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Research article

Performance of crossbred dairy cattle under commercial farming conditions in the Chattogram district, Bangladesh

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A B S T R A C T

The study was conducted in 10 different farms under 6 upazilas, i.e., Hathazari, Patiya, Anwara, Boalkhali, Bakalia and Patenga of Chattogram district. The records of 50 crossbred dairy cattle (CDC) were collected for two crossbred dairy breeds, i.e., Holstein Friesian × Jersey (HF × J) and Holstein Friesian × Local (HF × L) from March to June 2019. Farms having ≥50 CDC with complete records of each cattle were selected for the study purpose. Results indicated that the genotype, supply of green roughage and concentrate, and feeding of CDC immediate before milking had significant ($p<0.001$) positive linear effect on average daily milk yield (ADMY). Supply of green roughage and concentrate had further positive quadratic and cubic effects ($p<0.001$) on ADMY. Postpartum period quadratically influenced the ADMY ($p<0.05$) although linear and cubic effects were nil ($p>0.05$). Parity and genotype had significant ($p<0.05$) positive effect on lactation period of the CDC. Among the HF × J crossbreds, 75%+25% genotypes resulted in greater milk yield than the others. Similarly, the 87.5% + 12.5% HF × L produced more milk than the other genotypes. However, the farm type, housing systems, grass type, milking system, parity, service per conception, lactation period, age at puberty, age at first calving, and the dry period had no effect ($p>0.05$) on ADMY in the CDC. Overall, HF × J performed better than the HF × L. It was concluded that both HF × J and HF × L crossbreds were well adapted under medium-scale commercial farming conditions of Bangladesh.

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1. INTRODUCTION

Livestock is a crucial component for the economy of Bangladesh (Edwards and Shamsuddoha, 2000; Karim et al., 2010). Dairying is one of the most important sectors of livestock (Hamid and Hossain, 2014; Barua et al., 2018; Rahman et al., 2020). The productive and reproductive performance of dairy cattle depends on feed, genetics, disease control and management of the environmental factors (Sarder and Hossain, 2001; Thornton, 2010; Rahman et al., 2014; Hamid et al., 2017). In Bangladesh, the low performance of crossbred dairy cattle (CDC) is due to the poor genetic potential and lack of appropriate management systems (Uddin et al., 2011). Indigenous cattle, although well-adapted in the harsh environment and more resistant to the common diseases, have poor milk yield, short lactation length, long calving interval and late sexual maturity (Majid et al., 1995).

Low herd yield is indicative of necessity for their proper management system. A long term genetic improvement program will be necessary to select the high performing indigenous cattle (Edwards and Shamsuddoha, 2000; Rahman et al., 2014). Another effective way of improving the performance that has been followed over the last few decades is by replacing the indigenous cattle with high yielding crossbreds. There are over 2.3 million crossbreds available throughout the country (Halder and Barua, 2003; Karim et al., 2010; Hamid and Hossain, 2014). The dynamic effects of introducing crossbreds are reflected in the milk yield of the country which increased from 23.7 to 106.8 lakh metric ton in the last decade (DLS, 2020). Despite that, the availability of milk does not fulfill the per capita demand which is 250 ml/day (DLS, 2020). It instigates the necessity to expand the growth of dairying. To improve the performance of CDC, along with production, some other related factors including reproduction, scientific management and disease control procedures need to be focused (Barua et al., 2018). Among crossbreds, the most common temperate breeds are Holstein Friesian (HF) and Jersey, which were introduced first in 1973 (Hamid et al., 2017). The HF has improved production performance than local and other available CDC in Bangladesh (Islam et al., 2017). To produce high performance CDC, the HF was crossed with local and other breeds. However, the fertility rate of these CDCs is lower than the indigenous cattle. In dairying, reproductive efficiency indicates the farm profitability. Both productive and reproductive performances are influenced by the cow level and farm level determinants (Sarder and Hossain, 2001). Although few studies have been conducted in Bangladesh to evaluate the performance of crossbred cattle, there is no consistent information of CDC in the Chattogram district. The present study, therefore, aimed to determine the milk production potentials and reproductive efficiency of the CDCs and the factors associated with individual as well as herd level productivity under existing farming conditions in Bangladesh.

2. MATERIALS AND METHODS

Study area and duration

The study was conducted in 6 Upazillas of Chattogram district. For collection of data, 10 different farms from Hathazari, Patiya, Anwara, Boalkhali, Bakalia and Patenga were selected. Animal records were collected for two crossbred dairy cattle (CDC) which were HF × J and HF × L from March to June 2019. Farms having ≥50 CDC along with complete record sheet of each cattle were selected for the study purpose.

Preparation of questionnaire

The requisite primary data for the study purpose were collected through a cross-sectional survey. A structured questionnaire was prepared to get the required information as per the objectives of the study. The questionnaire was pretested and then finalized. Data related to the farm type, breed, genotype, housing system, parity, feeding systems, milking system, service per conception, age, weight, lactation period, average daily milk yield, age at puberty, age at first calving, postpartum period and dry period were collected.

Collection of data

All data were collected directly by visiting the selected farms in the study area and using a questionnaire to interview the farmers. From the selected farms under study, 32 HF × J and 18 HF × L cows were selected. The farmers were interviewed face to face. A break of half an hour was given between two successive interviews. Verbal consent of the farmers was taken before an interview.

Statistical Analysis

After collection, data were compiled, scrutinized and structured in Microsoft Excel 2019 professional. Raw data were tested for the outliers and multicollinearity by interquartile range test and variance inflation factors. Normality of variable was examined by using a normal probability plot and equality of variances of the response variable was tested by the Shapiro Wilk test. Data were analyzed for the generalized linear model (GLM) by Stata 14.1 SE (Stata Corp LP, College Station, Texas, USA). Duncan's new multiple range tests were used to determine the significant differences among the analyzed means of the productive and reproductive parameters. Statistical significance was accepted at $p<0.05$ for Fisher’s F-tests. The following GLM was used:

$$Y_{ijklmnopqrs} = \mu_i + A_{ij} + B_{ik} + C_{il} + D_{im} + E_{in} + F_{io} + G_{ip} + H_{iq} + I_{ir} + J_{is} + e_{ijklmnopqrs}$$

Where,

μ_i	=	Overall population mean for the trait i;
A_{ij}	=	Fixed effects of j^{th} breed for the trait i (j=1,2);
B_{ik}	=	Fixed effects of k^{th} farm type for the trait i (k=1,2);
C_{il}	=	Fixed effects of l^{th} feeding system for the trait i (l=1,2,…3);
D_{im}	=	Fixed effects of m^{th} parity for the trait i (m=1,2,…6);
E_{in}	=	Fixed effects of n^{th} service per conception for the trait i (n=1,2,…3);
F_{io}	=	Fixed effects of o^{th} lactation period for the trait i (o=1,2,…11);
G_{ip}	=	Fixed effects of p^{th} age at puberty for the trait i (p=1,2,…6);
H_{iq}	=	Fixed effects of q^{th} age at first calving for the trait i (q=1,2,…7);
I_{ir}	=	Fixed effects of r^{th} postpartum period for the trait i (r=1,2,…5);
J_{is}	=	Fixed effects of s^{th} dry period for the trait i (s=1,2);
$e_{ijklmnopqr}$	=	Random sampling error distributed as $N(O,I\delta^2 e)$;
$Y_{ijklmnopqrs}$	=	Observed effects of the trait i for j^{th} breed, k^{th} farm type, l^{th} feeding system, m^{th} parity, n^{th} service per conception, o^{th} lactation period, p^{th} age at puberty, q^{th} age at first calving, r^{th} postpartum period and s^{th} dry period.

3. RESULTS

Productive performance

The result showed that the genotype of the cows, the extent of feeding roughage and concentrate and immediate before milking had significant ($p<0.001$) positive linear effect on ADMY. However, breed, farm type, housing system, grass type and milking type had no ($p>0.05$) effects on ADMY in crossbred dairy cows (Table 1). Among the HF × J crossbreds, 75%+25% genotypes resulted in greater milk yield than the others. Similarly, the 87.5%+12.5% HF × L produced more milk than the other genotypes. Medium type farm and face in housing system had better milk yield compared with large farm type and face out housing system. Feeding both Napier and German grass resulted in improved milk yield than feeding only Napier or German grass.Feeding more green roughages and concentrates resulted in more milk yield. Machine milking was more effective in increasing ADMY than the hand milking in crossbred dairy cows.

Reproductive performance

Postpartum period quadratically influenced the ADMY ($p<0.05$) although linear and cubic effects were nil ($p>0.05$). The parity, service per conception, lactation period, age at puberty, age at first calving, and the dry period had no effect ($p>0.05$) on ADMY in the crossbred dairy cows (Table 2). Lactation period was significantly ($p<0.05$) influenced by parity and genotype of crossbred cows although service per conception, post-partum period, dry period and peak yield were unaffected ($p>0.05$).

4. DISCUSSION

Milk yield

Our study revealed that the average daily milk yield of HF × J and HF × L were 16.3±0.64 and 15.6±0.82 kg/day, respectively with overall mean 16.0±0.50 kg/day. It was observed that the exotic blood level significantly influenced both productive and reproductive performances. The majority of the crossbred cows have 50% to 75% exotic blood. Higher productive performance of crossbred cattle especially Holstein Friesian (HF) fluctuates due to the use of exotic blood (50%, 75%, 87.5% or 93.8% of HF) with the local zebu or Sahiwal breed. Galukande et al. (2013) reported that the exotic inheritance of 75% *Bos tauras* genes had 2.7 times higher milk yield than the local cows. Cunningham and Syrstad (1987) concluded that the consistent improvements in most of the performance traits were achieved in upgrading cattle to as much as 50% with the temperate dairy breeds in the tropics and up to 50% genes from temperate breeds can be recommended for the genetic improvement. Crosses with less than 50% *Bos tauras* genes are

Table 1. Effects of breed, genotype, farm type, housing system, feeding system and milking type on average daily milk yield (ADMY) in crossbred dairy cows.

Variable	ADMY (kg/d)	SE[1]	β[2]	Significance		
				Linear	Quadratic	Cubic
Breed						
HF × J[3]	16.3	0.64		NS		
HF × L[4]	15.6	0.82	-0.67			
Genotype						
HF × J						
87.5%+12.5%	15.5	0.96				
75%+25%	17.1	0.99	1.56			
62.5%+37.5%	14.0	0.93	-1.50			
50%+50%	15.3	1.01	-0.17	***		
HF × L						
87.5%+12.5%	20.0	0.83				
75%+25%	15.2	0.86	-4.81			
50%+50%	18.0	0.79	-2.00			
Farm type						
Large	16.0	0.58		NS		
Medium	16.1	1.07	0.08			
Housing system						
Face in	16.7	0.74		NS		
Face out	15.8	0.65	-0.90			
Grass type						
German	16.0	0.57				
Napier	15.0	1.03	-1.00	NS		
Napier and German	18.4	2.32	2.40			
Green roughage/day (kg)						
15.0	11.0	1.00				
16.0	11.0	1.30	0.00			
18.0	11.3	0.88	0.33			
20.0	13.9	0.75	2.90	***	***	***
22.0	14.7	0.67	3.67			
25.0	16.8	0.68	5.88			
30.0	18.8	0.79	7.80			
Concentrate/day (kg)						
6.0	10.5	0.50				
8.0	12.8	0.60	2.32			
9.0	13.5	0.57	3.00			
10.0	17.4	0.43	6.90	***	***	***
11.0	19.0	1.00	8.50			
12.0	18.3	0.85	7.83			
13.0	20.0	0.93	9.50			
15.0	24.0	2.00	13.50			
Feeding before milking						
No	15.0	0.67		***		
Yes	17.0	0.70	-2.08			
Watering before milking						
No	15.1	0.77		NS		
Yes	16.7	0.65	-1.57			
Milking system						
Hand	15.7	0.51		NS		
Machine	18.3	1.66	2.61			

[1]SE = Standard error;
[2]β = Slope of the regression line;
[3]HF × J = Holstein Friesian × Jersey;
[4]HF × L = Holstein Friesian × Local;
NS = Non-significant (p>0.05); *= Significant (p<0.05); ***= Significant (p<0.001).

Table 2. Effects of parity, service per conception, lactation period, age at puberty, age at first calving, postpartum period and dry period on average daily milk yield in crossbred dairy cows.

Variable	ADMY (kg/d)	SE[1]	β[2]	Significance		
				Linear	Quadratic	Cubic
Parity						
1	15.0	1.13				
2	16.2	0.94	1.20			
3	16.0	0.93	1.00	NS		
4	17.3	0.99	2.25			
5	10.0	0.83	-5.00			
6	17.0	1.00	2.00			
Service per conception (no.)						
1	16.1	0.63				
2	16.1	0.84	-0.04	NS	NS	NS
3	15.1	0.73	-.108			
Lactation period (days)						
230	16.0	1.32				
240	15.2	1.85	-.80			
250	17.3	2.03	1.33			
260	18.0	2.78	2.00			
270	15.3	0.84	-.67			
275	20.0	0.93	4.00	NS	NS	NS
280	17.1	0.89	1.11			
285	11.0	0.67	-5.00			
290	16.4	2.04	0.40			
300	16.0	1.38	0.00			
305	11.0	0.73	-5.00			
Age at puberty (months)						
16	14.5	2.02				
17	16.5	1.56	2.00			
18	17.6	0.97	3.07	NS	NS	NS
19	15.4	0.92	0.94			
20	16.9	0.70	2.36			
22	15.2	1.28	0.67			
Age at first calving(months)						
25	11.0	1.32				
26	15.3	1.72	4.33			
28	15.8	1.15	4.82			
29	16.6	0.66	5.63	NS	NS	NS
30	19.0	1.00	8.00			
33	17.5	1.26	6.50			
34	13.8	0.85	2.75			
Postpartum period (days)						
50	17.2	1.02				
60	16.1	0.61	-1.10			
70	15.4	1.72	-1.80	NS	*	NS
75	18.4	2.32	1.20			
90	12.8	1.16	-4.40			
Dry period (days)						
60	16.5	0.86		NS	NS	NS
90	15.8	0.62	-.68			

[1]SE = Standard error;
[2]β = Slope of the regression line;
NS = Non-significant ($p>0.05$); *= Significant ($p<0.05$).

Table 3. Effect of parity on performance of crossbred dairy cows

Parameter	Parity						Avg.	SEM[1]	Sig.
	1	2	3	4	5	6			
Service per conception (n)	1.6	1.7	1.3	1.6	1.0	1.0	1.5	0.08	NS
Lactation period (d)	260.0	272.0	266.8	282.5	290.0	285.0	271.5	2.66	*
Post-partum period (d)	59.4	68.8	62.3	62.5	70.0	60.0	64.5	1.51	NS
Dry period (d)	82.5	76.5	79.1	78.8	90.0	60.0	78.0	2.10	NS
Morning yield (kg)	9.8	10.7	10.5	10.9	6.5	11.3	10.5	0.37	NS
Afternoon yield (kg)	5.9	5.4	5.5	6.1	3.5	5.8	5.6	0.23	NS
Peak yield at month (m)	2.0	2.1	2.4	2.1	1.0	1.5	2.1	0.11	NS

1 = Standard error of the means;
NS = Non-significant (p>0.05); *= Significant (p<0.05).

Table 4. Effect of genotype on performance of crossbred dairy cows

Parameter	Genotype									Avg.	SEM	Sig.
	HF × J					HF × L						
	87.5 × 12.5	**75 × 25**	**62.5 × 37.5**	**50 × 50**	**Avg.**	**87.5 × 12.5**	**75 × 25**	**50 × 50**	Avg.			
Service per conception (n)	1.8	1.7	1.0	1.2	1.5	2.0	1.5	1.0	1.5	1.5	0.08	NS
Lactation period (d)	275.0	262.5	280.0	273.3	267.7	250.0	280.0	280.0	278.3	271.5	2.66	*
Post-partum period (d)	60.0	69.4	60.0	64.4	66.6	50.0	62.2	50.0	60.8	64.5	1.51	NS
Dry period (d)	75.0	73.3	60.0	83.3	75.9	90.0	80.6	90.0	81.7	78.0	2.10	NS
Morning yield (kg)	9.4	11.6	9.0	10.0	10.8	13.5	9.6	12.0	9.9	10.5	0.37	NS
Afternoon yield (kg)	5.6	5.8	5.0	5.3	5.6	5.5	5.6	6.0	5.6	5.6	0.23	NS
Peak yield at month (m)	2.0	1.9	1.0	2.0	1.9	3.0	2.3	3.0	2.4	2.1	0.11	NS

1 = Standard error of the means; NS = Non-significant (p>0.05); *= Significant (p<0.05)

poor dairy animals for milk production (Syrstad, 1989). In the current study, both the amount of green roughage and concentrate per day had significant (p<0.001) effects on average daily milk yield. Nahar et al. (2007) found that green grass increases milk yield in lactating crossbred cows. Similarly, Reddy (1998) stated that supplement of green forage with rice straw increased milk production. Macleod et al. (1983) also reported an increase in milk production by 0.06 kg per percentage unit increase of concentrates. Similar observations were also found in other studies (Sanh et al., 2002; Kuoppala et al., 2004). On the other hand, Beyero et al. (2015) revealed that increasing green roughage and concentrate ratio in dairy ration reduced milk production. The result may be due to the variation in dry matter intake as well as the change in ruminal fermentation pattern (Beyero et al. 2015; Shan-shan et al., 2016). Feeding right before milking showed significant (p<0.05) effect on milk yield. A study by Johansson et al. (1999) revealed that feeding during milking increased milk production compared to feeding 1.5 hour before and after milking. The average daily milk yield, milk yield per lactation or milk yield per calving interval increases with the advancement in parity. Our study revealed that the highest number of cows was in the second to fourth parity and peak milk yield was also higher from the first to third months of lactation. This result is in well agreement with the findings of Mohamed (2004**)** and Qureshi et al. (2020**)** who reported that milk yield increased with advanced lactation up to fourth parity.

Lactation length

Our study revealed that the average lactation period of HF × J and HF × L were 267.7±3.46 and 278.33±3.7 days, respectively with overall mean 271.5±2.66 months. It was observed that the average daily milk yield of these crossbreds had no significant effect (p>0.05) on lactation length. Lactation length in genetic groups from 50 to 75% exotic inheritance was not much different. The result is also in agreement with the findings of Asaduzzaman and Miah, (2004) and Islam et al. (2017) who reported that the lactation length was highest for the Local × HF cows (263±34.03 days). Hasan (1995) reported that the average lactation period of Jersey, Holstein, Sahiwal and Sindhi crosses were 286, 272, 262 and 255 days, respectively.

Age at puberty

Our study revealed that the age at puberty of HF × J and HF × L were 19.0±0.41 and 18.1±0.556 months, respectively with overall mean 18.7±0.24 months. These findings are almost similar with the study of Morrow (1986) and Meyer et al. (2004**)** who found that the age at puberty for the crossbred cattle should be approximately between the 1.4 to over 2 years in their native conditions. In previous studies, it has been demonstrated that the well-nourished temperate heifer has the potential to reach the specific weight at 10-12 months, and conceive at 14-15 months of age (Hafez and Hafez, 2013). It was further suggested that the high plan of nutrition could accelerate puberty by increasing the growth rate of heifers. Rahman et al. (1998) found similar findings with our result that the age at puberty of Local × HF was 19±2.3 months. In another study, Singh and Mishra (1980) reported that the age at maturity of Jersey cows were 619.4±35.69 days. The differences may be attributed to the variation in feeding and management practices. But the pubertal age of HF × J and HF × L did not agree with the findings of Rahman et al. (1998) who observed the values to be 31 months 27 days and 34 months 27 days, respectively. This variation may be due to numerous genetic (sex and breed) and environmental (nutritional status, social interactions, temperature and photoperiod) factors. Longer age of puberty (968.77±7.43 days) of Jersey crossbred cows in summer as observed by Varade et al. (1997) may be associated with high ambient temperature during the months of July to August.

Age at first calving

In the present study, the age at first calving (AFC) were 29.5±0.25 and 27.8±0.581 months, respectively for HF × J and HF × L which is shorter than AFC of 36.37 months reported by Tassew and Seifu (2009) and higher than that of Kiwuwa et al. (1983) and Mekonnen (1983) who reported 497 and 420 days, respectively for crossbred cows. It also differs with Asaduzzaman and Miah (2004) who found that the age at first calving of Friesian × Local and Sahiwal × Local was 36.3±3.08 and 37.3±3.01 months, respectively. The age at first calving was 32 to 40 months in Friesian crosses demonstrated by Lahousse (1960) and 40.2 months in crossbreds of Boran with Friesian and Jersey (Demeke et al., 2004) which differs with the present finding. Sadek et al. (1994) depicted that a reduction in AFC will minimize the raising costs and shorten the generation interval and subsequently maximize the number of lactations per head. In general, earlier first calving increases the lifetime productivity of cows. It was also observed that intensive management practices reduced the age at first calving (Sarder and Hossain, 2001). Crossbred cows born in spring, has lower age at first calving (1189±6.6 days) while higher in cows born in Autumn (1557±6.9 days) (Hassan and Khan, 2013). Mureda and Zeleke (2007) mentioned that the different factors are responsible for the advance or delay AFC such as environmental factors, especially nutrition, determine pre-pubertal growth rates, reproductive organ development, and the onset of puberty and subsequent fertility. Substantial evidence exists dietary supplementation of heifers during their growth will reduce the interval from birth to first calving, probably because heifers that grow faster cycle earlier express overt estrus. There was the difference between the age at puberty and AFC of two Friesian crosses. And this is also outlined by Abera (2016) that the variation in age at first service (AFS) and AFC between different exotic blood levels production systems probably due to the difference in genetic potential among different exotic blood levels and difference in management and feeding systems among production systems.

Postpartum period

The average postpartum period of HF × J and HF × L crosses were 66.6±0.05 and 60.8±0.129 days which was almost similar. Rokonuzzaman et al. (2009) found the shortest time of post-partum heat period 86.5±23.7 in the LF cow, which was similar to our findings. It is satisfactory that proper management for crossbred cattle, providing an adequate amount of concentrate and roughage and check the proper heat detection might be contributory factors for the short interval from calving to conception for crossbred dairy cows reported in this study. But these results did not coincide with Majid et al. (1995) who observed that average post-partum heat period for Local and Friesian × Local were 120.0±7.84 and 117.2±7.29 days, respectively. Hafez and Hafez (2013) suggested that the postpartum breeding delayed up to 60 to 70 days after parturition when the uterus undergoes recovery and preparation for the next conception. Bauman and Currie, (1980) indicated that lactating cows are generally in negative energy balance during the early postpartum period because they cannot consume adequate energy in the diet. Negative energy balance reduces postpartum LH pulsatility and, therefore, delays the resumption of ovarian activity (Butler, 2000; Bayemi et al., 2015). Nutritional deficiencies coupled with heat stress probably might have contributed to the long post-partum period. Additionally, good pre-partum nutrition shortens the length of post-partum heat period (49.9±7.1 days) in Holstein cows (Cavestany et al., 2003). Bayemi et al. (2015) found a non-significant variation regarding the postpartum heat period of the cows based on pre-partum feeding level (low-level feeding and high-level feeding: 79 and 70 days, respectively), body condition score at calving (BCS≤3 and BCS≥3: 69 and 68 days, respectively), genotypes (Local, Holstein and Crosses: 76, 55 and 56 days, respectively) and postpartum supplementation (≤3 kg and 3 to 6 kg: 61 and 64 days respectively).

Dry period

The average dry period was 75.9±2.89 and 81.67±3.26 days for HF × J and HF × L respectively with an overall mean of 78.0±2.1 days. The dry period estimated in our study was almost similar to the standard value. The dry period increases with calving age, as a result of the increase of milk yield with the age of the herd. It can be speculated that if milk yield increases with calving age, the dry period would decrease. Dairy cows are usually dried-off for two months prior to the next calving. This rest period is necessary to maximize milk production in subsequent lactations. It was reported that the dry period is required for the renewal of the udder glandular tissue (Capuco et al., 1997; Annen et al., 2004). Nevertheless, the optimal dry period was established as 60 days. A significant increase in milk yield of the dairy cows exhibited new attention in creating the optimum dry period. A research done in Poland by Borkowska et al. (2006) and Winnicki et al. (2008) indicated that the extended or excessively shortened dry period leads to a reduction in milk production as compared to the recommended optimum. Long dry periods decrease the average annual production of the cow by extending the calving interval beyond the normal 13 to14 months interval and causing a decrease in the lifetime production of the dairy cow.

5. CONCLUSIONS

Both HF × J and HF × L crossbreds are well adapted under medium-scale commercial farming conditions of Bangladesh. Providing a mixture of green roughage and concentrate immediately before milking may improve average daily milk yield in crossbred dairy cows.

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