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RESEARCH ARTICLE

Effect of Feeding Intervention on Reproductive Performance of crossbred Cows in different Seasons of Bangladesh

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ABSTRACT

The study was undertaken to investigate the reproductive performance of crossbred cows raised at farm conditions in Bangladesh through nutritional intervention during the last trimester of pregnancy in different seasons of a year. Feeding intervention in monsoon consists of feeding urea molasses straw (UMS) instead of only rice straw with increased concentrate level. This resulted in increased total DM intake from 8.07 to 9.26 kg/d, DCP intake from 0.23 to 0.60 kg/d and ME intake from 54.57 to 75.92 MJ/d in crossbred cows. Feeding intervention decreased postpartum estrus period from 91.72 to 84.02 d, calving to conception interval from 104.45 to 95.89 d and increased calf birth weight from 21.54 to 22.94 kg, irrespective of breed type. Breed had also similar effect on these reproductive parameters irrespective of feeding type. In winter, legume forage supply was curtailed over that supplied traditionally and rice straw with concentrates was increased resulting in decreased total DM, DCP and ME intake of cows. Intervened feeding, irrespective of genotype of the cows, decreased postpartum estrus period from 88.42 to 83.72 d, calving to conception interval from 99.52 to 92.56 d, service per conception from 1.56 to 1.39 number and increased calf birth weight from 21.77 to 23.42 kg. Breed also affected the reproductive performance irrespective of feeding intervention. Feeding intervention in summer season was to reduce rice straw and concentrates, and to increase the supply of green grass to the cows. Intervened feeding resulted in pronounced increase in intake of all the nutrients as well as the feed cost. As in the case of winter, both feeding and genotype had significant effects on postpartum estrus period, calving to conception interval, service per conception and calf birth weight, when considered individually. From the results of the present study it may be concluded that feeding interventions have significant effect on reproductive performance of crossbred cows.

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INTRODUCTION

It is well established that maintaining a satisfactory fertility level in a herd of breedable animals is the essential phase for successful dairy farming. If conception and instigation of pregnancy do not result from the minimum number of services, it constitutes an economic loss to the farmers and consequently reducing the total productive life. When cows do not conceive, it is very uneconomic for the farmers or farms. Thus, to get maximum profitability it is very important to increase the conception rate to optimal level. Ideally, optimum economic fertility could be achieved with a maximum of 1.3 services per conception and an average of 85 days between parturition and conception (Morrow, 1980). Calving intervals as well as total performance of cows are affected by postpartum heat period (PPHP). Nutritional fluctuations due to seasonal shortage of herbage cause

delay in puberty and postpartum cycle under extensive free grazing condition (Perera, 1999).

Reports of Jalil *et al.* (1995) indicate that improved feeding has a positive effect on reproductive performance including milk production of cattle and an imbalanced feeding has been shown to be one of the factors for high incidence of reproductive disorders in the crossbred cows (Shamsuddin *et al.,* 1988). Moreover, postpartum live weight loss has a direct negative effect on the resumption of ovarian cycle in the cows, while improved and balanced diet can alleviate this (Butler and Smith, 1989). Several studies on nutritional effect on the production of dairy cattle suggest that, feed supplied in particular to cows postpartum should be enough to maintain body condition, to support milk production, as well as to initiate the ovarian cycle (Butler and Smith, 1989; Ghosh *et al.,* 1993). In Bangladesh, the problems associated with fertility failure in cows have been acknowledged as a burning issue in cattle breeding program (Alam, 1983). In Baghabarighat milk pocket area, postpartum anestruous problem was common in almost all the dairy farms. As a result, calving interval of the cows lengthens as well as feed cost of the farm increases. Therefore, the present study was launched to improve the reproductive efficiency of crossbred cows raised in farm conditions at Baghabarighat milk pocket through nutritional manipulation during the last trimester of pregnancy.

MATERIALS AND METHODS

Location, farms and animals

Baghabarighat milk pocket area under Sirajgonj district was selected for the present study. Animals were crosses between Local and Sahiwal (L×SL), Local and Friesian (L×F) and Local, Friesian and Sahiwal (L×F×SL). One hundred cows from each genotype at their last trimester of pregnancy were randomly selected for the study. Animals of each genotype were grouped into two such as traditional feeding group and intervened feeding group having 50 animals in each. Average age and live weight were 5 years and 340 kg, respectively. All pregnant cows were serviced through artificial insemination and were kept in separate shed near dwelling house consisting tin sheet, roof and brick made floor. Some of them were under thatched roof and uneven soil floor. All the animals were under similar management system.

Nutrient requirements and feeding intervention

Total dry matter (DM), digestible crude protein (DCP) and metabolizable energy (ME) of the animals were calculated based on ARC (1980). In monsoon, usual feeding practice was to supply concentrates and rice straw where concentrate mixture was prepared by wheat bran (*Triticum aestivum*), pea bran (*Pisum sativum*), chola bran (*Cicar ariatenum*) and sesame oil cake (*Sesamum indicum*) at a ratio of 50:20:15:15. In intervened feeding, urea molasses straw (UMS) was prepared by rice straw, molasses, urea and water in the proportion of 10.0, 2.1, 0.3 and 5.0 kg respectively (BLRI, 2003). Concentrate mixture was as similar as in traditional feeding. In winter season, cows were fed legume forages *ad libitum* in traditional feeding. Rice straw and concentrate mixture were supplied in small amount, however, in intervened feeding; supply of rice straw was increased compared to that used in traditional feeding in order to reduce the quantity of legume forages. The concentrate mixture was prepared with wheat bran and pea bran in the proportion of 80 and 20. In summer, animals were supplied rice straw, non-legume green forage (mainly *Cynodon dactylon*, *Pennisetum purpureum* and *Zea mays*) and concentrates. Supply of rice straw was reduced in intervened feeding and napier grass was increased in order to make the ration more balanced in terms of nutrients availability. Concentrate mixture consisting of wheat bran, pea bran, khesari bran and mustard oil cake at the ratio of 50:20:20:10. Cost and nutritional values of the ingredients were considered to include in the concentrate mixture. Average daily quantity of feed supplied to the animals in traditional and intervention feeding is shown in Table 1. Feeding intervention was carried out to correct the nutrient deficiency or excess based on the comparison of ARC (1980) standard.

Table 1: Feeding interventions for pregnant crossbred cows in different seasons of a year

Ingredients (kg DM/d/cow)	Traditional feeding (mean ± sd)	Improved feeding (mean ± sd)
Monsoon		
Rice straw	6.05±1.02	-
Urea molasses straw (UMS)	-	8.06±0.79
Concentrate mixture[1]	2.03±0.20	3.24±0.41
Winter		
Rice straw	2.03±0.60	2.08±0.48
Legume forage	7.21±0.51	5.85±0.49
Concentrate mixture[2]	1.98±0.29	2.25±0.37
Summer		
Rice straw	5.92±1.16	4.06±0.62
Green forage (non-legume)	0.85±0.25	3.38±0.36
Concentrate mixture[3]	2.14±0.22	2.95±0.21

[1]Proportion of concentrate mixture of wheat bran, pea bran, chola bran and sesame oil cake at a ratio of 50:20:15:15 both for Traditional and Intervention feeding; [2]Proportion of concentrate mixture of wheat bran, rice polish, pea bran and mustard oil cake for Traditional feeding was 60:20:10:10 and for intervened feeding the mixture of wheat bran and pea bran at a ratio of 80:20 respectively; [3]Proportion of concentrate mixture in traditional feeding was wheat bran, pea bran, matikalai bran and mustard oilcake at a ratio of 50:20:20:10 and intervened feeding the mixture was wheat bran, pea bran, khesari bran and mustard oilcake at a same ratio of traditional feeding

Feeding management

In monsoon, rice straw was supplied to the cows in the morning and evening after milking traditionally. The daily average requirement of UMS of the animals was determined based on their live weight and milk yield. The preparation of UMS was done twice daily at 8:00 and 15:00 hours and was supplied to the animals after half an hour of its preparation. UMS was used as sole roughage source for the animals. In winter, the excess feeding of legume forage was reduced to save some forage by making hay for future feeding. One of the aims of feeding restricted amount of legume forage was to minimize the cost of feeding simultaneously keeping the nutrient supply as per requirements of the animal. On the other hand, in summer season, the supply of rice straw was reduced and that of napier grass was increased in order to make the

ration more balanced in terms of nutrients availability. Napier grass was supplied as cut and carries system at the rate of about 20 kg per cow per day. In all the seasons, the concentrates were supplied to cows before milking at 7:00 and 14:00 hours.

Data collection and record keeping

The period from calving to first estrus was observed and recorded as the postpartum estrus period (days). Calving to conception interval (days) of the animals under study was recorded. Conception was considered as successful conception. Service per conception was recorded to determine the average number of artificial insemination required for each successful conception. The date of service was recorded to calculate the average number of service required for the successful conception of the cows. Calf birth weight (kg) was recorded by taking the weight of the calves with the help of a hanging balance immediately after birth. The weight of the calves was recorded individually for each animal.

Statistical analysis

The data for feed and nutrient intake by the animals during traditional and intervention feeding were analyzed using *pared t-test*. Data for reproduction parameters were analyzed to compute ANOVA appropriate for a 2×3 factorial experiment in completely randomized design (CRD) using MSTAT statistical programme. Treatment sum of squares are partitioned into three components such as main effects of feeding systems, main effects of breeds and their interaction effects.

RESULTS

Monsoon season

Feed and nutrient intake

Intake of rice straw in traditional feeding (6.03 kg/d) was almost similar to that of intervened feeding (6.02 kg/d), however, the difference was significant (P<0.01) in concentrate intake. DM intake of straw and concentrates was reflected in the total DM intake, as there was significant (P<0.01) difference between the animals of traditional and improved feeding groups (Table 2). DCP intake of improved feeding (0.60 kg/d) was higher (P<0.01) than that of traditional feeding (0.23 kg/d). Similarly, ME intake of improved feeding was higher (P<0.01) than that of traditional group. Feed costs of traditional feeding group was 38.54 Tk/d/cow that were increased (P<0.05) to a value of 45.86 Tk/d/cow for intervention group, making a difference of Tk 7.00 per day per cow (Table 2).

Reproductive performance

Intervened feeding reduced (P<0.01) interval between calving to first estrus from 91.72 to 84.02 days (Table 3). Among the breeds, L×F and L×SL×F crossbred cows showed significant (P<0.01) reduction in calving to first estrus than L×SL crossbred, while there is no difference (P>0.05) between L×SL×F and L×F crossbred cows. It appears from the results that L×F cows showed heat after calving earlier than that shown by other crossbred cows. There was no interactive effect of feeding and genotype in terms of calving to first estrus. Improved feeding reduced (P<0.01) calving to conception interval from 104.45 to 95.89 days when compared to that in traditional feeding. Similarly, genotype of cows had significant (P<0.01) effect on calving to conception interval. The crossbred cows of L×F (90.78 d) were lower (P<0.01) calving to conception interval followed by L×SL×F (100.44 d) and highest in L×SL (109.30 d). However, there was no significant effect of interaction of feeding intervention and genotype of cows on calving to conception interval. The number of service for each successful conception of cows decreased (P>0.05) by improved feeding from 1.63 to 1.50. Meanwhile, number of service per conception varied (P<0.01) among different genotypes of cows that was significantly (P<0.01) lower in L×F (1.39) than that of L×SL (1.70) and L×SL×F (1.62) cows. However, there is no difference (P>0.05) between L×SL and L×SL×F. The difference in number of service per conception was statistically non-significant in respect of interaction of feeding intervention and breeds. Calf birth weight increased (P<0.01) from 21.54 to 22.94 kg through improved feeding. Similarly, there was significant (P<0.01) difference in calf birth weight among three crossbred genotypes. Calf birth weight was higher (P<0.01) in L×F (25.37 kg) cows than that of the others two genotypes while calf birth weight in L×SL (18.68 kg) was lower (P<0.01) than L×SL×F (22.68 kg) cows. However, no significant interactive effect between feeding group and breed was recorded.

Winter season

Feed and nutrient intake

Feeding intervention slightly increased (P>0.05) the intake of rice straw (2.08 kg/d) when compared to that of traditional feeding (2.03 kg/d). However, intake of green grass was decreased (P<0.01) from 7.21 to 5.85 kg/d and increased concentrate intake from 1.98 to 2.25 kg/d with intervened feeding (Table 2). Total DM intake was decreased (P<0.001) from 11.22 to 10.19 kg/d in cows fed improved diet compared to that in cows fed on traditional diet. Intake of DCP decreased (P<0.01) from 1.36 to 1.17 kg/d due to feeding intervention. As in the case of DCO, ME intake significantly (P<0.01) decreased compared to that of traditional feeding. Similarly, modified feeding reduced (P>0.05) the cost of feeding from 37.10 Tk/d to 36.91 Tk/d.

Reproductive performance

Intervened feeding reduced (P<0.01) post partum estrus period from 88.42 to 83.72 days (Table 3). Similarly, there was significant (P<0.01) effect of genotype of cows on calving to first estrus interval. Among the breeds, L×F cows showed higher (P<0.01) reduction in calving to first estrus (82.48 d) than that of L×SL (90.59 d) but the reduction was non-significant (P>0.05) in L×SL×F (85.14 d). No significant interactive effects were observed for feeding system and breed for postpartum estrus. Calving to conception interval was reduced (P<0.01) due to intervened feeding (92.56 d) than that of traditional feeding (99.52 d). Similarly, cows of L×F (90.89 d) and L×SL×F (94.28 d) had no significant difference (P>0.05) between calving to conception but significantly (P<0.01) lower in the cows of L×SL (102.96 d) compared to that of the other two genotypes. However,

Table 2: Feed and nutrient intake of pregnant crossbred cows in different seasons of a year

Feeds and nutrients	Traditional feeding (mean ± sd)	Intervened feeding (mean ± sd)	t- value	Level of Significance
Monsoon				
Rice straw[1], DM (kg/d)	6.03±1.18	6.02±0.61	0.121	NS
Concentrate mixture, DM (kg/d)	2.03±0.45	3.24±0.63	- 17.907	**
Total feed, DM (kg/d)	8.07±1.45	9.26±0.95	- 6.496	**
DCP (kg/d)	0.23±0.05	0.60±0.08	-30.672	**
ME (MJ/d)	54.57±9.71	75.92±7.88	-17.301	**
Total feed cost, (Tk/d)	38.54±6.48	45.86±5.87	- 4.024	**
Winter				
Rice straw, DM (kg/d)	2.03±0.60	2.08±0.48	-0.347	NS
Green forage, DM (kg/d)	7.21±0.51	5.85±0.49	9.494	**
Concentrate mixture, DM (kg/d)	1.98±0.29	2.25±0.37	-2.882	**
Total Feed (kg/d)	11.22±0.78	10.19±0.64	5.116	*
DCP (kg/d)	1.36±0.09	1.17±0.09	7.526	*
ME (MJ/d)	105.84±6.59	94.58±6.31	6.171	**
Total feed cost (Tk/d)	37.10±3.20	36.91±3.70	0.185	NS
Summer				
Rice straw DM (kg/d)	5.86±1.48	4.00±1.01	5.942	*
Green forage DM (kg/d)	1.10±0.73	3.60±0.80	- 5.443	**
Concentrate mixture DM (kg/d)	2.00±0.82	2.80±0.91	- 6.803	*
Total Feed (Kg/d)	8.96±1.50	10.39±1.25	-3.935	*
DCP (Kg/d)	0.23±0.10	0.56±0.14	-16.963	**
ME (MJ/d)	57.48±11.04	77.36±10.31	-9.308	**
Total feed cost (Tk/d)	32.16±7.95	42.9±8.46	- 5.466	**

[1]Rice straw fed to the animals of improved feeding group was the urea molasses straw (UMS); NS= non-significant; * = Significant at 5% level;** = Significant at 1% level; 1US $= 70.00 Tk (BDT)

Table 3: Effect of feeding intervention on reproductive performance of crossbred cows in different seasons of Bangladesh

Particulars		Parameters			
		Postpartum estrus period (day)	Calving to conception (day)	Service per conception (No)	Calf birth weight (kg)
Monsoon					
Feeding Groups (F)	Traditional feeding	91.72^{a}	104.45^{a}	1.63	21.54^{b}
	Intervened feeding	84.02^{b}	95.89^{b}	1.50	22.94^{a}
	lsd	4.590	5.110	0.138	0.547
Breeds (B)	L×F	81.76^{a}	90.78^{a}	1.39^{a}	25.37^{a}
	L×SL	94.75^{b}	109.30^{c}	1.70^{b}	18.68^{c}
	L×SL×F	87.11^{a}	100.44^{b}	1.62^{b}	22.68^{b}
	lsd	5.805	6.443	0.174	0.690
[#]Level of significance	F	**	**	NS	**
	B	**	**	**	**
	BF	NS	NS	NS	NS
Winter					
Feeding Groups (F)	Traditional feeding	88.42^{a}	99.52^{a}	1.56^{a}	21.77^{b}
	Intervened feeding	83.72^{b}	92.56^{b}	1.39^{b}	23.42^{a}
	lsd	4.134	4.401	0.134	0.594
Breeds (B)	L×F	82.48^{a}	90.89^{a}	1.35^{a}	24.86^{a}
	L×SL	90.59^{b}	102.96^{b}	1.62^{b}	20.68^{c}
	L×SL×F	85.14^{a}	94.28^{a}	1.46^{ab}	22.26^{b}
	lsd	5.063	5.390	0.164	0.727
[#]Level of significance	F	**	**	*	**
	B	**	**	**	**
	BF	NS	NS	NS	NS
Summer					
Feeding Groups (F)	Traditional feeding	92.96^{a}	104.64^{a}	1.58^{a}	21.49^{b}
	Intervened feeding	85.03^{b}	94.42^{b}	1.41^{b}	23.80^{a}
	lsd	3.708	5.210	0.135	0.614
Breeds (B)	L×F	85.16^{a}	93.72^{a}	1.37^{a}	24.69^{a}
	L×SL	93.13^{b}	105.82^{c}	1.62^{b}	20.49^{c}
	L×SL×F	88.71^{a}	99.05^{b}	1.50^{ab}	22.77^{b}
	lsd	3.708	5.210	0.135	0.614
Level of significance[#]	F	**	**	*	**
	B	**	**	*	**
	BF	NS	NS	NS	NS

NS = Not significant; * = Significant at 5% level; **= Significant at 1% level; ***= Significant at 0.1% level; [#]Contrasts; F = main effect of feeding systems; B= main effect of breed; BF= interaction between feeding system and breed; lsd = least significance difference; [a,b,c]Means in the same column within categories without common letter in their superscripts differ significantly.

there was no significant interactive effect of feeding intervention and genotype of cows on calving to conception interval. Number of service for each successful conception was decreased (P<0.05) in modified feeding compared to traditional feeding (Table 3). Similarly, service per conception varied (P<0.01) among three different genotypes of cows. Number of service per conception was lower (P<0.01) in cows of L×F than L×SL but non-significantly lower than L×SL×F. However, there is no significant difference between L×SL and L×SL×F. No interaction effect was observed for this parameter between feeding regimen and breed. Birth weight of calves increased (P<0.01) in the improved feeding compared to that in traditional feeding. Similarly, there was significant (P<0.01) difference in calf birth weight among three genotypes of cows. Calf birth weight was significantly (P<0.01) higher in L×F cows than that of L×SL and L×SL×F genotype groups. When the latter two genotypes were compared it was observed that calf birth weight of L×SL×F cows were significantly (P<0.01) higher than that of L×SL cows. However, no significant interaction between feeding group and breed was recorded for this parameter.

Summer season

Feed and nutrient intake

Intake of rice straw in intervened feeding was decreased (P<0.01) than that of the animals in traditional feeding (Table 2). Meanwhile, green forage intake was higher (P<0.01) in improved feeding compared to that in traditional feeding. Concentrate intake gave similar results as in the case of forage intake, which was higher (P<0.05) on improved feeding. Total feed intake was also higher (P<0.01) in animals on improved feeding. In traditional feeding group, intake of DCP was 0.23 kg/d while in improved feeding it was 0.56 kg/d and the difference was significant (P<0.01). In respect of ME intake by the pregnant animals it can be seen from the Table 2 that ME intake in intervention feeding (77.36 MJ/d) was higher (P<0.01) than that of the traditional feeding (57.48 MJ/d). Feeding cost increased (Tk 10.74/d) in intervened feeding group which was significant (P<0.01).

Reproduction performance

Postpartum estrus period was reduced (P<0.01) due to feeding intervention (Table 3). The cows of L×SL had higher (P<0.01) period of postpartum estrus than those of other two types. There was no significant difference between the cows of L×F and L×SL×F, and was lower in L×F than that of the cows of L×SL×F. The interaction between feed and breed had no significant effect on postpartum estrus period of reproductive performances of the animals. Length between calving to conception was significantly (P<0.01) lower in L×F cows than those of the other two genotypes. Calving to conception was significantly (P<0.01) lower in the cows of L×SL×F than that of the cows of L×SL genotype. The interaction of feeding regimen and genotype had no significant effect on calving to conception interval. Service for each successful conception decreased (P<0.05) in improved feeding group. There was significant (P<0.05) variation for service per conception among the breeds. The highest number of service per conception was observed in L×SL followed by those of L×F×SL and the lowest in L×F cows. It was also found that there was significant (P<0.05) difference in number service per conception between the cows of L×F and L×SL but not between L×F and L×SL×F. However, there were no significant differences between the cows of L×SL×F, and L×F and also between L×SL×F and L×SL. It appears that the lowest number of service was required for successful conception in L×F cows. No significant interaction was recorded between feeding regime and breed for this parameter. Birth weight of calves of the animals of improved feeding group increased (P<0.01) compared to that of the traditional feeding group. When the effect of genotype on the calf birth weight was considered, the highest birth weight was recorded in L×F, followed by L×F×SL and the lowest in L×SL. Calf birth weight of the cows of L×F was significant (P<0.01) higher than the other two genotypes and that of the cows of L×SL was significantly (P<0.01) lower than that of the other two types. However, there was no significant interaction for calf birth weight between the feeding regimen and the genotype.

DISCUSSION

Monsoon season

Although there was no difference in DM intake of rice straw between improved feeding group and traditional feeding group UMS was supplied in a higher quantity to the former group than that to the latter group. This was because of the lower DM content of the UMS than that of the untreated straw. However, the significantly (P<0.01) higher total DM intake in improved feeding than that in traditional feeding might be due to higher intake of concentrate mixture by the animals of the improved feeding group. In fact, concentrates were supplied to animals in higher quantity in improved feeding than that of the traditional feeding, as that was the major option for improving the supply of nutrients to the pregnant cows. As regards to digestible crude protein (DCP) intake, it was more than double in the improved feeding group than that of traditional group. The reason could be two-folds, the contribution of UMS, which contains higher CP against zero content of available protein in untreated straw. In addition, increased quantity of concentrates in the improved feeding group contributed to the higher level of DCP in the ration of this group and hence to the significantly higher intake. Similarly, energy intake of the cows of improved feeding was significantly (P<0.01) higher than that of the traditional feeding, which might again be due to higher energy content of UMS as well as higher amount of concentrate intake by the animals of improved feeding group compared to that of the traditional feeding group. The total feed cost, as one should expect, was the reflection of the UMS preparation and the supply of increased amount of concentrates. The cost of preparation of UMS and the cost of additional amount of concentrates made the total feed cost of the improved feeding group significantly (P<0.01) higher than that of the traditional feeding group.

Reproductive performance of the pregnant cows as affected by feeding regime showed somewhat mixed effects. Some of the parameters were affected significantly, however, some were unaffected. Calving to

first estrus interval (postpartum estrus period), calving to conception interval and the calf birth weight were significantly improved by improved nutrition. The reason for significant reduction in the interval of calving to first estrus and also calving to conception might be that the animals of improved feeding group utilized more nutrients (due to higher supply) for quick regaining their body conditions for the preparation of conception than the animals of the other group on traditional feeding. There are reports that calving to first estrus is an important parameter affected by feeding (Dziuk and Bellows, 1983). Evidence suggests that during this period improved feeding initiates early estrus (Montgomery *et al.,* 1985) and also conception (Dominguez *et al.,* 1996). The results of the present study are in agreement with these statements. The effect of improved feeding to pregnant cows resulted in significant increase in calf birth weight, which might have again been due to higher level of nutrients available and utilized by this group compared to that of the traditional group. This can also be supported by the higher intake of protein in improved feeding group than traditional group as can be seen in Table 2. There is also evidence in support of this finding that high nutritional status of pregnant cows results in more foetal growth during pregnancy (Robinson, 1990).

Although number of service required per conception in animals of improved feeding group, irrespective of breeds, were reduced slightly compared to that of the animals on traditional feeding, the differences were not significant which indicated that the feeding might have little effect on the number of services per successful conception. The values of the present study in respect of number of services per conception was similar to those reported by Ghosh (1995) giving the figures ranging from 1.63 to 1.69 for crossbred cows.

As regards to effect of genotypes on reproductive performance of cows, the results indicated that irrespective of feed type all the reproductive parameters studied – postpartum estrus period, calving to conception interval, service per conception and calf birth weight were significantly affected by the genotypes of the animals. The effect of genotype on the reproductive performances of the farm animals was also reported by other scientists (Patel, 1988 and Rahman *et al.,* 2001). In the present study the findings clearly showed that the crossbred cows of L×F had the lowest postpartum estrus period, lowest interval for calving to conception, lowest number for service per conception and the highest birth weight of calves compared to all other genotypes. So this crossbred had the best and L×SL had the lowest reproductive performance.

Winter season

In the modified feeding, the amount of legume forage was reduced to a quantity that presumably did not affect reproductive performance adversely and met the DM requirements of the animals. Although the amount of legume forage was reduced by about 1.36 kg/d, the amount of concentrates was kept same assuming that the amount of forage supplied would still meet the requirement of the animals as the farmers previously supplied the forage in excess of the requirements for the cows. Since, there was sufficient quantities of legume forage available and there was less trading of straw and its price was also low, the quantity of rice straw were slightly increased to fill partly the gap created in total DM supply because of the reduction in the legume forage supply in the intervention feeding group compared to that in the traditional group. Total DM, DCP and ME intake of the animals also decreased significantly due to feeding intervention compared to traditional feeding which might have been due again to the reduced amount of legume forages containing high amount of protein and energy.

Effect of feeding intervention significantly affected the reproductive parameters such as postpartum estrus period, calving to conception interval, number of service per conception and calf birth weight. It can be mentioned here that the nature of feeding intervention in the winter season was different than those in the other two seasons studied. The main objective of the intervention was to save some of the legume forages for feeding during lean period as has been mentioned earlier. The other objective was to make the ration economical since the farmers feed the forages in excess of their requirements. The idea behind the study was also not to affect significantly the reproductive performance of the cows due to intervention. Therefore, instead of supplying more nutrients to the animals in the form of improved feeding in the intervention group the nutrients were supplied based on the animals' requirements. As a result the total amount of feed and nutrients supplied to the animals' intervention group were less than those of the traditional group. Nevertheless, the reproductive performance of the cows of the intervention-feeding group was significantly improved.

The significant variation in all the reproductive parameters in different genotypes of cows indicated that each of the individual genotype had its own reproductive efficiency. Several scientists supported this statement (Majid *et al.,* 1995 and Khan *et al.,* 1999). Among the crossbred cows under the experiment, the cows of L×F showed the best performance in all the reproductive parameters studied and L×SL seemed to be lowest in terms of performance.

Summer season

Total DM intake in animals of the improved feeding group was significantly higher than that of the traditional group which significantly improved DCP and ME intake of the animals also. This is possible as the increased feed ingredients such as green grass and concentrates; both had much higher protein and energy contents than those of rice straw, which is well known to be the poor quality feed, giving no DCP at all, and small quantities of energy. The increased supply of green grass as well as concentrates to the animals resulted in increased feed cost during the study period, which was accepted by the farmers as because there were efficient reproductive performance of cows due to feeding intervention.

Improved feeding that gave rise to increased feed and nutrient intake compared to those in the traditional feeding might have resulted in significant improvement in all the parameters of reproduction such as postpartum estrus period, calving to conception interval, number of service per conception and calf birth weight. There are number of published reports that the increased supply of energy and protein to the pregnant cows especially during

the last trimester of pregnancy allows the cow to regain its body condition and meet the deficiency of essential nutrients that are used up by the previous foetal development and milk production (Robinson *et al.,* 1999). These increased energy and protein supply initiate early ovarian cyclicity of the cows (Henniawati and Fletcher, 1986). Reduction of gap between calving to first estrus (which is also called postpartum estrus period) is very important to the dairy farmers as that result in more number of calves in a cow's life time and that also means more milk and more profit for the farmers.

Reduction of interval between calving to conception of a cow is also important for a dairy farmer, which increases the efficiency of reproduction of the cow and is affected by plane of nutrition of cows. Laven *et al.* (1999) supported and indicated that the level of nutrition of the pregnant cows affected calving to conception interval. Results of the present study agree with these statements, as there was improvement in the calving to conception interval. There are reports that number of service per conception also affects reproductive performance of cows and is affected by nutrition (Clark *et al.,* 1985) which has been evident in the present study through the reduction in number by improved feeding of pregnant cows in its last trimester. Increased calf birth weight of the pregnant cows at calving as has been observed in animals fed on improved diets might be due to better nutritional status of the cows compared to that of the animals of traditional feeding group. The improved nutrition of the pregnant cows resulted in increased foetal growth has been reported by Robinson *et al.* (1999). The increased foetal growth results in the increased birth weight of calves, which has been evident in the present study.

Although cost of feeding the animals in the improved feeding group was significantly higher than that of traditional group, which was offset by the improved efficiency of all the reproduction parameters as observed in the present study. As in the case of monsoon and winter seasons, summer season also showed that genotype had significant effect on all the parameters of reproduction studied such as postpartum estrus period, calving to conception interval, number of service per conception and calf birth weight. Among the crossbred cows in the experiment L×F gave the highest and L×SL gave the lowest reproductive performance in all parameters. Therefore, L×F crossbred cows may be preferred for improvement of reproductive performance of cows in the area.

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