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Effect of Two Types of Housing and Levels of Feeding on Voluntary Feed and Water Intakes, and Associated Changes in Body Weight and Body Measurements of Crossbred Female Calves in Winter Season♣

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Abstract

The effect of two housing systems (loose house vs. conventional barn) and two levels of protein feeding (80 vs. 100% NRC, 1988) on feed and water intake and, associated changes in body weight and body measurements of twenty crossbred female calves that had an average body weight of about 85 .6±2.18 kg and age of 6-10 months was studied in 2x2 factorial experiment over a period of 98 days in the winter season. The average daily dry matter intake per head and intake per unit of metabolic body weight were significantly ($p<0.001$) affected by level of protein. The differences in these parameters between housing systems were not significant. Average voluntary water intake per head and intake per kg dry matter consumed and per kg $w^{0.75}$ were not significant. Housing system and level of protein did not significantly influence average final body weight and daily body weight gain. The average monthly increases in body measurements (body length, height, heart girth, abdominal girth and hip width) were not significantly influenced by housing system. Abdominal girth was however, significantly ($p<0.001$) affected by level of protein. It was higher for the 100% than 80% level of feeding.

Keywords: Body weight, crossbred calves, feed intake, water intake, housing system

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Introduction

Exotic breeds of dairy cattle have been introduced in many tropical and subtropical countries to meet growing demand of milk and milk products. As a result, a large number of crossbred populations have become available with the farmers. A farmer expects his cows to produce more milk and calve early with minimum inputs. Unfortunately, the above-mentioned targets are not realized in view of a number of constraints such as poor nutrition, disease and climatic stress. It has been well recognized that feed and climate affects the growth, production and reproduction at large.

Feed shortages, low nutritive value of existing feed resources and nutritional imbalance limit animal production and retard the onset of puberty. Provision of adequate nutrients in the diet of ruminants is of primary importance for the expression of their full genetic potential for growth and reproduction. On the other hand, adverse climate is another constraint for efficient livestock production systems. High or extremely low temperatures; high humidity and high solar radiation that characterized tropical environments are associated with lower livestock performance. These factors have led livestock owners in many parts of the tropics and sub-tropics to provide shelter for their animals. The purpose of housing dairy cattle like other farm animals is to reduce climatic stress on the animals that hinder production, reproduction and proper growth and development. Results of several trials conducted under a variety of conditions suggest that shelter is more beneficial in winter than in summer (Curtis, 1983). Winters are severe enough in most of the tropics and young calves are more susceptible to cold stress due to less adaptation ability to environmental stress. Severe cold weather not only reduces the feed efficiency but also causes to decrease resistance and suppresses growth and future development of the animal (Hahn, 1981 and Collier *et al*, 1982). This effect is more pronounced in crossbred cattle as compare to native breeds.

As indicated earlier, adverse climate make the raising of crossbred calves and maintenance of dairy cattle a difficult task under prevailing feed shortages (Jain *et al,* 1996). Although a number of studies have been conducted to reduce the deleterious effect of climate and feed on growth and production of different species (Dattilo and Congiu, 1979; Charles, 1994; Singh and Singh, 1994; Chauhan *et al,* 1999; Poudel, 2001), no comprehensive study appears to have been conducted to study the associative effect of housing and level of feeding on performance of growing crossbred female calves. Hence, the present investigation has been planned to study the effect of two housing systems and two levels of protein feeding on dry matter and water intakes, body weight gain and body measurements of crossbred female calves in winter season.

Materials and Methods

Study area

The study was conducted at the dairy farm of the College of Animal Sciences, Chaudhary Charan Singh (CCS) Haryana Agricultural University in Hisar, India for 98 days (from December 1, 2000 to March 10, 2001) during winter season. Hisar is located at 29^0 to 10' North latitude and 75^0 to 45' East longitude. The maximum daily temperature during the summer (hot season) varies between 40 and 46 degree Celsius. During winter (cold season) it ranges from 1.5 degree to 4 degree Celsius.

Allocation of treatments

Twenty crossbred female calves of 6 to 10 months of age that had an average body weight of about 85.6 ± 2.18 kg that varies from 68 to 100 kg were selected from the cattle herd. The crossbred female calves were of Indian zebu
$\times$ European dairy breeds. All calves were treated against internal and external parasites. After a preliminary adjustment period of 10 days, all the calves were divided into four groups of five animals each according to age and body weight. Animals in each group were randomly assigned to one of the following housing and feeding treatments: Loose housing system +80% feeding as per NRC (1988) recommendations (T_1); Loose housing system +100% feeding as per NRC (1988) recommendations (T_2); Conventional barn system + 80% feeding as per NRC (1988) recommendations (T_3) and Conventional barn system + 100% feeding as per NRC (1988) recommendations (T_4).

Management of animals

Two types of housing systems were used to house the calves as described by Heizer *et al.* (1953). Calves in T_1 and T_2 were sheltered in loose house that employed an open lot free-stall system that permits freedom of movement. The open lot has a shelter (partially protected shed) on one side where animals can retire during time of excessive heat, cold or rain. The other two groups of calves (T_3 and T_4) were housed in a conventional barn that is also known as closed barn or tie barn or stanchion barn. In this system animals are confined by stanchions or tie stalls on a lightly bedded hard surface floor. The barn is completely roofed and the wall is also complete with windows and ventilators located at suitable places. During the experimental period the average daily internal house temperature ranged from 12.4 to 20.4 °C in the loose house and 14 to 22.3 °C in the conventional barn. The overall mean values of maximum and minimum temperatures recorded in both the housing systems were 25 and 8.0 °C in loose house and 22.3 and 12.7 °C in conventional barn respectively. The maximum temperatures in loose house and conventional barn varied from 17.3 to 30.4 °C and 16.8 to 28.7 respectively, while the minimum temperature varied from 5.3 to 11.4 °C in loose house and 9.5 to 15.9 °C in conventional barn respectively. The calves in both house types were fed and treated individually. Both shelters were cleaned daily and fresh drinking water was continuously available in each shed.

Percent ingredient composition of the concentrate mixture fed to the experimental calves is given in Table 1. The amount of concentrate offered to the calves in each treatment group was fixed in such a way that T_1 and T_3 received 20 per cent below the normal NRC (1988) recommended level while T_2 and T_4 were fed on normal NRC (1988) recommended level of crude protein per head per day. An equal and weighed amount of seasonally available green fodder was fed to all the calves daily and its crude protein content was taken into consideration while fixing the allowance of concentrate feed for each group. Calves in each group were offered wheat straw *ad libitum*. The ration of each calf was adjusted in proportion to its body weight change in each fortnight.

Table 1. Ingredient composition (%) of concentrate mixture fed to experimental

Feed ingredients	**Proportion of mixture**
Maize	13
Wheat	19
Barley	14
Rice polish	20
Mustard cake	15
Groundnut cake	16
Common salt	01
Mineral mixture	02

The feed intake during the experimental period was determined on the basis of weighing the concentrate, green fodder and wheat straw offered and left over in a fortnight. Representative samples of concentrate mixture, wheat straw, maize and mustard green chops were taken and were kept in hot air-oven for determination of dry matter content. These samples were then analyzed for proximate principles according to AOAC (1980). Calves were weighed at the beginning of the experiment and fortnightly then after. The weights were recorded in the morning before providing water and feed. Body measurements such as body length, height, heart girth, abdominal girth and hip width were taken at the beginning and monthly then after. The water intake of individual calves was recorded for three consecutive days in a fortnight during the experimental period and the mean was taken for calculation. A measured quantity of fresh water was offered ad libitum individually to each calf by placing a graduated bucket full of water in front of the calves twice a day. The leftover was also measured to find out the actual voluntary water intake.

Statistical analyses

Data on dry matter and water intakes, body weight and body measurements were analyzed based on housing and feeding effects in a 2 x 2 factorial arrangement as per the standard statistical procedure recommended by Snedecor and Cochran (1980). The Least significant difference (LSD) was used to locate treatment means that were significantly different

Results and Discussion

Dry matter intake

The proximate composition of feeds and fodder on dry matter basis is presented in Table 2.

Table 2. Proximate composition (%) of feeds

Feed components	DM	Expressed as percent of dry matter				
		CP	CF	NFE	EE	Ash
Concentrate	90.00	20.00	8.96	62.73	4.24	5.65
Maize green	12.35	8.94	25.11	52.93	1.26	11.75
Mustard green	12.83	8.50	19.94	56.41	3.24	9.90
Wheat straw	90.08	3.53	31.13	53.04	1.81	10.47

The data for daily dry matter intake and intake per kg metabolic body weight are presented in Table 3. On an average the daily dry matter intake and intake per kg metabolic body weight in the two housing systems were 2.89 ± 0.086, 2.96 ± 0.092 kg and 84 ± 0.002 and 85 ± 0.002g in loose house and conventional barn respectively. These differences were not statistically significant (p>0.05). This supported the earlier findings by researchers (Martin, 1971; chakrabarti, 1991; Fiems *et al*, 1998; Chauhan et al, 1999 and Poudel, 2001) on cattle and buffalo calves in winter under similar housing conditions.

Table 3. Average daily dry matter intake of crossbred calves

Variables	**Number of animal**	**Average DM Intake (kg) (Mean ±SE)**	**Dry matter intake / kg Metabolic body weight (g) (Mean ±SE)**
Overall mean	20	2.93±0.06	85±0.001
A. Housing			
Loose House (LH)	10	2.89±0.09	84±0.002
Conventional Barn (CB)	10	2.96±0.09	85±0.002
B. Level of feeding			
1. 80% NRC (F_1)	10	2.71^b±0.08	79^b±0.002
2. 100 % NRC (F_2)	10	3.14^a±0.09	90^a±0.002
C. House x Feed			
1. LH x F1	5	2.71±0.12	80±0.003
2. LH x F_2	5	3.07±0.12	88±0.002
3. CB x F_1	5	2.71±0.12	79±0.002
4. CB x F_2	5	3.20±0.13	91±0.002

Within variables means in the same column without a common superscript differ significantly (p<0.001)

The average values for daily dry matter intake and intake per kg metabolic body weight under two levels of proteins were 2.71±0.084, 3.14 ±0.087 kg and 79 ±0.002 and 90 ±0.002 g in 80 and 100% NRC levels of protein feeding respectively. These differences were statistically significant (P<0.001). It was higher for the 100% than the 80% level. This may be due to the 20% additional concentrate intake by calves of this group than calves of other group fed on 80% level. Similarly Taparia *et al*. (1983), Mai and Kurar (1990b), Singh *et al.* (1991) and Shenu (2000) reported that there was significant increase in feed intake in crossbred calves that were fed higher levels of crude protein. On the contrary, Gupta and Saba (1983), Krishna and Ranjhan (1985) and Sampath *et al*. (1983) did not find significant effect on dry matter intake in crossbred calves reared on different levels of protein. The interaction between housing systems and level of feeding was not significant.

Table 4. Average daily voluntary water intake of crossbred calves

Variables	Number of animals	Voluntary water intake/ h/d(Liters) (Mean ± SE)	Voluntary water intake / kg DM consumed (Liters) (Mean ± SE)	Voluntary water intake / kg metabolic body weight (ml) (Mean ± SE)
Overall mean	20	6.00±0.16	2.13±0.069	174±0.004
A. Housing				
1. *Loose House (LH)*	10	5.70±0.22	2.07±0.11	166±0.006
2. *Conventional Barn (CB)*	10	6.30±0.24	2.18±0.09	181±0.006
B. Level of feeding				
1. 80% NRC (F_1)	10	5.74±0.22	2.25±0.12	168±0.006
2. 100 % NRC (F_2)	10	6.26±0.24	2.01±0.07	179±0.006
C. House x Feed				
1. LH x F1	5	5.63±0.31	2.23±18	166±0.008
2. LH x F_2	5	5.77±0.32	1.92±0.10	165±0.007
3. CB x F_1	5	5.85±0.30	2.27±0.14	170±0.008
4. CB x F_2	5	6.74±0.35	2.09±0.11	192±0.008

Voluntary water intake

The data for daily voluntary water intake and intake per kg metabolic body size by experimental animals are presented in Table 4. The daily voluntary water intake and ratio of water to dry matter intake were 5.70 ± 0.22, 6.30 ± 0.24 liter and 2.07± 0.11 and 2.18± 0.09 liter in loose house and conventional barn respectively and intake per kg metabolic body weight were 166 ±0.006 and 181 ±0.006 ml in loose house & conventional barn respectively. These differences were not statistically significant (p>0.05). However the trend was clearly in favor of the conventionally housed group. This may be due to the higher internal temperature observed in the conventional barn, (17.5 vs. 16.5 °c) which initiated the calves of this house group to consume more water than the calves in loose house. Chakrabarti (1991) and Poudel (2001) reported similar findings on buffalo calves under similar housing systems in winter.

The analysis of variance indicated no significant difference in voluntary water intake between the two levels of protein, which is in agreement with earlier reports. For instance, Mudgal and Sivaiah (1982) and Sivaiah and Mudgal (1984) observed non-significant difference in voluntary water intake per unit of dry matter consumed between different levels of feeding. Shenu (2000) reported non-significant difference in voluntary water intake at 100 and 125% level of feeding and Poudel (2001) observed non-significant difference in voluntary water intake per kg dry matter consumed and intake per kg metabolic body weight at 80 and 100 % levels of protein. The interaction between housing system and level of protein feeding was not significant.

Body weight changes

The data for body weight changes of calves under the two housing and two levels of protein feeding are presented in table 5. Average daily body weight gain under two housing systems and two levels of protein feeding was 535 ±0.03 and 540 ±0.04 g and 525 ±0.03 and 553 ±0.03g in loose house, conventional barn, 80 and 100% NRC feeding respectively. The analysis of variance revealed that housing system and level of protein of the diet and the interact between housing system and level of protein had no significant influence (p>0.05) on final body weight, total weight gain and daily body weight gain of crossbred females calves. The results indicated that for a dry land environment like Hisar during a cold winter season housing of crossbred female calves in a conventional barn had no advantage in respect to growth of the calves over the loose house. Murely and Calvahouse (1958) reported no significant variation in growth of calves between conventional barn open shed or portable pens. Similarly, significant difference was not reported in body weight gain of beef cattle due to closed building and open front pole barn during winter (Hillickson *et al,* 1972). Chakrabarti (1991) observed better growth in conventional barn housed calves than the calves hosed in the other housing systems. On the contrary Saseendranath *et al.* (1983) and Poudel (2001) reported significantly higher weight gains in crossbred and buffalo calves housed in conventional barn as compared to loose house in winter.

Values for the level of feeding were slightly higher in 100% than the 80% level. This trend was clearly in favor of the 100% level however, the higher dry matter recorded by calves fed on 100% NRC level was not reflected in their body weight gain. This may be due to the fact that the difference in protein level between the two levels may not be large enough to detect a significant difference in body weight gain of crossbred calves. This could also be due to the facts that diet containing 80% protein might be optimum for crossbred calves to attain their maximum genetic potential for growth. Similar findings were reported earlier by many workers (Rathee and

Yadava, 1970, Krishna and Ranjhan, 1982, Singh *et al,* 1991, Sampath *et al.* 1993, Loerch and Fluharty, 1998 and Shenu 2000) who observed similar body weight gain ($p>0.05$) between different levels of feeding on crossbred and buffalo calves. However, on the contrary Hassan *et al,* (1991), Song *et al,* (1998) and Poudel (2001) reported significant difference in growth rates of calves between different protein levels.

Table 5. Average body weight changes of crossbred calves during the experimental period

Source of variation	Number of animals	Average initial body weight (Kg) (Mean ± SE)	Average final body weight (Kg) (Mean ± SE)	Average total weight gain (kg) (Mean ± SE)	Average daily weight gain (g) (Mean ± SE)
Overall mean	20	85.60±2.18	138.30±5.10	52.7±1.07	539±0.024
A. Housing					
1. Loose House (LH)	10	85.30±2.89	137.60±5.09	52.30±1.05	535±0.031
2. Conventional Barn (CB)	10	85.90±3.38	139.00±5.69	53.10±1.10	540±0.037
B. Level of feeding					
1. 80% NRC (F_1)	10	85.50±3.29	134.30±4.44	51.30±0.05	525±0.033
2. 100 % NRC (F_2)	10	85.70±3.008	139.80±6.09	54.10±0.10	553±0.036
C. House x Feed					
1. LH x F_1	5	85.20±3.75	136.20±4.09	51.00±1.22	520±0.041
2. LH x F_2	5	85.40±4.68	139.00±9.43	53.60±1.27	550±0.048
3. CB x F_1	5	85.80±5.72	137.40±8.20	51.60±1.08	530±0.051
4. CB x F_2	5	86.00±4.34	140.60±8.80	54.60±1.14	557±0.053

Body measurements

The monthly changes in average body length and average body height during the experimental period were 245 ±0.025 and 200 ±0.019 mm, respectively, in loose house and 256 ±0.022 and 185 ±0.013 in the conventional barn, respectively. The corresponding values for the other body measurements for the two housing systems were 209 ±0.026 and 189 ± 0.012 mm for heart girth 210 ±0.027 and 225 ± 0.016 mm for abdominal girth, and 100 ±0.006 and 115±0.008 mm for hip width, respectively. The corresponding values between the two housing systems were not statistically different. Similar results reported earlier by Erb and Murdock (1951), Jorgenson *et al.* (1970), Macualay *et al.* (1995) and Poudel (2001) were in line with the findings in the present investigation.

The monthly average increases in body measurements (mm) of calves under the two levels of protein feeding were 253 ±0.022 and 249 ±0.025 (length),
185 ±0.014 and 200 ±0.017 (height) in 80 and 100% feeding levels respectively. The values for heart girth, abdominal girth and hip width were 175 ±0.011 and 223 ±0.026 mm, 179 ±0.016 and 256 ±0.025 mm, 104 ±0.008
and 112 ±0.007 mm in both protein levels respectively. Statistical analysis revealed no significant differences in body length, height, heart girth and hip width between the two levels of feeding. Though Significantly ($p<0.001$) higher value of abdominal girth was observed in calves fed higher level of protein. This may be due to more concentrate intake observed by calves of this group. The findings of Mudgal and Ray (1965) and Sreenivasa *et al.* (1986) who reported no significant difference in heart girth, body height and body length and a significant difference in abdominal girth of calves between different levels of feeding on protein support the present results. However, Awate *et al.* (1975) observed significant differences in chest girth, posterior girth and height at withers of calves due to different levels of feeding, while Sarma (1991), Shenu (2000) and Poudel (2001) did not observe significant differences in body length, height, heart girth abdominal girth and hip width of calves between different levels of feeding on protein. The interaction between housing systems and level of feeding in the present study was not significant.

Feed conversion efficiency

The data for dry matter intake per kg body weight gain of crossbred calves are presented in Table 6. The average dry matter intakes per kg body weight gains under the two housing systems were 8.19±0.097 and 8.99 ±1.17 kg in loose house and conventional barn respectively. Statistical analysis indicated that dry matter intake per kg body weight gain was not significantly ($P>0.05$) influenced by housing systems. Chakrabarti (1991) also did not observe significant effect on DM intake due to housing systems. However, Poudel (2001) reported significantly higher values in DM intake per kg body weight gain in calves housed in conventional barn as compared to calves in loose house.

The values for DM intake per kg body weight gain under two levels of protein feeding were 8.75 ±1.14 and 8.43 ±0.01kg in 80% and 100% respectively. Level of feeding did not influence ($p>0.05$) dry matter intake per kg body weight gain. The present results are in agreement with those of earlier workers who also did not observe any significant difference in DM intake per kg body weight gain on crossbred and buffalo calves fed different levels of protein (Shenu, 2000 and Poudel, 2001). On the contrary Mai and kurar (1990a) observed a significant difference in DM intake per kg body weight gain in crossbred calves fed different protein and energy levels. The interaction between housing systems and levels of protein was not significant (P>0.05).

Table 6. Daily Average dry matter intake (kg) per kg body weight gain of crossbred calves

	Level of feeding		
	80% NRC	100%NRC	Mean
Housing system:			
Loose house	8.18 ± 1.33	8.20 ± 1.43	8.19 ± 0.97
Conventional barn	9.33 ± 1.86	8.65 ± 1.43	8.99 ± 1.17
Mean	8.75 ± 1.14	8.43 ± 1.01	

Conclusion

Findings of the present study confirmed that type of housing and level of protein in a diet had no significant influence in body weight, body measurements, water intake and dry matter intake per kg body weight gain of crossbred females calves in winter. However the significant effect of level of protein observed on dry matter intake of the calves was not reflected in their body weight gain. Thus these results suggest that in cold winter season crossbred females calves can be economically reared in loose house with 80% NRC protein feedings.

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