

Effect of Shelter Management Practices on Growth and Physiological Responses of Female Cross-Bred Calves in Semi-Arid Zone

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Abstract Fifteen crossbred calves were divided into 3 groups of 5 animals each on the basis of their similar body weight and age. Each group was allotted to three housing system viz. (T₁ loose house; T₂ loose house + bedding + curtains and T₃ conventional barn) during winter. Average maximum temperature was significantly ($p < 0.05$) higher in T₁ and minimum temperature was higher ($p < 0.05$) in T₃ as compared to other two groups in microclimate. Crossbred calves reared under T₃ (5.51) consumed more

($p < 0.05$) DM (kg) than reared in T₂ (5.45) and T₁ (5.22). Mean DM intake /100 kg body weight was higher ($p < 0.05$) in T₃ calves as compared to other group calves. Average daily VWI and VWI/kg DM consumed were higher ($p < 0.05$) in T₃ group calves as compared to T₁ and T₂ group calves. Average daily weight gain (g) was 484.44 ± 48.98 , 566.67 ± 102.05 and 560.00 ± 94.08 in T₁, T₂ and T₃ groups, respectively. The weight gain and feed conversion ratio (DMI : gain) was significantly higher ($p < 0.05$) in T₂ as compared to other groups. The feed conversion efficiency (kg) was better in T₂ (9.62) as compared to T₁ (10.78) and T₃ (9.84) groups. The animals spent more time in feeding during day than in night in all the groups. Average feeding time (minutes) per day (24 h) was more ($p < 0.05$) in T₃ calves as compared to T₁ and T₂ group calves. The average resting time (minutes) was higher ($p < 0.05$) in T₂ (641.73) and as compared to T₁ (604.67) and T₃ (625.00) during day (24 h). The total cost/kg body weight gain was lowest in T₂ (Rs 129.53) followed by T₃ (Rs 131.16) and T₁ (Rs 142.27) groups. Therefore, it is concluded that the modified house (Loose house + bedding + curtains) and conventional barn improves body growth and physical comfort of crossbred calves as well as more economical during winter season in semi-arid zone.

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Introduction

India is a sub-tropical country where climate varies in most of its part. The main constraint in the efficient livestock production in India is climate. The climatic conditions in Rajasthan state are extremely hard both in summer and winter where ambient temperature varies from 46—48°C in summer and 0°C to 4°C in winter. This adverse climatic condition affects the growth and age of maturity of the calves [1]. During winter, the structures especially those parts coming in contact with animal, like floors and walls, should not get too cold and provide protection from cold winds. To combat cold stress, the animal must increase its housing, feeding and management technologies are available through which climatic stress on animal can be reduced. The various management practices such as water sprinkling, air conditioning, showering and wallowing during summer [2]. Similarly, providing Tarpaulin, bedding and jacketing protect cattle from cold stress during winter. The degree of comfort depends upon the type of housing which indirectly affects the health of animal inhabiting it [3]. Animal housing helps in moderating the range of micro-environment to which the animals are exposed and optimizes their production by protecting them from extreme climates. A shelter is required both during summer as well as winter to counter the various vagaries of adverse climate and to provide a comfortable environment to the animals. Cows may prefer a particular housing system, which may have covered space, open area, tree shade or any other additions. Bedding helps to insulate animals from the cold ground. The calves are exposed to cold atmosphere temperature as well as wet floor which may affect their growth and health. The young calves are future herd replacement stock and need a special attention including climate protection, therefore; growth of calves determines the future production as well as reproduction efficiency in cattle. Hence optimum growth must be ensured through proper housing, feeding and health management as per their genetic potential. The aim of good management of calves during their early life is to attain optimum growth and better feed conversion efficiency and thereby to reach early maturity. This may reduce the age of first calving, which is an important trait of significance, leading to improvement of

life time production performance of the animals [4].

Materials and Methods

Fifteen crossbred (Tharparkar/Sahiwal × HF) calves (10-30 months) were taken from the dairy farm of SKN College of Agriculture, Jobner from 05-12-2014 to 05-03-2015 and divided into 3 groups of 5 animals each on the basis of their body weight and age. Each group was allotted randomly to the following housing conditions/treatments :

T₁ - Loose house (control) : House having covered area with asbestos cement sheet roofing, brick paved floor and open area surrounded by 1.5 meter high from three sides.

T₂ - Loose house + Bedding + Curtains : Bedding of left over wheat bhusa was changed at weekly intervals and loose house as detailed above in T₁ was used as modification. Curtains were provided to calves at night hours for protection from cold stress.

T₃ - Conventional Barn (closed) : In conventional barn is completely closed structure as roofed and walls are also complete with windows and ventilators located at suitable places to get more ventilation and lighting. Animals were tied at neck by iron - chains.

The maximum, minimum, dry and wet bulb temperatures were recorded at 8.30 am and 3.00 pm daily. The relative humidity was calculated from dry and wet bulb reading using hygrometric table. The Temperature Humidity Index (THI) was calculated [5]. Crossbred calves were offered wheat straw (*Triticum aestivum*) *ad lib*. dry fodder. The concentrate as pelleted feed (Sarus Gold) / readymade feed was formulated which contained 20.53% CP, 2.25% EE and 14.69% CF. The animals were fed in the morning as per NRC recommendations for dairy cattle. The samples of feed and fodder were analyzed for proximate principles. The voluntary water intake of calves was recorded once a week in morning and evening by offering measured quantity of clean and fresh water by spring balance with a bucket during experiment. All calves were weighted at the beginning and at monthly interval and at the end of the experiment. The body weight of the animals was re-

corded in the morning at 9 am after they had been kept off-feed for 14 h. Fasting before weighing was done in an attempt to reduce the gut fill, thereby minimizing the weight fluctuations. Rectal temperature ($^{\circ}\text{F}$) and Respiration rate (counts/minute) were recorded at 9 am and 3 pm at fortnightly interval during experiment. The body temperature was recorded by inserting the clinical thermometer into the rectum of animal for one minute. Respiration rate was recorded by counting movements of right flank (counts/minute) of calves [5]. Resting behavior is the total period of in hours when the animal is lying down/sitting in 24 h. The feeding habit and manner by which the animals are continue to intake during 24 h in standing situation as per their habit studies during feeding behavior. The record of cost (from feed and fodder store of the LPM Dept) of feed and fodder fed to the animal used for house modifications (wheat straw and curtains) were also maintained. The cost of each treatment was calculated on the farm basis prices. The experiment was conducted in a completely randomized design (CRD) and data was statistically analyzed by standard statistical methods.

Results and Discussion

Microclimate in different experimental houses

The data on climate variable are given in Table 1. The average maximum temperature was higher ($p < 0.05$) in T_1 (loose house) as compared to T_2 (Modified house) and T_3 (Closed barn). While minimum temperature was significantly higher ($p > 0.05$) in T_2 and T_3 was observed due to protection from cold by curtains as well as bedding in modified loose house and maximum area closed by wall in conventional barn. But the minimum temperature was lower ($p < 0.05$) in loose house than other groups. The minimum temperature was also significantly higher which is between the ranges of comfort zone of crossbred calves. The mean relative humidity was significantly higher ($p < 0.05$) in conventional barn (T_3) as compared to other treatments. The loose house had lower ($p < 0.05$) THI than other types of houses. The THI is commonly used method to know the degree of heat stress in animals [3, 5, 6]. The results are in agree-

Table 1. Climate parameters in different dairy houses during winter season. Means having different superscript differ significantly ($p < 0.05$).

Parameters	T_1 (loose house)	T_2 (LH + Bedding + Curtains)	T_3 (Closed barn)
Maximum temperature			
Morning	22.42 ^a ± 0.101	20.87 ^b ± 0.174	20.60 ^c ± 0.170
Evening	22.69 ^a ± 0.118	21.32 ^b ± 0.139	20.62 ^c ± 0.151
Mean	22.55 ^a ± 0.184	21.09 ^b ± 0.132	20.61 ^c ± 0.137
Minimum temperature			
Morning	13.61 ^c ± 0.252	13.79 ^c ± 0.206	15.41 ^a ± 0.162
Evening	13.78 ^c ± 0.242	14.35 ^b ± 0.204	15.59 ^a ± 0.143
Mean	13.69 ^c ± 0.245	14.07 ^b ± 0.204	15.50 ^a ± 0.150
Relative humidity (%)			
Morning	74.39 ^a ± 0.386	77.54 ^b ± 0.830	77.97 ^a ± 1.25
Evening	63.08 ^b ± 1.083	57.42 ^c ± 0.914	66.93 ^a ± 2.202
Mean	68.74 ^b ± 0.546	67.48 ^c ± 0.424	72.45 ^a ± 1.676
Temperature humidity index			
Morning	59.69 ^b ± 1.736	59.92 ^a ± 1.553	58.98 ^c ± 1.721
Evening	67.50 ^c ± 0.988	68.69 ^b ± 0.878	7029 ^a ± 1.316
Mean	63.59 ^b ± 1.256	64.30 ^b ± 1.138	64.64 ^c ± 1.153

ment with findings of earlier workers [2,7,8].

Dry matter and water intake

Dry matter and voluntary water intake are presented in Table 2. DM intake per 100 kg body weight were affected significantly ($p < 0.05$) in T_3 , T_2 and T_1 treatments. Mean DM intake was higher ($p < 0.05$) in closed barn calves followed by T_2 than T_1 calves. However, there was significant difference in DMI of T_2 as compared to T_1 calves. Average daily VWI and VWI/kg DM consumed were lower ($p < 0.05$) in T_1 group calves as compared to T_2 and T_3 group calves.

Growth

The average daily body weight gain was 484 + 48.98, 566.67 + 102.05 and 560.00 + 94.08 g in T_1 , T_2 and T_3 , respectively (Table 3). The lowest gain in weight was observed in crossbred calves reared in loose

Table 2. Effect of shelter modifications on dry matter intake (kg) and voluntary water intake (Lit.) of crossbred calves. Means having different superscript differ significantly ($p < 0.05$).

Parameters	T ₁	T ₂	T ₃
Total DMI	5.22 ^c ± 0.094	5.45 ^b ± 0.136	5.51 ^a ± 0.203
DMI/kg/100 kg			
BW	2.816 ^c ± 0.085	2.817 ^b ± 0.083	2.862 ^a ± 0.088
Voluntary water intake/day	14.67 ^c ± 0.89	16.68 ^b ± 0.91	19.41 ^a ± 0.79
Voluntary water intake/kg DMI	2.75 ^c ± 0.081	3.06 ^b ± 0.112	3.51 ^a ± 0.215

house followed by barn and modified house calves. The calves are in loose house to be by cold atmosphere temperature as well as wet floor which may affect their growth. The growth rate was significantly higher ($p < 0.05$) in T₂ as compared to T₁ and T₃ groups which direct impact of protection from cold by bedding and curtains as modifications of loose house. The results are similar to those earlier reported [8—10].

Feed conversion efficiency

The feed conversion efficiency was 10.78 + 1.958, 9.62 + 1.333 and 9.84 + 1.159 kg in T₁, T₂ and T₃ groups, respectively (Table 3). The average daily body weight gain was 0.484 + 0.048, 0.566 + 0.102 and 0.560 + 0.094 kg in T₁, T₂ and T₃, respectively. The loose house calves required more amount of dry matter, to obtain one kg gain than animals in other two groups which may be attributed to less DMI and less weight gain due to cold and less for comfortable. The feed conversion efficiency or input-output ratio was significantly better in T₂ than T₃ and T₁ groups. This feed conversion efficiency is better in T₂ due to higher growth rate as well as physically comfort and more resting and feeding of these calves.

Table 3. Effect of shelter modifications on body weight gain (g) and feed conversion efficiency in cross bred calves. Means having different superscript differ significantly ($p < 0.05$).

Parameters	T ₁	T ₂	T ₃
Average body weight gain /day (g)	484.44 ^c ± 48.98	566.67 ^{ab} ± 102.05	560.00 ^{ab} ± 94.08
Average daily body weight gain (kg)	0.484 ^c ± 0.048	0.566 ^{ab} ± 0.102	0.560 ^{ab} ± 0.094
Feed conversion ratio (DMI : gain)	10.78 ^a ± 1.958	9.62 ^c ± 1.333	9.84 ^b ± 1.159

Similar results obtained earlier [8, 9, 11].
Physiological responses of calves

Respiration rate

Average daily respiration rate was 14.67 + 0.847, 14.52 + 0.418 and 15.30 + 0.783 counts per minute in respective treatments (Table 4). The average respiration rate was higher ($p < 0.05$) in T₃ group calves as compared to T₁ and T₂ group due to mostly wet floor and higher humidity. The respiration rate in T₂ group was significantly ($p < 0.05$) lower as compared to T₁ and T₃ due to more comfort and warmth made available through wheat straw bedding performed a protective barrier preventing further heat lost from body of calves to cool ambient atmosphere. The present findings are in agreement with the result of [2, 7].

Body temperature

The mean morning rectal temperature of crossbred calves was 101.51 + 0.561, 101.32 + 0.429 and 100.81 + 0.494 °F in T₁, T₂ and T₃, respectively (Table 4). The corresponding values for evening were 102.06 + 0.462, 101.74 + 0.502 and 101.29 + 0.477 °F. The average daily rectal temperature (°F) was 101.79 + 0.270, 101.54 + 0.399 and 101.05 + 0.346 °F in T₁, T₂ and T₃, respectively. The morning, evening and average rectal temperature was higher ($p < 0.05$) in T₁ as compared to T₂ and T₃ group calves. The higher rectal temperature in loose housed calves might be due to sunrays coming directly in the loose house leading to warming of shed which in correlation to maximum higher temperature. The present findings are in agreement with the earlier result [13—14] reported that rectal temperature was significantly higher in morning and evening in loose

Table 4. Average respiration rate/minute and body temperature (°F) of crossbred calves under different housing modifications. Means having different superscript differ significantly ($p < 0.05$).

Parameters	T ₁	T ₂	T ₃
Respiration rate/minute			
Morning	14.40 ^b ± 0.955	14.27 ^{bc} ± 0.516	15.33 ^a ± 0.851
Evening	14.93 ^b ± 0.806	14.63 ^b ± 0.474	15.27 ^a ± 0.761
Average	14.67 ^b ± 0.847	14.52 ^{bc} ± 0.418	15.30 ^a ± 0.783
Body temperature (°F)			
Morning	101.51 ^a ± 0.561	101.32 ^{ab} ± 0.429	100.81 ^c ± 0.494
Evening	102.06 ^a ± 0.462	101.74 ^{ab} ± 0.502	101.29 ^c ± 0.477
Average	101.79 ^a ± 0.270	101.54 ^b ± 0.399	101.05 ^c ± 0.346

house as comfort to conventional barn.

Behavior pattern of calves

Feeding behavior

The average eating time was 195.47 + 5.557, 227.47 + 10.866 and 248.40 + 9.926 minutes during day time in T₁, T₂ and T₃ respectively. The average eating time was 76.87 + 2.821, 93.67 + 1.045 and 99.60 + 2.613 minutes during night time in T₁, T₂ and T₃ respectively. The average time spent in eating during 24 h was significantly less ($p < 0.05$) in loose house as compared to T₂ and T₃ during winter season (Table 5). The results are in close agreements with the findings earlier [1, 8,14,15].

Lying (resting) down time

The average resting times spent by crossbred calves were 200.00 + 7.388, 225.27 + 8.892 and 215.00 + 7.072 minutes during day (12 h) time in T₁, T₂ and T₃ respectively (Table 5). The corresponding figures for night were 404.67 + 7.525, 416.47 + 6.820 and 410.00+ 5.913 minutes. The total time spent in resting per day (24h) in T₁, T₂ and T₃ group calves was 604.67 + 11.915, 641.73 + 12.687 and 625.00 + 12.520 minutes, respectively.

Economics/ Variable cost

The total feeding cost based on farm price was Rs

Table 5. Effect of shelter management practices on feeding time and resting time (minutes) of crossbred calves. Means having different superscript differ significantly ($p < 0.05$).

Parameters	T ₁	T ₂	T ₃
Feeding behavior			
Day	195.47 ^c ± 5.557	227.47 ^b ± 10.866	248.40 ^a ± 9.926
Night	76.87 ^c ± 2.821	93.67 ^b ± 1.045	99.60 ^a ± 2.613
24 h	272.33 ^c ± 6.023	321.13 ^b ± 10.731	348.00 ^a ± 11.369
Resting behavior			
Day	200.00 ^c ± 7.388	225.27 ^b ± 8.892	215.00 ^a ± 7.072
Night	404.67 ^c ± 7.525	416.47 ^b ± 6.820	410.00 ^a ± 5.913
24 h	604.67 ^c ± 11.915	641.73 ^b ± 12.687	625.00 ^a ± 12.520

25275.6, 26096.4 and 26312.4 in T₁, T₂ and T₃, respectively (Table 6). The total variable cost per kg gain was Rs 142.27, 129.53 and 131.16 in T₁, T₂ and T₃, respectively. The total variable cost per calf was Rs 6203.12, 6606.28 and 6610.48 in T₁, T₂ and T₃, respectively. The higher cost in T₃ group may be due to more expenditure incurred on labor and feed. The la-

Table 6. Cost of calves rearing under different housing modifications. Figures in parentheses are percentage.

Particulars	T ₁	T ₂	T ₃
1. Cost of curtain/bedding	-	695 (2.11)	-
2. Cost of labor	5500 (17.74)	6000 (18.16)	6500 (19.67)
3. Cost of medicine	240 (0.77)	240 (0.73)	240 (0.73)
4. Quantity of feed consumed (Qt)			
i. Concentrate-	11.25	11.25	11.25
ii. Wheat straw-	14.48	15.62	15.92
5. Cost of feed consumed (Rs)			
i. Concentrate-	14850.0	14850.0	14850.0
ii. Wheat straw-	10425.6	11246.4	11462.4
iii. Total	25275.6 (81.49)	26096.4 (79.00)	26312.4 (79.60)
6. Total variable cost of raising (5 calves)	31015.6 (100)	33031.4 (100)	33052.4 (100)
7. Total variable cost of one calve	6203.12	6606.28	6610.48
8. Total body weight gain/calf (kg)	43.6	51	50.4
9. Cost/kg gain	142.27	129.53	131.16

bor cost was higher in barn house group as compared to other groups. The cost per unit gain in body weight was less in T₂ followed by T₃ and T₁. Relatively lower cost/kg gain in body weight in T₂ can be attributed to higher growth rate of calves in this group. The present findings are in conformity with those reported earlier [16].

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