$) in G1 and G2 groups as compared to G3 and G4 groups in morning as well as in the afternoon periods.

### Production parameters

Data pertaining to the milk yield (table 2) revealed the overall mean milk yield during the study period to be 5.32±0.65, 5.63 ±0.89, 6.71±0.73, and 6.92± 0.7, in G1, G2, G3, and G4 groups, respectively. The milk yield differed significantly ($p<0.05$) between the control and treatment groups G3, and G4, while no significant difference in milk yield was evident between G2 and G1 groups. The G3 and G4 groups maintained significantly higher production throughout the study period, compared to G1. The milk total solid of different fortnights was 12.72±0.42 13.19±0.28, 13.43±0.28 and 13.71±0.33 (table-3)in G-1,G-2, G-3 and G-4 groups, respectively (table 4.10). Findings of the present experiment indicated that treatment did not affect (P>0.05) total solid content. There was a non-significant difference between groups of experimental animals under G-2, G-3, G-4 and G-4 (control) in mean total solids per cent. but lowest value was recorded in G-1 group . It might be due to highest somatic cell counts in G-1 group compared to other groups.

## Discussion

Housing is one of the key determinants of animal comfort, and in turn the productivity and welfare of animals. This study was an attempt to evaluate the effect of housing modifications on the biochemical, productive, and reproductive aspects of milking Sahiwal cows reared in hot arid region of the Great Thar Desert. On expected lines, the mean THI values were close to 80 in all the groups, indicating heat stress on animals. Other researchers have also reported THI in the zone of stress for dairy cows in northern India during summer and hot humid seasons (Bhan *et al*. 2012) [1]. The sheds with heat amelioration devices in the form of fans and water sprinkling however maintained lower THI compared to G1 and G2. This corroborates with the earlier reports have also shown lower temperature concomitant with housing modification (Singh *et al*. 2014) [14] who found significantly. Moreover, use of evaporative cooling in dairy barns lowered the THI by some points (Sinha *et al*. 2019; Bucklin *et al*. 2009) [12, 2].

Different housing modifications have been associated with improved performance of animals (Lowe, Lively and Gordon 2019). In our study, the cows housed in shelter provided with heat alleviating measures coupled with and without rubber mat flooring showed significantly better milk yield. Use of fogger with fans significantly improved the milk production of crossbred dairy cows (Sinha *et al*. 2019) [12]. Spraying water on animals reduces the heat load (Tresoldi *et al*. 2018) [13] and negates the adverse impact of heat stress to some extent. Earlier studies in cows and buffaloes have also shown the animals housed with heat stress alleviation strategies to maintain higher production (Yadav *et al*. 2016) [15]. However, cows reared on rubber mats alone without any heat alleviation strategies did not improve production, agreeing with the reports of Upadhyaya *et al*. (2015) [14], Eicher *et al*. (2013) [5]

**Table 1:** Experimental design

| Groups | Treatments |
|---|---|
| G1 (n=6) | Control, cows reared on floor made of concrete slabs |
| G2 (n=6) | Cows reared on concrete floor covered with 25mm thick rubber mats in the covered area |
| G3 (n=6) | Cows reared on concrete floor with provision of fans in the covered area and sprinkling of water twice daily at 11.00 AM and 3.00 PM. |
| G4 (n=6) | Cows reared on concrete floor covered with 25 mm thick rubber mats with provision of fans in the covered area and sprinkling of water twice daily at 11.00 AM and 3.00 PM. |

**Table 2:** Production parameters of cows in different treatment groups

| Parameters | Days | Treatments | | | |
|---|---|---|---|---|---|
| | | G-1 | G-2 | G-3 | G-4 |
| Milk Yield | 15 | 6.62 ± 0.85 | 6.31± 0.37 | 6.43 ± 0.66 | 7.02 ± 0.42 |
| | 30 | 6.69 ± 0.85 | 6.43± 0.78 | 8.31* ±0.73 | 8.7* ± 0.56 |
| | 45 | 6.26 ± 0.61 | 6.44 ± 1.02 | 7.53* ± 0.55 | 7.75*± 0.63 |
| | 60 | 6.25 ± 0.81 | 6.56 ± 1.09 | 7.61*± 0.66 | 7.84*± 0.8 |
| | 75 | 5.61 ± 0.75 | 6.04 ± 0.98 | 7.26* ± 0.69 | 7.46* ± 0.86 |
| | 90 | 4.99± 0.64 | 5.37± 1.06 | 6.94* ± 0.82 | 7.11* ± 0.81 |
| | 105 | 4.81 ± 0.65 | 5.22 ±1.07 | 6.72* ±0.83 | 6.91* ± 0.85 |
| | 120 | 4.33± 0.72 | 5.09*± 1.1 | 6.23*± 0.88 | 6.42* ± 0.89 |
| | 135 | 4.28 ± 0.58 | 4.76± 1.17 | 5.45*± 0.91 | 5.55*± 0.92 |
| | 150 | 3.55± 0.48 | 3.97 ± 1.16 | 4.54* ± 0.96 | 4.67* ± 0.92 |
| | Mean | 5.32*± 0.65 | 5.63* ± 0.89 | 6.71*± 0.73 | 6.92*± 0.7 |
| Total Solids | 15 | 12.75± 0.37 | 12.63± 0.17 | 13.24± 0.44 | 13.23± 0.41 |
| | 30 | 12.72± 0.35 | 12.75± 0.15 | 13.18± 0.35 | 13.43± 0.42 |
| | 45 | 12.48± 0.37 | 12.75± 0.26 | 13.04± 0.29 | 13.42± 0.32 |
| | 60 | 12.49± 0.4 | 12.84± 0.27 | 13.13± 0.22 | 13.43± 0.32 |
| | 75 | 12.46± 0.43 | 13.03± 0.34 | 13.12± 0.23 | 13.31± 0.32 |
| | 90 | 12.52± 0.45 | 13.2± 0.35 | 13.41± .31 | 13.79*± 0.3 |
| | 105 | 12.75± 0.49 | 13.46± 0.36 | 13.67± 0.32 | 13.89± 0.29 |
| | 120 | 13.14± 0.59 | 13.94± 0.45 | 14± 0.26 | 14.39± 0.38 |
| | 135 | 12.95± 0.58 | 13.82± 0.44 | 13.79± 0.25 | 14.17*± 0.35 |
| | 150 | 12.77± 0.56 | 13.83± 0.39 | 13.71± 0.26 | 14.12*± 0.39 |
| | Mean | 12.72±0.42 | 13.19±0.28 | 13.43±0.28 | 13.71±0.33 |

Note- mean bearing superscript '*' differ significantly ($p<0.05$)

## Conclusion

Housing conditions directly impact the production and welfare of animals. Though the use of rubber mat alone did not reveal any significant effect on the studied parameters, cows reared in shelter with improved floor and cooling strategy had the best performance. This can indicate the burden of heat stress to mask the effect of using rubber mat flooring alone on improving the performance of animals. Overall, the use of heat amelioration strategies coupled with or without improved flooring during the stressful periods of summer and hot humid seasons can help reduce the stress on animals and help to maintain their productive performance.

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