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SUITABILITY OF TEMPERATE AND TROPICAL CROSSBRED DAIRY CATTLE UNDER PERI-URBAN PRODUCTION SYSTEM IN BANGLADESH

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ABSTRACT

Suitability of temperate and tropical crossbred dairy cattle under peri-urban production system was investigated.The study was conducted during a period from April, 2010 to March, 2013 in peri-urban dairy production system of Mymensingh district. The available dairy crossbred genotypes were 50% Holstein Friesian(HF) , 62.5% HF ($^{5/8}$HF), 75% HF ($^{3/4}$HF).A total of 103 households, possessing 358 lactating cows were selected where two different management environments were applied: (i) Intervention (E_1) group and (ii) Non-intervention (E_2) group. There were a total of 158 cows registered from 58 households in E_1 and a total of 200 non-registered cows from 145 households in E_2. Average daily milk yield was 8.11±0.24 kg, it is higher in 62.5% HF genotype (8.60±0.41 kg) compared to 50% HF(8.32±0.42 kg) and 75% HF (7.42±0.42 kg). However, the intervention group (E_1) was more efficient with an average of 9.85 ±0.39 than non intervention group (E_2) with6.38±0.28 kg. The highest milk yield in 180 days was found (1550±74 kg) at 62.5 % HF and lowest (1339±76) at 75% HF genotype. Against, G×E interaction effects were not significant on total milk yield (TMY) and daily milk yield though effect of environment was highly significant ($P<0.001$). The shortest dry period was found in 50% (89±2.53 days) and highest in 75% HF cross cows (102±2.72 days). The shortest age at first heat was found in 50 % (28±0.28) and highest in 75% (36±0.29) months. The shortest age at fist calving was found in 50% HF (37±0.30) and highest was in 75% HF (45±0.32) month. The shortest calving interval was found in 50% HF (378±8.63) and highest was in 75% HF (438±10.53) days. The shortest post-partum heat period found in 62.5% (91±3.31) days and highest in 75% HF (109±3.72) days. The lowest number of services per conception found in 62.5% (1.42±0.07) and highest in75% (1.64±0.08) HF cross genotype. Conception rate was found shortest in 50% (71±2.66) and highest in 75% 80±2.52Holstein Friesian cross cows. In case of reproductive performances (number of services per conception, conception rate,

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age at first heat, age at first calving, dry period, calving interval), genotype, environment and G x E interaction had highly significant effects (P<0.001). Therefore, it can be concluded that for reproduction 50% HF crossbred cows and for production both 50% and 62.5% HF crossbred cows are suitable in small holder peri-urban dairying system.

Keywords: Holstein friesian crossbred cows, Peri-urban system, Tropical region, Reproduction traits, Milk yield, Genotype by environment interaction.

Contribution/ Originality

This study contributes in the existing literature to inventive estimates of genotype by environment interactions to recommend appropriate crossbred cattle genotype to help Bangladeshi farmer for higher milk yield in the peri-urban area. This study uses new estimation of methodology to use herd book keeping, following breeding policy properly, Feeding management, Farmers training, proper recording system, etc .

1. INTRODUCTION

In order to increase milk production in the tropical region of the world, cattle crossbreeding programs have long been used as one of the main strategies and temperate breeds have been introduced in many developing countries. To meet an increasing demand for milk, the livestock sector in Bangladesh is undergoing rapid changes and intensive production expands by preferring a certain range of high-output dairy genotypes. Genetic improvement of indigenous populations in the tropics through pure breeding (selection) is an extremely slow process because of poor infrastructure and organization among local small-holder dairy farmers. The first choice of means for genetic improvement should be use of a superior tropical breed for upgrading. Improvement of indigenous zebu populations through upgrading with *Bos Taurus* breeds have to be carefully considered taking into account the perspective of not only well performing F_1cows but also the establishment of a sustainable system in later generations. But in order to maximize overall profitability, the herd must have appropriate combination of genetically high potential breeds along with better feeding, management and healthcare practices [1].

The existing cattle breeding policy of the country is a two-tier system which kept provision of dairy development in the country using both i) high yielding variety (HYV) cattle which are crossbred e.g. ½ Holstein Friesian- ½ Local, and ii) important indigenous dairy cattle types / breeds e.g. Red Chittagong, Pabna, Munshigonjetc. But high proportion crossbreds are not suitable for their maximum performance in our local environmental condition rather they need extra feed and other management of its origin, but our farmers are not able to provide these management. In addition, no attempt has yet been made in Bangladesh know the degree of interaction between genotype and environment (G×E). As a result, different productive and reproductive problem arises in these crossbreds such as late puberty, lower conception rate, lower milk yield, late pregnancy, anestrous, increased calf mortality, various diseases etc. An estimation of G x E in various traits can there after help designing appropriate measure to avoid the said problems because the said improvement can be limited due to genotype by environment interaction.

In the village condition, farmers are not able to develop the dairy production. The major constrains are choice of species, breeds, availability of animals, smart feeding management, improved breeding, reproduction, animal health care, management of manure, organized marketing system, marketing outlet, capacity of investment. These constraints provide major opportunity to challenge research and develop to increase dairy production. Nowadays, in peri-urban area peoples are very much interested of rearing the crossbred cows for more profitable business because of easy marketing and available resource management. In Bangladesh, a peri-urban area refers to a transition or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications, inducing by human activities. The present study was therefore carried out to reveal the suitability of temperate and tropical crossbred cattle in peri-urban dairy production system of the country.

2. MATERIALS AND METHODS

2.1. Place of Study

This work was carried out at the peri-urban farmers' herds of Mymensingh district within seven kilometers around the Artificial Insemination Centre, Department of Animal Breeding and Genetics, Bangladesh Agricultural University (BAU).

2.2. Source of Experimental Data

The research data of the present study were collected from an on-going project titled "Production of HYV vis-à-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh", supported by Department of Animal Breeding and Genetics, Bangladesh Agricultural University (BAU), Mymensingh from April, 2010 to March, 2013 to evaluate productive and reproductive performances of available Holstein Friesian (HF) crossbred. An in-depth data collection format was prepared for collecting information on individual cows (mainly Holstein – Local crossbreds of different grade) in the project area. A total of 103 households, which 358 lactating cows were selected where two different environments): (i) Intervention (E1) group- where year round inputs and services such as vaccination, de-worming (thrice in a year), AI using superior semen, fodder seeds and cuttings, necessary treatment, medicine, feces test, feeding and management advice, testing for tuberculosis (TB) and mastitis, management tools for mastitis control were provided on routine basis; and (ii) Non-intervention (E2) group-where farmers provided their animals with conventional practices.. From the study area a total of 158 cows were selected from 58 households on the basis of intervention group and 200 cows were taken in non-intervention group. Data on a total of 158 lactating cows were collected from Holstein Friesian x Local crossbred cows. All cows were registered and every cow had an ID number. Non intervention group was unregistered and cows had no ID number and management system was traditional.

2.2.1. Data Structure

The number of records in various traits according to parity, environment and genotype are presented in Table 1Trait	Environment		Genotype (%HF)		
	Intervention (E_1)	Non-intervention (E_2)	50	62.5	75
AFH (m)	197	150	117	131	99
AFC (m)	197	150	117	131	99
DP (day)	149	196	118	131	99
CI (day)	150	198	118	131	99
NSC (no.)	150	200	118	131	99
CR (%)	150	98	84	76	88
180DMY (kg)	75	140	74	78	67
DMY(kg)	75	140	74	78	67

AFH= Age at first heat (month), AFC=Age at first calving (month), DP=Dry period (day), CI= Calving interval (day), NSC= Number of service per conception, CR= Conception rate (%), DMY=Daily milk yield (kg)

2.3. Herd Book Opened

A small book, where detailed information (e .g. ID no. date of birth, sire, dam, date of maturity, production performance, reproduction efficiency, disease incidence, vaccination schedule etc.) of an animal is being recorded in written form. Herd books were opened for every registered cows / heifers in the working area.

2.4 Farmer's Training

Training on scientific cattle husbandry, record keeping and dairy production system was offered to the elite cattle owners. Copies of **"Cattle Rearing Manual"** was prepared and distributed among the farmers as ready reference. Capacity building of a total of 210 farmers in a total of 4 training sessions were conducted to date.Repeated trainings on the importance, contents and methods of maintaining Herd book were arranged for both the Animal Recorder and the farmers.

2.5. Feeding and Management Practices

Feeding and management practices followed at the farmers' herd were almost uniform throughout the year. Most of the crossbred animals concentrate fed were supplied twice / thrice daily in the morning and evening and composed of rice polish, wheat bran, bran of legumes and oil cakes. Among concentrates, wheat bran (29.6% for cow), oil cake (25.23% for cow), rice polish (18.38% for cow) are highly preferred. Rice straw was used as bulk basal feed with some green grasses and concentrates. Very few (around 5%) farmers' fed fresh fodder to their crossbred cows and road side grasses. It is also important to mention here that green grass supply was not on *ad libitum* basis because of the unavailability and seasonal fluctuations in the availability of green grass during different seasons of the year.

2.6. Milk Production Recording

Test day (morning and evening) milk yield data were recorded on fortnightly basis. Moreover, all lactation parameters of elite cows were being recorded properly. Alongside, all other information demanded by the Herd book such as pedigree, date of birth, weight at birth, age and weight at weaning and maturity, disease incidence etc were being recorded through periodic visit to farmers' home by animal recorder who maintained data with the assistance of animal owner.

2.7. Daily Milk Yield

To get daily milk yield the whole lactation period was divided into start of lactation, peak of lactation and end of lactation with duration. Then the average daily milk yield was calculated using the following equation.

"Total" milkyield = $x_1y_1 + x_2y_2 + x_3y_3$

Where,

y_1= milk yield at the start of lactation

y_2= milk yield at the peak of lactation

y_3= milk yield at the end of lactation

x_1, x_2 and x_3 denote the interval lengths of the different stages of lactation (start, peak and end) and they were summed up to lactation length.

Adjusted daily mean milk yield = $\frac{\text{"Total" milk yield}}{(x1+x2+x3)}$

The average daily milk yield (DMY) of a cow was measured by:

$$180DMY\ (kg) = \frac{\text{Sum of all test day yield}}{\text{Number of test day records}} \times 180$$

$$\mathbf{DMY} = \frac{\text{Total milk produced in a lactationlactation}}{\text{Total number of days in the given lactation}}$$

2.8. Estimation of Genotype by Environment Interaction (G × E)

The G ×E estimation of age at first calving, number of service per conception, age at first calving, parity, dry period, calving interval, lower conception, milk yield, increased calf mortality, various diseases etc. in dairy crossbred cattle (between Local and Holstein Friesian) were measured taking two environments into consideration described above. In this study, factorial analysis of variance using a linear model, with an environmental factor, a genetic factor and interaction effect between the two factors, was fitted with genetic and interaction effects as random effects.

3. RESULTS AND DISCUSSION

3.1. Age at First Heat (AFH)

Table 1 shows the least squares means (±SE) of reproductive traits of Holstein-Friesian crossbred cows. Age at first heat of overall Holstein-Friesian crossbred of the present study was 30.96±0.18 months which is higher than the findings of Majid, et al. [2] which was 26 months whereas, Al-Amin and Nahar [3] found an AFH of 25 months) and very similar to intervention group (25.39±0.23 months) of present study. In ½ HF (50%) and (5/8) HF crossbred (62.5% inheritance) AFH were 28.03±0.28 and 28.69±0.25 moths which are almost same. But in ¾ HF (75%), it is higher (36.16±0.29 months). It was also evident that temperate crossbreds come into maturity at an earlier age than the breeds of tropical environment. In case of first heat, highly significant (P<0.001) of G x E interaction and genotype was observed.

Table-1. Least squares means (±SE) of reproductive traits of Holstein-Friesian crossbred cow

Factors	Parameters					
	Mean± SE					
	AFH (m)	AFC (m)	CI	DP	NSC (no)	CR (%)
Parity	-	-	NS	NS	NS	NS
1	-	_	411.51±9.86(77)	90.39^{b}±2.82(77)	1.45±0.08 (089)	76.74±2.95(76)
2	-	_	397.364±8.20(116)	95.27^{b}±2.29(116)	1.51±0.06 (116)	76.99±2.40(116)
3	-	_	400.28±9.23(85)	96.96^{b}±2.65(85)	1.39±0.07(85)	79.94±2.79(84)
4	-	_	400.49±19.94(22)	87.34^{bc}±5.10(22)	1.57. ±0.15 (22)	73.20±5.53(22)
5	-	_	384.41±14.08(29)	88.87^{a}±4.52(29)	1.710±0.12 (29)	69.90±4.72(29)
6+	--	_	426.144±22.58(19)	105.86^{c}±5.57(19)	1.46±0.15 (19)	76.50±5.88(19)
Environment	***	***	NS	***	***	***
Intervention	25.39^{a}±0.23(150)	34.66^{a}±0.26(197)	394.10±7.27(150)	66.78^{a}±2.30(149)	1.38^{a}±0.06 (150)	83.56^{a}±2.41(150)
Non-intervention	36.54^{b}±0.23(198)	45.47^{b}±0.23(150)	411.79±8.68(198)	121.13^{b}±2.06(196)	1.66^{b}±0.06 (200)	67.50^{b}±2.16(198)
Genotype	***	***	***	***	*	*
50%HF	28.03^{a}±0.28(117)	37.30^{a}±0.30(117)	378.13^{a}±8.63(118)	88.99^{a}±2.53(118)	1.49^{a}±0.07 (118)	74.42^{a}±2.86(76)
62.5%HF	28.69^{a}±0.25(131)	38.00^{a}±0.28(131)	394.17^{a}±8.73(131)	90.66^{a}±2.42(131)	1.42^{a}±0.07 (133)	80.49^{a}±2.52(88)
75%HF	36.16^{b}±0.29(99)	44.99^{b}±0.32(99)	437.80^{b}±10.53(99)	102.19^{b}±2.72(99)	1.64^{b}±0.08 (099)	71.48^{b}±2.66(84)
GXE	***	***	***	***	**	*
Overall	30.96±0.18(348)	40.07±0.17(347)	403.37±6.27(348)	93.95±1.69(331)	1.52±0.05(350)	75.53±1.78(348)

[1]Parity-calving parity; Environment-based on proper feeding, good management& health care (intervention) and conventional feeding and management (non-intervention); Genotype- based on % of genetic material contents; GXE- interaction between genotype and environment; [2]NSC- number of services per conception; CR- conception rate; AFH-age at first heat; AFC-age at first calving; *-significant at 0.05 level (P<0.05); **- significant at 0.01 level (P<0.01); ***- significant at 0.001 level (P<0.001); NS- non significant (P>0.05); Figures in the parenthesis indicate the number of observation; Means with uncommon superscripts in the same column differed significantly (P<0.05).

3.2. Age at First Calving (AFC)

Tropical cattle are delayed to reach sexual maturity and though there may be some differences between breeds it is largely influenced by environment and especially poor nutrition, which can retard growth and development. In the majority of breeds age at first calving is generally about 36-48 months [4]. Age at first calving for some breeds in Indian cattle may be cited here on this context for comparisons by Taneja and Bhat [5]. They reported age at first calving for Kankrej, Sahiwal, Tharparkar, Red Sindhi, Gir, Hariana, Deoni, Ongole and Non-descript cattle as 47±0.8, 40±0.2, 49±0.4, 42±0.6, 47±0.8, 53±0.3, 53±1.0, 40±0.4 and 59±2.5 months, respectively.

In the present study overall age at first calving was 40.00±0.17 months in HF crossbred cows, but in Intervention group it was 35±0.26 months which were more or less similar to 37±3.21, 39±7.1, 36±3.48 months in Holstein Friesian crosscows according to, Sarder [6] and Islam, et al. [7], respectively in Bangladesh. But in non intervention group it was 45±0.23

months whereas results of Rokonuzzaman, et al. [8], Faruk, et al. [9], Al-Amin and Nahar [3]which are respectively 34.00±3.78, 33.00±2.32, 34.3 months are very similar to intervention group in this study. In the present study average AFC for 50%, 62.5%, and 75% HF crossbred cows were respectively 37.30± 0.30, 38.00± 0.28 and 44.99± 0.32 months which are higher than studies reported above.

3.3. Dry Period (DP)

In present study, 50%, 62.5%and 75% HF cross cows had dry period of 88.99±2.53, 90.66±2.42 and 102.19±2.72 respectively. Qureshi, et al. [10] in Pakistan found a dry period of 89 days in 50 to 75% HF crossbred cows which are very close to the present findings of 50%, 62.5% and 75% HF crossbred cows. **I**t was found that the effect of genotype, environment, G x E interaction were highly significant ($P<0.001$). Early parity cows (Table 1) showed shorter dry period (90 days) than the later (6+) parity cows (106 days). The highest dry period was found at parity six+ (106 days) and lowest dry period found at first parity (90 days) as shown in Table 2. The dry period was slightly variable with the increase in parity but statistically non-significant ($P>0.05$) and could be considered as aging effect.

It is generally believed that milk yield is affected by the preceding days of dry period. Considering the biological limits and economics of the operation involved, many workers in tropical and sub-tropical regions have set a range of 40-60 days as an optimum dry period for the perspective of cow's health and farmer’s profit. This also indicates that length of dry period is largely influenced by environment. Pointed out that some managers of the farm are inclined to dry off their animals earlier to improve the herd average, while other managers go on milking the cows as long as it is affordable. Emphasis should be given to select the animals on the basis of their production level and higher persistency of lactation, which should automatically lead to a decrease in dry period.

3.4. Calving Interval (CI)

In the present study, overall calving interval of HF crossbred cows was 403.37± 6.27 days .. In the present study, 50%, 62.5%, and 75% HF crossbred cows had CI of 378.13± 8.63, 394.17± 8.73 and 437.80±10.53 days respectively. On the other hand, Majid, et al. [2] reported calving intervals of 484±11.50, 514±21.63 and 515±28.28 days, respectively in 50% Friesian (F_1), 50% Friesian (F_2) and 75% Friesian (F_2) crossbred cows, Qureshi, et al. [10] in Pakistan found a slightly higher calving interval of 390 days in 50% HF crossbred cows than the present study. The effect of parity of cows on CI was non-significant ($P>0.05$) though 2nd parity cows had lowest CI with highest in parity 6+. This might be due to the practice of selective culling against slow breeders in later parities and the additional nutritional requirements of cows in early lactation life for growth.

3.5. Number of Services per Conception (NSC)

The overall service per conception of HF crossbred cows found was 1.52±0.05 in the present study. Al-Amin and Nahar [3] and Hoque, et al. [11] found 1.50±0.1, 1.35±0.26 which is nearly similar to our study. Analysis of variance shows that the number of services per conception is strongly related to the effect of the environment and its interaction with genotype ($p < 0.001$) than the effect of genotype alone ($p < 0.05$).

The variations of services per conception from different workers for same as well as different breeds might be due to different genetic make-up, nutritional status of cattle, management, and failure in proper heat detection or efficiency of inseminator.

3.6. Conception Rate (CR)

Conception rate is an important factor affecting herd reproduction efficiency. The overall conception rate of present was 76±1.78. The conception rate depends on different genetic and non-genetic factors as cow herself, semen quality, time of insemination, proper heat detection, efficiency of inseminator, proper feeding management etc. Highest conception rate was found in this study in third parity (80%)but no significant difference compared with other parities ($p > 0.05$).While Islam, et al. [7] reported significant effect ($P < 0.05$) of conception rate on parity. It is evident by many workers that age has significant cause of variation for conception rate and is negatively associated with reproductive performance. But in this study age/parity did not show any significant variation on conception rate that could be due to habitual delayed age at puberty in tropical cross cattle that may lead to have retained reproductive efficiency up to senility begins.

3.7. 180-Day Milk Yield (180DMY)

The overall milk yield of 180 days was 1463± 44kg (Table 2). Al-Amin and Nahar [3] found the highest TMY observed in 50% HF was 1837±18 kg and L× SL was 1362±13 kg. Reported that TMY in L×F (1765 kg). In this study, 180-day milk yield (180DMY) of 50% HF, 62.5% and 75% HF crossbred were 1500.33 ±76.46, 1549.79±73.86, and 1339.00±75.83 kg respectively. The effect of genotype was non-significant but 62.5% crossbred had higher milk yield than 75% HF crossbred cows. In this study environmental effect was highly significant ($P < 0.001$). In intervention group, 180DMYwas 1774.02±70.46 kg and non- intervention group it was 1152.06±51.13 kg. The G×E interaction was non-significant ($P > 0.05$). The variations of lactation milk yield within and between breeds among different authors might obviously be due to animals of different origin, genetic make-up, lactation duration, feeding, management, environments, sample size etc.

3.8. Daily Milk Yield (DMY)

In this study, overall average daily milk yield was 8.11±0.24 kg and in 50% HF, 62.5% HF and 75% HF crossbred genotypes it was 8.32±0.42, 8.60±0.41 and 7.42±0.42 kg respectively. The intervention and non-intervention group had yields of 9.85±0.39 and 6.38±0.28.respectively

(Table 2) which was statistically significantly different (P<0.001). Molee, et al. [12] in Thailand reported a daily milk yield of 11.84 kg in < 80% HF crossbred cows which slightly higher than present study results. Mohamed-Khair, et al. [13] reported daily milk yield of 50%, 62.5% and 75% HF crossbred cows were 9.77±0.30, 9.57±0.35 and 10.17±0.49 liters, respectively; which are almost similar with intervention group (9.85±0.39) of the present study. The effect of G x E was non-significant (P>0.05).

Table-2. Least squares means (±SE) of milk yield traits as affected by genotype and environment

Factors	Milk production traits	
	180 day milk yield (kg)	Daily milk yield (kg)
Genotype	NS	NS
50% HF	1500.33±76.46 (74)	8.32±0.42 (74)
62.5% HF	1549.79±73.86 (78)	8.60±0.41 (78)
75% HF	1339.00±75.83 (67)	7.42±0.42 (67)
Environment	***	***
Intervention	1774.02^{a}±70.46 (75)	9.85^{a}±0.39 (75)
Non-intervention	1152.06^{b}±51.13 (144)	6.38^{b}±0.28 (144)
G×E	NS	NS
Overall mean	1463.04±43.53 (219)	8.11±0.24 (219)

NS-Non-significant (P<0.05); ***-Significant (P<0.001); Figures in the parenthesis indicate the number of observation; Means with uncommon superscripts in the same column differed significantly (P<0.05); CV-co-efficient of variation; HF-Holstein-Friesian; G×E-Interaction between genotype and environment

4. CONCLUSION

The specific trait leads to the need for additional research to determine the effect of genotype by environment interaction. Inventive estimates of genotype by environment interactions to recommend appropriate crossbred cattle genotype to help Bangladeshi farmer for higher milk yield in the peri-urban area The present study indicates that the performance of 50% HF crossbred genotype are acceptable for the reproduction and 50% and 62.5% HF crossbred cows are acceptable for production under smallholder peri-urban dairying system in Bangladesh . The study concludes that the performance of available selected dairy genotypes crossbreds were favorable for the farmers Finally, herd book based farmer's participatory system might be one of the best ways to support small holder dairying in Bangladesh.

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