Journal of Agricultural Science and Technology A 5 (2015) 770-781
doi: 10.17265/2161-6256/2015.09.008

Growth Performance, Feed Conversion Ratio and Economics of Production of Native and Crossbred (Local × Holstein Friesian) Bulls for Fattening under Different Improved Feeding

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Abstract: An experiment was conducted to evaluate the growth performance and cost per gain of indigenous and crossbred (local × Holstein Friesian (L × HF)) bulls under four different improved feed treatments to determine the appropriate ration for economic organic beef production in Bangladesh. Twenty indigenous bulls (average body weight 208.08 ± 13.98 kg) and 20 crossbred (L × HF) bulls (average body weight 256.26 ± 26.85 kg) of 24 months age were divided into four equal groups and fed on four diets (T_0, T_1, T_2 and T_3) up to 120 d, where T_0 referred to the conventional diet, and T_1, T_2 and T_3 referred as improved organic diets. Required dry matter for individual animal was supplied by roughage and concentrate sources of the ration in the ratio of 2:1. Local grass and paddy straw were supplied to group T_0 and T_1, Napier grass and straw to group T_2, and Napier grass *(Pennisetum purpureum*), straw and Ipil-ipil leaf (*Leuceana leucucephala*) to group T_3 as roughage; whereas, the concentrate was supplied as 1.5% of live weight. The results revealed that total dry matter intake (DMI), total DMI as percent live weight (%LW), feed conversion ratio (FCR) and average daily gain (ADG) varied significantly ($P < 0.01$) among different treatment groups. Breed also had significant ($P < 0.01$) effect on total DMI, FCR and ADG, but total DMI (%LW) was not affected by breed type. Feed cost expressed as per kg live weight gain (LWG) (BDT/kg LWG; 1USD = 78.95 BDT), were also affected ($P < 0.01$) by feed treatments and breed type. Indigenous and crossbred bulls fed diet T_3 had higher ADG (0.49 kg and 1.17 kg, respectively) and comparatively lower feed costs (156 BDT/kg LWG and 96.78 BDT/kg LWG, respectively). But crossbred (L × HF) bulls showed the highest ADG (1.17 kg) and the lowest feed cost (96.78 BDT/kg LWG). Therefore, considering the growth performance and cost per kg gain of the experimental animals, it may be concluded that the crossbred (L× HF) bulls treated with T_3 diet may be used for economic organic beef production in Bangladesh.

Key words: Feed treatment, growth performance, FCR, cost per gain.

1. Introduction

The local × Holstein Friesian (L × HF) crossbred animals are expected to be a faster growing than native animals for profitable beef production. The growth and carcass yield potentials of indigenous and crossbred cattle may not be sufficiently exploited, unless adequate nutrition both in terms of quantity and quality is ensured. Local farmers mostly fed rice straw and local grass to feed their cattle, and the straw—poor quality roughage, failed to support even the maintenance requirement of energy and protein while it is fed alone. The growth rate of young indigenous cattle was found to be 100 g/d to 200 g/d, and on improved feeding, it was improved to 300 g/d to 800 g/d [1, 2]. Whereas, the feeding of a diet with fresh Napier to concentrate ratio of 1:1 to L ×

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Brahman F1 crossbred bulls yield an average daily live weight gain (LWG) of 518 g/head to 624 g/head with an average feed conversion ratio (FCR) of 10.2 to 15.8 [3]. A feedlot ration should be designed to give the maximum weight gain and fattening rate at the lowest cost. The requirement of the quantity of dry matter depends on the body weight of the animal and also on the nature of its production. Cattle will generally eat daily 2.0 kg to 2.5 kg dry matter for every 100 kg of live weight. Crossbred animals are slightly heavy eaters and their dry matter consumption varies from 2.5 kg to 3 kg daily for per 100 kg body weight. Naturally, all its requirements, whether organic nutrients, like carbohydrate protein, fat and minerals or vitamins, should come from the total dry matter that has to be allotted. Since the bulk is essential, the total dry matter allowance should be divided as two-thirds as roughages and one-thirds as concentrates [4]. Over time, there has been a trend towards higher grain feeding in most feedlot diets. Supplementation of straw with the concentrate even up to 73% may improve growth and feed conversion efficiency of local growing animals [5], but increasing level of concentrate may affect benefit cost ratio of cattle fattening system. In a trial of three iso-nitrogenous and iso-caloric diets, cost estimates were higher (1 kg of gain) for cattle fed with the high concentrate diet, and as the grain level increased, cost of gain estimates also increased [6]. Therefore, it is quite necessary to establish a proper ration for feedlot cattle in the aspect of Bangladesh. However, literature regarding feeding effect on growth performance of indigenous and L × HF crossbred bulls under feedlot is scanty in Bangladesh. So, the present study was conducted to evaluate the effect of traditional diet along with three improved diets and their comparison on growth performance and cost per kg gain in local and L × HF crossbred bulls and to determine the appropriate ration for economic beef production in Bangladesh.

2. Materials and Methods

2.1 Experimental Site, Animals and Housing

The experiment was conducted at Raiganj Upazila, Sirajganj, district of Bangladesh for a period of 120 d starting from May, 2013. Twenty indigenous bulls (average body weight 208.08 ± 13.98 kg) and 20 crossbred (L × HF) bulls (average body weight 256.26 ± 26.85 kg) of 24 months age were selected and given to 40 women who were well trained by the local non-governmental organizations (NGOs) for beef fattening. The experimental animals were kept in individual stall with adequate space and separate feeding and watering system. The animals were kept under hygienic conditions and uniform management throughout the experimental period. Each animal was vaccinated with anthrax and foot and mouth disease (FMD) vaccines and de-wormed with anthelmintics immediately before starting the experimental diets.

2.2 Experimental Diet

The animals were divided into two major groups—indigenous and crossbred, and each group was divided into four treatment groups (T_0, T_1, T_2 and T_3) containing five animals. The animals of group T_0 were treated with conventional feeding method. Whereas, the experimental animals of treatment groups (T_1, T_2 and T_3) were received *ad libitum* Napier grasses (*Pennisetum perpureum*; hybrid), local grasses and paddy straw after harvesting as basal diet. They also received a concentrate mixture at the rate of 1.5% of their live weights.

Feed formulation for different groups was as following:

T_0: rice straw + local green grass + concentrate (conventional feeding);

T_1: rice straw + local green grass + concentrate;

T_2: rice straw + Napier grass + concentrate;

T_3: rice straw + Napier grass + Ipil-ipil + concentrate.

Different concentrate mixtures were prepared for the control groups and treatment groups. Concentrate ration for bulls of control group contained wheat bran 50%, rice polish 49% and salt 1%; and the bulls of treatment groups were fed concentrate mixture, which was composed of maize crush 40%, wheat bran 10%, rice polish 16%, Kheshari bran 10%, bone meal 0.5%, salt 1%, fish meal 2.5% and Mustard oil cake 20% on fresh basis. Table 1 shows different chemical compositions of roughages; while Table 2 shows chemical composition of different feed ingredients of concentrate mixture for experimental animals on dry matter basis.

2.3 Feeding

The ration was supplied on the basis of dry matter requirement according to their live weight. Required dry matter for individual animal was supplied by roughage and concentrate sources of the ration in the ratio of 2:1 [4]. Napier grass, local grass and rice straw were provided to all the animals (if needed, additional grass and straw were supplied to the animals) and Ipil-ipil leaf meal was supplied 300 g as a supplementary feed to the T_3 group. During the feeding trial, animals were supplied with concentrate mixture at the rate of 1.5% of their respective live weight. The concentrate allowance was divided into two halves and offered at 9:00 am and 4:00 pm. The supply of concentrate mixture to an animal was adjusted with the increase of its live weight. During the whole 120 d of experimental period, amount of green grass, straw and concentrate offered and residue left by the individual animals were recorded every day. Feed intake was determined by subtracting the refusal from the amount given. Feed refusals were collected every morning before feeding, and weighed out regularly to find out daily feed intake.

2.4 LWG and FCR

Initial live weight of each animal was measured before feeding at the beginning day of experiment, and final live weight was measured at the end of the feeding period. The LWG was measured by Eq. (1):

Total LWG = final live weight – initial live weight (1)

The daily LWG of an individual animal was calculated with Eq. (2):

Table 1 Chemical composition of roughages for experimental animals.

Items	DM%	DM basis				
		OM%	CP%	ADF%	EE%	Ash%
Local grass	18.40	90.91	8.92	35.12	2.25	9.87
Napier grass	14.93	92.42	11.39	34.17	1.12	7.36
Paddy straw	91.57	82.98	9.52	46.85	1.97	17.02
Ipil-ipil leaf	27.80	92.73	23.12	18.19	3.17	7.13

DM = dry matter, OM = organic matter, CP = crude protein, ADF = acid detergent fiber, EE = ether extract.

Table 2 Chemical composition of feed ingredients of concentrate mixture for experimental animals.

Name of ingredients	DM%	DM basis			
		CP%	Ash%	OM%	CF%
Maize crush	89.50	11.06	13.14	86.86	2.17
Wheat bran	88.51	17.11	9.04	90.96	17.11
Rice polish	90.61	13.37	14.96	85.03	13.37
Kheshari bran	89.12	16.65	7.99	92.00	16.65
Fish meal	87.69	59.04	27.21	72.79	59.04
Mustard oil cake	91.51	35.72	15.03	84.97	12.42
Bone meal	-	-	-	-	-
Salt	-	-	-	-	-

DM = dry matter, CP = crude protein, OM = organic matter, CF = crude fiber.

Daily LWG = total LWG/total days of the experiment (2)

FCR for each animal was determined by Eq. (3):

FCR = total DMI (kg)/total LWG (kg) (3)

2.5 Economic Analysis

Economic analyses were done considering feed cost only. The costs of concentrate mixtures, straw and grass were calculated as 19.89, 2.15 and 5.94 BDT/kg DM, respectively. Thus, the costs of diet were calculated as: 8.63 BDT/kg DM of T_0 diet, 9.57 BDT/kg DM of T_1 diet, 10.31 BDT/kg DM of T_2 diet and 10.74 BDT/kg DM of T_3 diet for indigenous bulls; whereas, the costs of diets were: 8.24 BDT/kg DM of T_0 diet, 9.14 BDT/kg DM of T_1 diet, 10.15 BDT/kg DM of T_2 diet and 10.19 BDT/kg DM of T_3 diet for crossbred bulls. The gain cost was calculated according to Eq. (4):

Gain cost (BDT/kg gain) = [total DMI (kg) × cost/kg DM in diet]/total LWG (4)

2.6 Statistical Analysis

Data were presented as means and standard error of the means (SEM). Significant differences at $P < 0.05$ and $P < 0.01$ were determined by analysis of variance using statistical software SPSS version 20 and Microsoft Excel Software [7].

3. Results

3.1 Feed Nutrient Intake

All the parameters for feed nutrient intake varied significantly ($P < 0.01$) among different feed treatment groups of indigenous and crossbred bulls, except daily Ipil-ipil leaf intake (Table 3). Total DMI was the highest (11.07 kg/d) for group T_3 of crossbred bulls, while the lowest DMI (5.32 kg/d) was found for group T_0 of indigenous bulls (Table 3).

Significant variations ($P < 0.01$ and $P < 0.05$) of the daily intakes of different feed nutrients were found among different feed treatment groups of indigenous bulls, except the daily Ipil-ipil leaf intake (Table 4). On the other hand, the parameters of daily feed nutrient intake varied significantly ($P < 0.01$) among the treatment groups of crossbred bulls, except daily straw intake and Ipil-ipil leaf intake (Table 5). The lowest fresh grass intake, concentrate and higher straw intake in conventional feeding system (group T_0) resulted in the lowest total DMI both for indigenous and crossbred bulls (Tables 4 and 5). However, supplementation of Ipil-ipil leaf in group T_3 resulted in the highest total DMI both for indigenous and crossbred bulls (Tables 4 and 5). Significant breed effects ($P < 0.01$ and $P < 0.05$) were found for different parameters of feed nutrient intake, except the Ipil-ipil leaf (Table 6) meal supplementation group. Total DMI was significantly higher ($P < 0.01$) for crossbred bulls, but total DMI as percent live weight (%LW) did not differ significantly ($P > 0.05$) between indigenous and crossbred bulls (Table 6).

3.2 Average Daily Gain (ADG) and FCR

Breed and feed treatment interaction significantly ($P < 0.01$) affected ADG and FCR (Table 7). ADG was the highest (1.17 kg) for group T_3 of crossbred bulls and the lowest (0.27 kg) for group T_0 of indigenous bulls. The highest FCR (19.70) of the animals was found in group T_0 of indigenous bulls and the lowest FCR (9.48) was found in group T_3 of crossbred bulls.

ADG and FCR were affected significantly ($P < 0.01$) by feed treatment among the indigenous bulls. ADG was the lowest and FCR was the highest (0.27 kg and 19.70) in T_0 groups, and ADG was the highest and FCR was the lowest (0.49 kg and 14.51) in T_3 treatment group (Table 8). Significant effect ($P < 0.01$) of feed treatment was also found in crossbred bulls. ADG was the highest (1.17 kg) for group T_3 and the lowest (0.45 kg) for group T_0; while FCR was the highest (15.87) for group T_0 and lowest (9.48) for group T_3 (Table 9). Breed effect was also significant ($P < 0.01$) for ADG and FCR of experimental animals. ADG was significantly higher for crossbred bulls,

Table 3 Daily intake of feed nutrient by indigenous and crossbred bulls under different treatment groups.

Parameters	Indigenous				Crossbred				SEM	Sig. level
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3		
Fresh grass intake (kg/d)	9.08 ± 1.26^{d}	18.09 ± 1.24^{c}	21.46 ± 1.41^{b}	21.39 ± 1.88^{b}	10.36 ± 2.68^{d}	23.88 ± 1.89^{b}	26.45 ± 1.38^{a}	27.74 ± 2.88^{a}	1.31	**
Grass DMI (kg/d)	1.64 ± 0.23^{c}	3.26 ± 0.22^{b}	3.39 ± 0.22^{b}	3.38 ± 0.30^{b}	1.87 ± 0.48^{c}	4.30 ± 0.34^{a}	4.17 ± 0.22^{a}	4.38 ± 0.45^{a}	0.22	**
Grass DMI (%LW)	0.67 ± 0.08^{c}	1.32 ± 0.07^{a}	1.29 ± 0.07^{a}	1.20 ± 0.07^{ab}	0.55 ± 0.14^{d}	1.26 ± 0.11^{a}	1.11 ± 0.07^{b}	1.08 ± 0.11^{b}	0.06	**
Straw intake (kg/d)	1.75 ± 0.10^{bc}	1.92 ± 0.25^{b}	1.53 ± 0.23^{c}	1.40 ± 0.34^{c}	3.21 ± 0.12^{a}	2.98 ± 0.32^{a}	3.11 ± 0.25^{a}	3.24 ± 0.46^{a}	0.19	**
Straw DMI (kg/d)	1.52 ± 0.09^{bc}	1.67 ± 0.22^{b}	1.34 ± 0.20^{c}	1.22 ± 0.29^{c}	2.80 ± 0.11^{a}	2.60 ± 0.28^{a}	2.71 ± 0.21^{a}	2.82 ± 0.40^{a}	0.16	**
Straw DMI (%LW)	0.62 ± 0.04^{c}	0.68 ± 0.10^{bc}	0.51 ± 0.08^{d}	0.44 ± 0.11^{d}	0.82 ± 0.03^{a}	0.76 ± 0.08^{ab}	0.72 ± 0.06^{ab}	0.70 ± 0.10^{bc}	0.05	**
Conc. intake (kg/d)	2.28 ± 0.11^{f}	2.41 ± 0.10^{ef}	2.46 ± 0.03^{e}	2.74 ± 0.09^{d}	2.67 ± 0.06^{d}	3.41 ± 0.09^{c}	3.88 ± 0.18^{b}	4.11 ± 0.12^{a}	8.54	**
Conc. DMI (kg/d)	2.17 ± 0.11^{e}	2.18 ± 0.08^{e}	2.22 ± 0.03^{e}	2.48 ± 0.08^{d}	2.54 ± 0.06^{d}	3.14 ± 0.08^{c}	3.57 ± 0.16^{b}	3.79 ± 0.11^{a}	0.06	**
Conc. DMI (%LW)	0.89 ± 0.07^{b}	0.89 ± 0.05^{b}	0.85 ± 0.03^{c}	0.88 ± 0.02^{bc}	0.74 ± 0.01^{d}	0.92 ± 0.01^{ab}	0.95 ± 0.02^{a}	0.94 ± 0.01^{a}	0.02	**
Ipil-ipil leaf intake (kg/d)	-	-	-	0.30 ± 0.14	-	-	-	0.30 ± 0.07	-	NS
Ipil-ipil leaf DMI (kg/d)	-	-	-	0.08 ± 0.00	-	-	-	0.08 ± 0.00	-	NS
Total DMI (kg/d)	5.32 ± 0.25^{d}	7.11 ± 0.08^{c}	6.95 ± 0.12^{c}	7.13 ± 0.17^{c}	7.20 ± 0.62^{c}	10.41 ± 0.03^{b}	10.53 ± 0.09^{b}	11.07 ± 0.20^{a}	0.003	**
Total DMI (%LW)	2.19 ± 0.12^{f}	2.90 ± 0.05^{b}	2.65 ± 0.07^{de}	2.54 ± 0.05^{e}	2.10 ± 0.17^{f}	3.06 ± 0.07^{a}	2.81 ± 0.05^{bc}	2.73 ± 0.03^{cd}	0.0001	**

SEM = standard error of means; NS = not significant ($P > 0.05$); **significant at 1% level of probability ($P < 0.01$); $^{a\text{-}f}$values having different superscripts in the same row differ significantly.

Table 4 Daily feed nutrient intake by indigenous bulls under different treatment groups.

Parameters	Indigenous				SEM	Sig. level
	T_0	T_1	T_2	T_3		
Fresh grass intake (kg/d)	9.08 ± 1.26^{c}	18.09 ± 1.24^{b}	21.46 ± 1.41^{a}	21.39 ± 1.88^{a}	1.04	**
Grass DMI (kg/d)	1.64 ± 0.23^{b}	3.26 ± 0.22^{a}	3.39 ± 0.22^{a}	3.38 ± 0.30^{a}	0.17	**
Grass DMI (%LW)	0.67 ± 0.08	1.32 ± 0.07	1.29 ± 0.07	1.20 ± 0.07	0.05	NS
Straw intake (kg/d)	1.75 ± 0.10^{ab}	1.92 ± 0.25^{a}	1.53 ± 0.23^{bc}	1.40 ± 0.34^{c}	0.17	**
Straw DMI (kg/d)	1.52 ± 0.09^{ab}	1.67 ± 0.22^{a}	1.34 ± 0.20^{bc}	1.22 ± 0.29^{c}	0.15	**
Straw DMI (%LW)	0.62 ± 0.04^{ab}	0.68 ± 0.10^{a}	0.51 ± 0.08^{bc}	0.44 ± 0.11^{c}	0.06	**
Conc. intake (kg/d)	2.28 ± 0.11^{c}	2.41 ± 0.10^{b}	2.46 ± 0.03^{b}	2.74 ± 0.09^{a}	0.06	*
Conc. DMI (kg/d)	2.17 ± 0.11^{b}	2.18 ± 0.08^{b}	2.22 ± 0.03^{b}	2.48 ± 0.08^{a}	0.06	*
Conc. DMI (%LW)	0.89 ± 0.07^{a}	0.89 ± 0.05^{a}	0.85 ± 0.03^{b}	0.88 ± 0.02^{ab}	0.03	**
Ipil-ipil leaf intake (kg/d)	-	-	-	0.30 ± 0.14	-	NS
Ipil-ipil leaf DMI (kg/d)	-	-	-	0.08 ± 0.00	-	NS
Total DMI (kg/d)	5.32 ± 0.25^{c}	7.11 ± 0.08^{a}	6.95 ± 0.12^{b}	7.13 ± 0.17^{a}	0.12	**
Total DMI (%LW)	2.19 ± 0.12^{c}	2.90 ± 0.05^{a}	2.65 ± 0.07^{b}	2.54 ± 0.05^{bc}	0.05	**

SEM = standard error of means; NS = not significant ($P > 0.05$); *significant at 5% level of probability ($P < 0.05$); **significant at 1% level of probability ($P < 0.01$); $^{a\text{-}c}$values having different superscripts in the same row differ significantly.

Table 5 Daily intake of feed nutrient by crossbred bulls under different treatment groups.

Parameters	Crossbred				SEM	Sig. level
	T_0	T_1	T_2	T_3		
Fresh grass intake (kg/d)	10.36 ± 2.68^{d}	23.88 ± 1.89^{c}	26.45 ± 1.38^{b}	27.74 ± 2.88^{a}	1.616	**
Grass DMI (kg/d)	1.87 ± 0.48^{b}	4.30 ± 0.34^{a}	4.17 ± 0.22^{a}	4.38 ± 0.45^{a}	0.274	**
Grass DMI (%LW)	0.55 ± 0.14^{c}	1.26 ± 0.11^{a}	1.11 ± 0.07^{b}	1.08 ± 0.11^{b}	0.077	**
Straw intake (kg/d)	3.21 ± 0.12	2.98 ± 0.32	3.11 ± 0.0.25	3.24 ± 0.46	0.220	NS
Straw DMI (kg/d)	2.80 ± 0.11	2.60 ± 0.28	2.71 ± 0.21	2.82 ± 0.40	0.191	NS
Straw DMI (%LW)	0.82 ± 0.03	0.76 ± 0.08	0.72 ± 0.06	0.70 ± 0.10	0.050	NS
Conc. intake (kg/d)	2.67 ± 0.06^{d}	3.41 ± 0.09^{c}	3.88 ± 0.18^{b}	4.11 ± 0.12^{a}	0.087	**
Conc. DMI (kg/d)	2.54 ± 0.06^{b}	3.14 ± 0.08^{ab}	3.57 ± 0.16^{a}	3.79 ± 0.11^{a}	0.077	**
Conc. DMI (%LW)	0.74 ± 0.01^{b}	0.92 ± 0.01^{a}	0.95 ± 0.02^{a}	0.94 ± 0.01^{a}	0.007	**
Ipil-ipil leaf intake (kg/d)	-	-	-	0.30 ± 0.07	-	NS
Ipil-ipil leaf DMI (kg/d)	-	-	-	0.08 ± 0.00	-	NS
Total DMI (kg/d)	7.20 ± 0.62^{c}	10.41 ± 0.03^{b}	10.53 ± 0.09^{b}	11.07 ± 0.20^{a}	0.232	**
Total DMI (%LW)	2.10 ± 0.17^{c}	3.06 ± 0.07^{a}	2.81 ± 0.05^{b}	2.73 ± 0.03^{b}	0.067	**

SEM = standard error of means; NS = not significant ($P > 0.05$); **significant at 1% level of probability ($P < 0.01$); $^{a-d}$values having different superscripts in the same row differ significantly.

Table 6 Comparison of the daily intake of feed nutrient between indigenous and crossbred bulls.

Parameters	Breed		*P* value	Sig. level
	Indigenous	Crossbred		
Fresh grass intake (kg/d)	17.50 ± 5.35	22.11 ± 7.41	0.030	*
Grass DMI (kg/d)	2.91 ± 0.79	3.68 ± 1.13	0.018	*
Grass DMI (%LW)	1.12 ± 0.28	1.00 ± 0.30	0.193	NS
Straw intake (kg/d)	1.65 ± 0.30	3.14 ± 0.30	0.000	**
Straw DMI (kg/d)	1.44 ± 0.26	2.73 ± 0.26	0.000	**
Straw DMI (%LW)	0.56 ± 0.13	0.75 ± 0.08	0.000	**
Conc. Intake (kg/d)	2.48 ± 0.19	3.52 ± 0.58	0.000	**
Conc. DMI (kg/d)	2.26 ± 0.15	3.26 ± 0.50	0.000	**
Conc. DMI (%LW)	0.88 ± 0.05	0.89 ± 0.09	0.625	NS
Ipil-ipil leaf intake (kg/d)	0.08 ± 0.00	36.00 ± 0.71	-	NS
Ipil-ipil leaf DMI (kg/d)	0.30 ± 0.07	0.08 ± 0.00	-	NS
Total DMI (kg/d)	6.63 ± 0.79	9.80 ± 1.59	0.000	**
Total DMI (%LW)	2.57 ± 0.27	2.68 ± 0.37	0.301	NS

NS = not significant ($P > 0.05$); *significant at 5% level of probability ($P < 0.05$); **significant at 1% level of probability ($P < 0.01$).

Table 7 Effect of breed and feed treatment on ADG and FCR of indigenous and crossbred bulls of different treatment groups.

Parameters	Indigenous				Crossbred				SEM	Sig. level
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3		
Initial live weight (kg)	210.39 ± 11.66^{cd}	191.44 ± 6.94^{e}	208.45 ± 7.90^{d}	222.06 ± 9.19^{c}	287.49 ± 9.33^{a}	218.77 ± 8.01^{cd}	253.62 ± 8.80^{b}	265.15 ± 10.63^{b}	6.23	**
Final live weight (kg)	242.85 ± 11.88^{f}	245.48 ± 6.94^{f}	262.42 ± 8.20^{e}	281.03 ± 9.69^{d}	341.92 ± 9.83^{c}	340.26 ± 8.95^{c}	374.97 ± 9.73^{b}	405.26 ± 10.22^{a}	6.47	**
ADG	0.27 ± 0.01^{e}	0.45 ± 0.00^{d}	0.45 ± 0.00^{d}	0.49 ± 0.01^{c}	0.45 ± 0.04^{d}	1.01 ± 0.01	1.01 ± 0.01	1.17 ± 0.03^{a}	0.01	**
FCR	19.70 ± 0.33^{a}	15.78 ± 0.20^{b}	15.45 ± 0.15^{c}	14.51 ± 0.21^{d}	15.87 ± 0.14^{b}	10.28 ± 0.09^{e}	10.37 ± 0.09^{e}	9.48 ± 0.35^{f}	0.15	**

SEM = standard error of means; **significant at 1% level of probability ($P < 0.01$); $^{a-f}$values having different superscripts in the same row differ significantly ($P < 0.01$).

Table 8 ADG and FCR of indigenous bulls of different treatment groups fed different plane of nutrition.

Parameters	Indigenous				SEM	Sig. level
	T_0	T_1	T_2	T_3		
Initial live weight (kg)	210.39 ± 11.66^{ab}	191.44 ± 6.94^{c}	208.45 ± 7.90^{b}	222.06 ± 9.19^{a}	6.43	**
Final live weight (kg)	242.85 ± 11.88^{c}	245.48 ± 6.94^{c}	262.42 ± 8.20^{b}	281.03 ± 9.69^{a}	6.61	**
ADG	0.27 ± 0.01^{c}	0.45 ± 0.00^{b}	0.45 ± 0.00^{b}	0.49 ± 0.01^{a}	0.007	**
FCR	19.70 ± 0.33^{a}	15.78 ± 0.20^{b}	15.45 ± 0.15^{bc}	14.51 ± 0.21^{c}	0.166	**

SEM = standard error of means; **significant at 1% level of probability ($P < 0.01$); $^{a-c}$values having different superscripts in the same row differ significantly.

Table 9 ADG and FCR of crossbred bulls of different treatment groups fed different plane of nutrition.

Parameters	Crossbred					
	T_0	T_1	T_2	T_3	SEM	Sig. level
Initial live weight (kg)	287.49 ± 9.33^{a}	218.77 ± 8.01^{d}	253.62 ± 8.80^{c}	265.15 ± 10.63^{b}	6.53	**
Final live weight (kg)	341.92 ± 9.83^{c}	340.26 ± 8.95^{c}	374.97 ± 9.73^{b}	405.26 ± 10.22	6.85	**
ADG	0.45 ± 0.04^{c}	1.01 ± 0.01^{b}	1.01 ± 0.01^{b}	1.17 ± 0.03^{a}	0.02	**
FCR	15.87 ± 0.14^{a}	10.28 ± 0.09^{b}	10.37 ± 0.09^{b}	9.48 ± 0.35^{c}	0.14	**

SEM = standard error of means; **significant at 1% level of probability ($P < 0.01$); $^{a-c}$values having different superscripts in the same row differ significantly.

Table 10 Comparison of ADG and FCR between indigenous and crossbred bulls.

Parameters	Breed		*P* value	Sig. level
	Indigenous	Crossbred		
Initial live weight (kg)	208.08 ± 13.98	256.26 ± 26.85	0.000	**
Final live weight (kg)	257.95 ± 17.89	365.60 ± 28.86	0.000	**
ADG	0.416 ± 0.09	0.911 ± 0.28	0.000	**
FCR	16.36 ± 2.05	11.50 ± 2.62	0.0001	**

**Significant at 1% level of probability ($P < 0.01$).

while FCR was significantly higher for indigenous bulls (Table 10).

3.3 Relationship of Feed Nutrient Intake with ADG and FCR

3.3.1 Relationship between Feed Nutrient Intake and ADG

Fig. 1 shows the relationship of total DMI with ADG among different treatment groups. ADG was increased linearly with the increase of daily intake of feed nutrient.

3.3.2 Relationship between Feed Nutrient Intake and FCR

Fig. 2 shows that FCR is the highest when the daily DMI is the lowest; whereas, FCR was the lowest for the highest DMI.

3.4 Economic Efficiency

Daily feed cost and feed cost for 1 kg LWG varied significantly ($P < 0.01$) among different feed treatment groups of indigenous and crossbred bulls (Table 11). So, breed and feed treatment interaction had significant ($P < 0.01$) effect on economic efficiency. Daily feed cost was found the highest in group T_3 of both indigenous and crossbred bulls (76.66 BDT/d and 112.9 BDT/d, respectively) and the lowest in group T_0 of indigenous and crossbred bulls (45.99 BDT/d and 59.26 BDT/d, respectively). The feed costs required for 1 kg LWG was the highest for group T_0 (169.94 BDT/kg LWG and 130.86 BDT/kg LWG) and the lowest for group T_1 (151.04 BDT/kg LWG and 93.96 BDT/kg LWG) of both indigenous and crossbred bulls, respectively (Table 12).

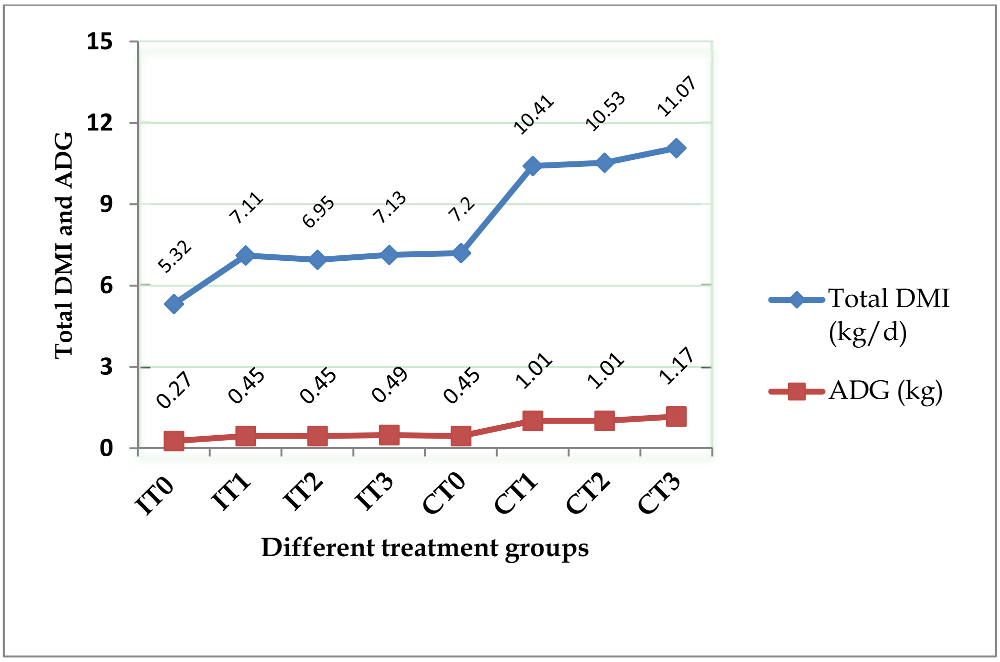

Fig. 1 **Feed nutrient intake and ADG of different treatment groups of indigenous and crossbred bulls.**

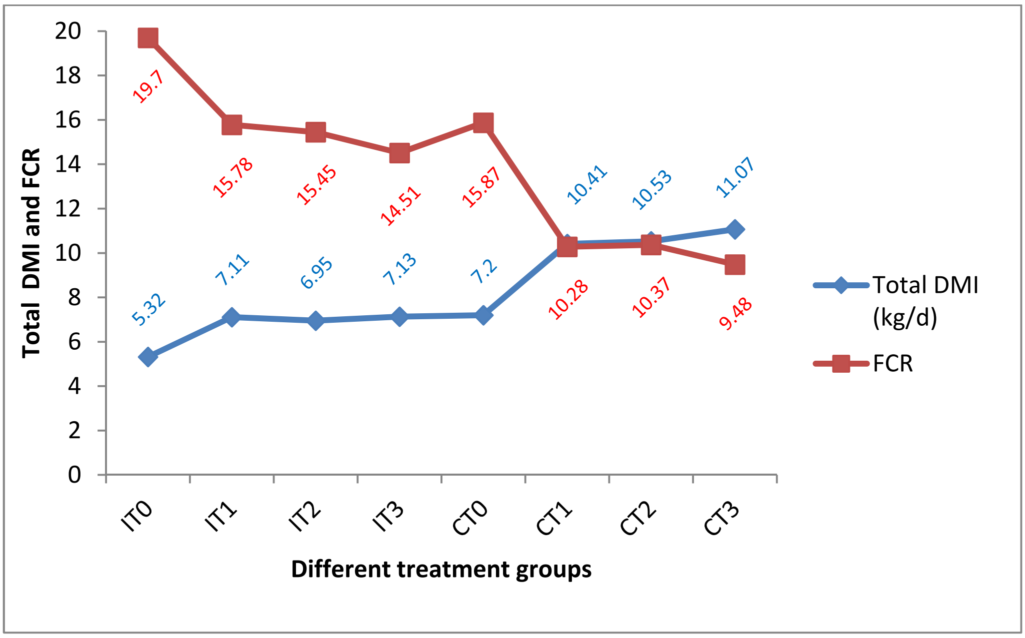

Fig. 2 **Feed nutrient intake and FCR of different treatment groups of indigenous and crossbred bulls.**

Table 11 **Feed cost of different feed treatments for indigenous and crossbred bulls.**

Parameters	Indigenous				Crossbred				SEM	Sig. level
	T_0	T_1	T_0	T_3	T_0	T_1	T_2	T_3		
Feed cost (BDT/d)	45.99 ± 4.7^{g}	68.04 ± 2.1^{e}	71.64 ± 1.4^{e}	76.66 ± 4.7^{d}	59.26 ± 3.6^{f}	95.13 ± 2.2^{c}	106.90 ± 3.3^{b}	112.90 ± 3.9^{a}	2.14	**
Feed cost (BDT/kg LWG)	169.94 ± 13.6^{a}	151.04 ± 3.6^{c}	159.26 ± 2.3^{b}	156 ± 4.9^{bc}	130.86 ± 3.6^{d}	93.96 ± 1.7^{f}	105.71 ± 2.5^{e}	96.78 ± 5.1^{f}	3.99	**

SEM = standard error of means; **significant at 1% level of probability ($P < 0.01$); $^{a\text{-}f}$values with same superscripts letter in a row do not differ significantly ($P > 0.05$), whereas, values with dissimilar superscripts differ significantly ($P < 0.01$).

Table 12 Feed cost of different feed treatments.

Parameters	Breed	T_0	T_1	T_2	T_3	SEM	Sig. level
Feed cost (BDT/d)	Indigenous	45.99 ± 4.7[c]	68.04 ± 2.1[b]	71.64 ± 1.4[b]	76.66 ± 2.7[a]	2.11	**
	Crossbred	59.26 ± 3.6[d]	95.13 ± 2.2[c]	106.91 ± 3.3[b]	112.90 ± 3.9[a]	2.35	**
Feed cost (BDT/kg LWG)	Indigenous	169.94 ± 13.6[a]	151.04 ± 3.6[b]	159.26 ± 2.3[b]	156.00 ± 4.9[b]	5.33	**
	Crossbred	130.86 ± 3.6[a]	93.96 ± 1.7[c]	105.71 ± 2.5[b]	96.78 ± 5.1[c]	2.46	**

SEM = standard error of means; **significant at 1% level of probability ($P < 0.01$); [a-g]values in a row with same superscripts letter do not differ significantly ($P > 0.05$), whereas, values with dissimilar superscripts differ significantly ($P < 0.01$).

Table 13 Comparison of average feed cost between indigenous and crossbred bulls.

Parameters	Indigenous	Crossbred	*P* value	Sig. level
Feed cost (BDT/d)	65.58 ± 12.3	93.55 ± 21.6	0.001	**
Feed cost (BDT/kg LWG)	159.06 ± 9.9	106.83 ± 15.3	0.001	**

**significant at 1% level of probability ($P < 0.01$).

Table 13 shows that the average feed cost per day is higher ($P < 0.01$) for crossbred bulls (93.55 BDT) than the indigenous bulls (65.58 BDT). Whereas, the average feed cost for 1 kg LWG is higher ($P < 0.01$) for indigenous bulls (159.06 BDT) than the crossbred bulls (106.83 BDT).

4. Discussion

4.1 Feed Intake

Feed treatment had significant effect ($P < 0.01$) on daily intake of total dry matter (kg/d) and DMI as percent live weight (%LW) both for indigenous and crossbred bulls in this study. Rashid et al. [8] also reported significant differences ($P < 0.05$) of DMI/d for three diets of experimental animals, where Con-UMS diet (50% concentrate + 50% urea, molasses, straw) group showed the highest DMI of 10.2 kg/d or 2.69% LW, followed by 100% concentrate diet group (Con.) of 7.56 kg/d or 1.99% LW, and 100% UMS diet group of 6.71 kg/d or 1.94% LW, respectively. But, Rashid et al. [6] and Zahradkova et al. [9] did not find any significant difference of DMI/d among different feed treatment groups, which could be due to the similar live weights of animals and the diets were iso-nitrogenous and iso-caloric, while animals having different live weights were used in the present study.

Total DMI (kg/d) was significantly ($P < 0.01$) affected by breed type in this study, and this was in accordance with result of Roy et al. [3], who found significant ($P < 0.01$) variations of DMI among Brahman crossbred bulls (6.91 kg/d), Pabna bulls (5.33 kg/d) and Red Chittagong bulls (4.46 kg/d); while unlikely to the present study , total DMI (%LW) varied significantly ($P < 0.01$) among different breeds [3]. Fox et al. [10] also found the significant ($P < 0.05$) differences of total DMI among different breeds. But, the findings did not agree with Zahradkova et al. [9].

The amount of DMI (kg/d) by the indigenous bulls in the present study was almost similar to the DMI reported by Zahradkova et al. [9], while the amount of DMI (kg/d) by crossbred bulls was almost similar to Fox et al. [10] and Bures and Barton [11]. Daily DMI as percent of live weight (%LW) was almost similar to Dung et al. [12] and Rashid et al. [8] (for Con-UMS diet) for indigenous and crossbred bulls. On the other hand, the lower amount of DMI (kg/d and as %LW) by the animals of 24 months of age reported by Roy et al. [3], may be linked to several factors, i.e., breed type, live weight, environment and feed ingredients of diet as they fed concentrate mixture at the rate of 1.25% of the live weight of animals, which was lower than the present study.

4.2 LWG and FCR

ADG varied significantly ($P < 0.01$) among different feed treatment groups. Significant ($P < 0.05$) variations of ADG among different feed treatment groups were also reported by Rashid et al. [8]; and the reported ADG were 0.954, 0.873, 0.205 kg for 100% concentrate diet group (Con.), Con-UMS diet group and 100% UMS diet group, respectively. Rahman [13] found higher ADG (0.492 kg/d) for UMS treated diet group than the control group (0.365 kg). Malole et al. [14] also found significant ($P < 0.001$) difference of ADG between two feed treatment schemes. Unlike the present study, Alberti et al. [15] did not find any significant effect of diet on ADG.

ADG of the experimental animals were also affected ($P < 0.01$) by breed type in the present study. Similar significant ($P < 0.01$) variations of ADG for breed type were determined by Roy et al. [3]; and the results were 0.709, 0.447, 0.624 kg for Pabna breed, Red Chittagong cattle (RCC) and Brahman crossbred bulls, respectively. Fox et al. [10] reported variations in ADG 1.28, 1.34, 1.40 and 1.29 kg/d for unselected Hereford, selected Hereford, Angus × Hereford × Charolais and Angus × Hereford × Holstein, respectively. Unlikely to the present study, Keane [16] did not find significant effect of breed on ADG of animals.

ADG of indigenous bulls in this study were almost similar to the Red Chittagong bulls, but ADG for crossbred bulls (HF × L) were higher than the Brahman crossbred bulls [3]. Similarly to the findings in the present study, the differences in ADG among the breed types were also reported by Barton et al. [17], who showed Charolais and Simmental gained more rapidly ($P < 0.05$) than Aberdeen Angus, while Hereford showed intermediate. Bonilha et al. [18] also reported a significant variation of daily LWG among the *Bos indicus* and tropically adapted *Bos taurus* breed.

FCR in the present study was significantly ($P < 0.01$) affected by different feed treatments, which is similar to the results reported by Rashid et al. [8] and Malole et al. [14]. In this study, crossbred bulls (HF × L) showed significantly lower ($P < 0.01$) FCR than the indigenous bulls. But, Roy et al. [3] observed significantly ($P < 0.01$) higher FCR values in Brahman crossbred bulls than the indigenous (Pabna breed and Red Chittagong cattle breed) bulls fed single plan of nutrition. Zahradhkova et al. [9] also reported significant ($P < 0.01$) differences of FCR values among different breed types, but they did not find any significant difference of FCR for different diets. Keane [16] found significantly ($P < 0.01$) lower efficiency of utilization of net energy for carcass weight gain in Holstein Friesian than Belgian Blue × Holstein Friesian. Malole et al. [14] also found that TSHZ (Tanzanian × Shahiwal Zebu) cattle had lower FCR compared to Ankole cattle, which supported the breed effect on FCR of the present study.

4.3 Economic Analysis

The result of economic efficiency shows that conventional diet group (T_0) had significantly lower ($P < 0.01$) daily feed cost and higher feed cost per kg LWG, which may be due to poor quality of concentrate in diet. On the other hand, improved diet groups showed higher ($P < 0.01$) daily feed cost and lower feed cost per kg LWG. Rashid et al. [6] reported significantly higher ($P < 0.05$) daily feed cost for higher level of concentrate in diets, and the feed cost required for 1 kg LWG increased with the increase of concentrate level in diet. Rashid et al. [8] also found replacing 50% of an all-concentrate diet with urea-molasses impregnated straw (UMS) reduced feed cost per kg LWG, while 100% UMS diet had the lowest ($P < 0.05$) daily feed cost. Parvez et al. [19] reported reduction of daily feed cost with the decreased level of energy and protein in the diet.

5. Conclusions

It is concluded that improved feed treatment T_3 performs more effectively and economically compared to feed treatment T_1 and T_2; and the conventional feeding is not suitable for profitable organic beef fattening in Bangladesh. The crossbred bulls (L × HF) are proved to be more effective and economic, as they have higher ADG and lower FCR than the indigenous bulls. So, L × HF crossbred bulls with improved diet T_3 may be used for profitable beef fattening instead of using indigenous bulls and feeding conventional diet on the aspect of Bangladesh.

Acknowledgments

The authors gratefully acknowledged the award of a Ph.D. grant of Pabna Meat Proprietor Md. Liaquat Ali under the project inclusion of Value Chain for Beef Fattening, funded by Business Innovation Facility (BIF), Department for International Development (DFID). The authors also acknowledged the laboratory staffs of Bangladesh Livestock Research Institute (BLRI) and staffs of Pabna Meat for their cooperation and generous help during lab analysis.

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