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Estimation of genetic parameters on the performance of Brahama graded calves

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ABSTRACT

Present study was carried out to estimate genetic and phenotypic parameters for early growth traits of Brahma graded calves. Data were collected from the records of selected areas of Bangladesh under the collaboration of ongoing projects of the Department of Livestock Services (DLS) and the Department of Animal Breeding and Genetics of Bangladesh Agricultural University. The data consisted of different pedigree information of 233 graded calves. The variances and covariance were estimated using VCE (Variance Component Estimation) software. The records on crossbred calves were birth weight, average daily gain and yearling weight with value of. 21.394 kg, 460.337 g and 187.195 kg, respectively. The range of birth weight of calves was 12.01 to 44.5 kg. The estimated additive genetic variance for birth weight, average daily gain and yearling weight were 8.53 kg2, 18.99 g2 and 5173.64 kg2, respectively. The estimated phenotypic variance for birth weight, average daily gain and yearling weight were 25.38 kg2, 56.82 g2 and 6008.37 kg2, respectively. The heritability estimates of birth weight, average daily gain and yearling weight were 0.34, 0.33 and 0.86, respectively. Estimated genetic correlation of yearling weight and average daily gain with birth weight were found to be 0.87 and 0.82, respectively. Genetic correlation of average daily gain with yearling weight was 0.76. Estimated phenotypic correlation of yearling weight and average daily gain with birth weight were found to be 0.74 and 0.71, respectively. Phenotypic correlation of average daily gain with yearling weight was 0.61. Estimates of phenotypic and genetic correlations were high (rp = 0.60 to 0.74; rg = 0.75-0.87). Positive genetic correlation and phenotypic correlation were observed for all the traits. The results indicated that variation exists in the studied traits, which can be exploited in selection programs. The estimated heritability for growth traits of Brahma graded calves indicated that it can be successfully used in bull selection programmers for the improvement of indigenous cattle in Bangladesh.

Introduction

The characteristics of the Brahman breed, which distinguishes it from the others, are the hump over the shoulder, long legs, large pendulous ears, abundance of loose folds of skin under the neck and smooth hair coat (Peacock et al., 1999). With reference to growth rate and maturation, Vargas et al. (1999) found that Brahma heifers reach puberty at an average age of 633 ± 6.7 days. The Brahma breed has traits that are useful for a wide range of production capability, such as adaptability in harsh areas and combining ability with other breeds. Improvement of live performance traits is an increasingly important breeding goal in beef cattle and other livestock production ability (Peters et al., 1998). Therefore, knowledge on the genetic parameters of traits in the selection programme is needed, to optimize breeding programmes and to predict genetic response to selection. Individual performance and pedigree information would provide the beef industry with reliable estimates of genetic parameters and would result in improved genetic evaluation programmes (Meyer, 1992 and Ferreira et al., 1999). The manner in which this genetic improvement is to be achieved can be described using a selection objective (Van der Westhuizen and Matjuda, 1999).

Heritabilities and genetic correlations are essential population parameters required in livestock breeding researches as well as in the design and application of practical animal breeding programmes. Genetic parameters are unique to the population in which they were estimated and they may change over time due to selection and management decisions (Koots et al., 1994; Lobo et al., 2000). According to Liu et al. (1991) in practice it would be useful to know the empirical relationships (genetic, phenotypic and environmental correlations) of these measures of growth rate in the population. Therefore, genetic correlations simply describing the existing relationships among measured traits for a population are also needed.

Growth rate is an important trait in meat animals (Liu et al., 1991). High growth rates and high weaning weights contribute to the efficiency of beef production. That efficiency depends on these basic elements such as maternal performance, reproduction and the growth of the young after weaning (Dickerson, 1970; Meyer et al., 1992;

Schoeman and Jordaan, 1999; Van der Westhuizen and Matjuda, 1999). High birth weights are also associated with high mature cow weights and this might lead to higher cow maintenance. Another factor to be considered when selecting for growth traits, is the relatively large negative genetic correlation between direct growth and maternal genetic effects. Other non-genetic factors are proposed to cause the negative correlation between maternal genetic effect and direct individual growth (Robinson, 1996b; Lee and Pollak, 1997; Meyer, 1997).

However, Peacock et al. (1999) showed that Brahma cows compared favourably with the Angus and Charolais in terms of birth rate (89.9%), survival rate (90.8%) and weaning rate (81.6%). Vargas et al. (1999) also reported an average calving rate of 92.1%, 58%, and 83.9% in the first, second and third parity of Brahman cows in Florida (USA). The corresponding survival rates were 80.7%, 83.4% and 47.9%, whereas the weaning rate was 65.2%, 54.3% and 72%, respectively. With this in mind, they concluded that selection based on production traits could increase total herd efficiency in a selection programme.

The goal of animal breeder is to achieve rapid genetic improvement, for which accurate prediction of breeding value is the most crucial factor. The breeder can rank the animals and cull those with the poorest evaluations, while selecting those with the best as replacements. Accurate evaluation requires proper application of heritability, genetic and phenotypic relationships among records of the animal and its relatives. Estimates of heritabilities and genetic correlations are essential genetic parameters required in animal breeding research and in the design and application of practical breeding programmes (Koots et al., 1994). Considering the above facts and circumstances the present study was undertaken to evaluate the growth traits of the Brahman graded calves and to estimate the genetic parameters of growth traits.

MATERIALS AND METHODS

Source of data

Experimental data were collected from the record sheets maintained at the Central Cattle Breeding Station and Dairy Farm (CCBDF), Savar, Dhaka and the book maintained for recording of body weight on individual animal at the upazila livestock office of the respective selected areas.

Traits

Economically important traits of Brahman graded calves relating to growth performances were taken into consideration to estimate mean, standard deviation (SD), heritability, genetic and phenotypic correlation. Traits included for this study were birth weight (BWT), average daily gain (ADG) and yearling weight (YWT). The data on BWT was recorded within 12 hours of birth in kilogram (kg) on 233 calves. Amount of weight gained per day per animal during 1 year of age was considered as ADG. The YWT was taken at 365 days of age on 210 calves in kilogram (kg) was considered as YWT.

Population size and data structure

A total of 233 graded calves were obtained from the study area of which 127 calves were males and 106 were females. For primary information, the name of the selected areas and the population size are given in Table 1.

Table 1. Selected areas of the project with graded population.

Area	No. of Calves	Area	No. of Calves
CCBDF, Savar	63	Tungipara, Gopalganj	08
Chirirbandor, Dinajpur	20	Kustia	10
Pirganj, Rangpur	29	Jessore	08
Shariakandi, Bogra	08	Moulovibazar	12
Belkuchi, Sirajganj	09	Charghat, Rajshahi	08
Chouhali, Sirajganj	14	Thakurgaon	44

In the project areas, highest number of the calves (63) is found from Central Cattle Breeding Station and Dairy Farm (CCBDF), Savar, Dhaka. The second highest number of the calves (44) found from Thakugaon. A number of the calves in Chiribandor, Pirganj, Shariakandi, Belkuchi, Chouhali, Tungipara, Kustia, Jessore, Moulovibazar and Charghat were 20, 29, 08, 09, 14, 08, 10, 08, 12 and 08, respectively. Appointed animal recorders were worked to keep information on calves born, e.g. birth weight, yearling weight and average daily gain.

Experimental animals

The imported bull through the project was used to inseminate indigenous cows to obtain graded progeny in different areas of Bangladesh. With the collaboration of DLS, Department of Animal Breeding and Genetics of Bangladesh Agricultural University (BAU) has started a sub-project entitled “Innovative research on livestock and poultry to increase milk, meat and egg production in Bangladesh” funded by Higher Education Quality Enhancement Programme (HEQEP) of University grants commission (UGC). In the present research under the above sub-project, 4 (four) Brahman crossbred (graded) breeding bulls have been selected from those graded population with the help of DLS. Bulls have been selected on the basis of average daily gain, physical appearance and libido.

Analysis of Data

Mean and standard deviation for the traits studied were estimated using SAS computer package program (Version 7, USA). Variance and covariance components of the growth traits were estimated using Restricted Maximum Likelihood approach by VCE (Variance Component Estimation) software (Groneneveld, 1998). Genetic and phenotypic co-relationship between different traits is also tested in this programme. For REML analysis animal model was used keeping season of birth as fixed effect. However, data were analysed using two – trait animal model.

The used model was.-
$Y = Xb + Za + e$
Where,
Y = Vector of observation
X, Z, and W = Known incidence matrices that associate with levels of b, a, and c with Y
b = Unknown vector of fixed effects (season of birth)
a = Unknown vector of fixed effect (sex of calves)
c = Unknown vector of permanent environmental effect
e = Vector of residual effects
Estimation of Heritability
Heritability (h^2) =

$$\frac{\delta^2 A}{\delta^2 p} = \frac{\delta^2 A}{\delta^2 G+\delta^2 E} = \frac{\delta^2 A}{\delta^2 A+\delta^2 D+\delta^2 I+\delta^2 E}$$

Where,

$\delta^2{}_G$ = Genotypic variance
$\delta^2{}_A$ = Additive genetic variance
$\delta^2{}_D$ = Variance due to dominance gene action
$\delta^2{}_I$ = Variance due to epistatic gene action
$\delta^2{}_E$ = Variance due to environmental variation
$\delta^2{}_p$ = Total phenotypic variance

Estimation of Genetic Correlation

Genetic correlation (r_g) = $\frac{CovXY}{\sqrt{\delta^2(x).\delta^2(y)}}$

Where,
$\delta^2{}_x$ = Variance component of trait X
$\delta^2{}_y$ = Variance component of trait Y
CoV_{xy} = Covariance component of trait X and Y

Results and Discussion

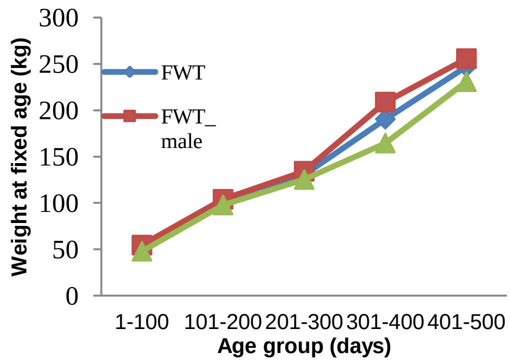
Mean values along with standard deviations (SD) of birth weight, average daily gain and yearling weight of Brahman graded calves is shown in Table 2. Mean values for birth weight, average daily gain and yearling weight were 21.394 kg, 460.337 g and 187.195 kg, respectively. Standard deviations of these traits were 4.978 kg, 239.877 g/d and 93.377 kg, respectively.

Table 2: Mean values along with standard deviations of growth traits of Brahma graded calves.

	BWT	ADG	YWT
n	233	210	210
Mean	21.394 kg	460.337g	187.195 kg
SD	4.978	239.877	93.377

n, number of observation; SD, standard deviation; BWT, birth weight; YWT, yearling weight; ADG, average daily gain.

Figure 1 indicates the weight at fixed age (FWT) of Brahman graded calves. The mean weight at fixed age increased as days increased. Mostert et al. (1998) reported mean for birth weight 32.5 kg as well as the means for yearling weight 270.0 kg and weight at fixed age 353.1 kg were slightly higher than the current study. Higher mean of yearling weight obtained might be due to the age range classification of calves used in this study.



FWT, weight at fixed age; FWT_male, weight at fixed age of male; FWT_female, weight at fixed age of female.

Figure 1. Growth curve of Brahma graded calves.

Figure 1 also indicates that male had slightly higher weight at fixed age than female at different age group. This difference was prominent when they attain 300-400 days of age. Age group of 1-100 days, of 101-200 days and of 201-300 days showed that weight at fixed age for both male and female calves increased comparatively at same rate. But weight at fixed age for males increased tremendously at age group of 301-400 days than females. But male had lower increasing level at age group of 401-500 days than age group 301-400 days.

The weights of Brahman graded calves were slightly lower than result reported by Plasse et al. 2002 was 28.2 kg, 157.5 kg and 292.4 kg for birth weight, yearling weight and weight at fixed age, respectively in Brahman cattle in Venezuela. Magnabosco et al. (2002) found a comparatively low mean weight of 320.7 kg for Brahman cattle in Mexico at an average age of 17 months.

The mean for average daily gain was 460.337 g in the present study. This mean was lower than the means reported by Crockett et al. (1979). Paschal et al. (1995) reported a higher average daily gain of 1.60 kg. Riley et al. (2002) reported a mean average daily gain of 1.4 kg for recording of 1,491 animals. The lower value of average daily gain was probably due to effect of poor management system.

High growth rate contributes to the efficiency of beef production. High birth weight has a positive and negative effect on beef production. Moreover, it is shown that high birth weights are related with dystocia, which can cause calf losses, reduced calf performance reduced cow fertility. Roberson et al. (1986) stated that extreme birth weights could in turn cause production problems and economic losses for beef producer. On the other hand, birth weight is also associated with high mature cow weights and this might lead to higher cow maintenance. In South Africa Schoeman (1996) showed that body weight at any stage as well as weight gain are strongly related to breed mature size as estimated by the dam weight at weaning when characterizing beef cattle breeds by virtue of their performance in the National Beef Cattle Improvement Scheme.

Co variance components and genetic parameters

The estimated variance components and heritability using two-trait analysis for birth weight, average daily gain and yearling weight are presented in Tables 3. A high heritability estimate 0.86 was found for yearling weight, while moderate low h^2 of 0.33 for average daily gain was almost similar to 0.34 for birth weight.

Table 3. Estimates of genetic parameters on growth traits of Brahma graded calves.

Parameters	Birth weight (BWT)	Average daily gain (ADG)	Yearling weight (YWT)
δ^2_A	8.53	18.99	5173.64
δ^2_P	25.38	56.82	6008.37
h^2±SE	0.34±0.21	0.33±0.12	0.86±0.32

δ^2_A means additive genetic variance; δ^2_P means phenotypic variance; h^2 means heritability and SE means standard error.

For body weight, additive genetic variance, phenotypic variance and heritability of Brahma cross calves were 8.53, 25.38 and 0.34±0.21, respectively. Heritability estimate for birth weight was 0.34, which is moderately higher than the estimates of 0.24 for Boran (*Bos indicus*) cattle in Ethiopia reported by Haile –Mariam and Kassa-Mersha (1995) and of 0.22 for Nellore (*Bos indicus*) cattle in Brazil observed by Eler et al. (1995). The estimate of heritability in this study was also higher the weighed mean estimate of 0.31 for several different beef breeds (Koots et al., 1994). It was similar to the heritability of 0.33 for *Bos taurus* and *Bos taurus* x *Bos indicus* crosses reported by Meyer (1992) and of 0.33 for Brahman cattle in Venezuela obtained by Plasse et al. 2002.

Estimated heritability of birth weight of 0.34±0.21 of present study was lower than the values obtained by Ahunu et al. (1997) and Padua and Silva (1996) obtained 0.45 and 0.46, respectively. Deb (2004) presented the estimated heritabilities for Local, Friesian x Local and Jersey x Local cattle of 0.365, 0.495 and 0.489, respectively which were higher than the result from present study.

A number of scientists (Martinez et al., 2006, Akbulut et al., 2002, Mandal and Saclideva 1999, Bittencourt et al., 1998, Magana and Segura 1998, Gutierrez et al., 1997, Padua and Silva 1996, Rege et al., 1992, Reynolds et al., 1991, Wakhungu et al., 1991 and Verma and Lohar 1985) worked on birth weight of different breeds in various corner of the world and exposed their estimated h2 values ranging from 0.21 to 0.49. The estimated value of the experiment was within this range.

For yearling weight, the additive genetic variance, phenotypic variance and heritability of the calves were 5173.64, 6008.37 and 0.86±0.32, respectively. The estimated heritability of 0.86 was higher than the estimates value reported by Eler et al. (1995). The higher than present values were also reported by Haile-Mariam and Kassa-Mersha (1995) and Diop and Van Vleck (1998). Haile- Marian and Kassa-Mersha (1995) suggested the estimated heritability of 0.24 for Boran was tremendously lower than the present value.

For average daily gain, additive genetic variance, phenotypic variance and heritability of Brahman graded calves were 18.99, 56.82 and 0.33±0.12, respectively. The estimate of heritability of 0.33±0.12 for average daily gain was lower than an estimate of 0.36±0.09 for purebred and composite populations of cattle reported by Gregory et al. (1995). But present estimate value of heritability for average daily gain was precisely similar to the estimate of 0.33±0.14 as reported by Smith et al. (2007). The magnitude of heritability estimates for the growth traits increased from birth weight (0.34) to yearling weight (0.86) and eventually fluctuation continued in the next traits also (Table 2). Diop and Van vlech (1998) also exposed the parallel result to the present study and he found the magnitude of heritability estimates for the growth traits increased from birth weight (0.08) to yearling weight (0.18).

Low to intermediate estimates of heritability indicated genetic changes in animal weight can be accomplished by selection. The results indicated no antagonistic relationships among animals at birth weight, yearling and average daily gain. Heritability of birth weight and average daily gain were medium. But heritability of yearling weight was high (0.86). It may be due to small number of observation.

Medium heritability values of birth weight suggested that the selection on the basis of individual performance will be effective in achieving increased gain in birth weight and therefore, should be paid more emphasis in cattle improvement programme.

Genetic and Phenotypic Correlations

Genotypic and phenotypic correlations among the different traits such as birth weight, yearling weight and average daily gain are given in Table 4.

Table 4. Genetic and phenotypic correlation between different growth traits of Brahma crosses calves.

Traits	Birth weight (BWT)	Yearling weight (YWT)	Average daily gain (ADG)
BWT		0.87±0.29	0.82±0.27
YWT	0.74		0.76±0.31
ADG	0.71	0.61	

Estimated genetic correlation of yearling weight and average daily gain with birth weight were found to be 0.87 and 0.82, respectively. Genetic correlation of average daily gain with yearling weight was 0.76. Phenotypic correlation of yearling weight and average daily gain with birth weight were found to be 0.74 and 0.71, respectively. Phenotypic correlation of average daily gain with yearling weight was 0.61. Most genetic correlations were between 0.75 and 0.87.

The genetic correlation between birth weight and yearling weight was relatively high (0.87 ± 0.29) than the estimate of 0.79 for Zebu graded reported by Meyer (1994). But it was extremely higher than the estimate of 0.52 for Brahma as reported by Mostert et al. (1998). Most of the phenotypic correlations were relatively higher (0.60 to 0.87) than the previous workers obtained for Brahma cattle. Birth weight was positively correlated with yearling weight (0.74) and average daily gain (0.71).

The genetic correlation between birth weight and yearling weight was relatively so high (0.87) than the estimate of 0.45 for Boran cattle as reported by Haile-Mariam and Kassa-Mersha, (1995), whereas phenotypic correlation (0.74) was high on the basis of the estimate found in this study. Eler et al. (1995) also found a lower genetic correlation (0.16) and high maternal genetic correlation (0.45) with almost equal residual (0.12) and low phenotypic correlation in a multivariate analysis between birth weight and yearling weight.

From two trait analysis the genetic correlation (rG) between birth weight and yearling weight was higher (0.87). This phenomenon might be due to the higher growth rate from birth up to yearling age. This high value explained the models for estimating genetic parameters which were well adjusted to the data set. Horimoto et al. (2004) also had the similar result using 33,567 records of a different Nellore data.

From Table 4, the genetic correlation between birth weight and average daily gain was the higher (0.82) among the traits considered. Mayer (1994) reported genetic correlation of Angus cattle between birth weight and average daily gain highest (0.81) among the different traits as birth weight, average daily gain, yearling weight and weight at fixed age.

Genetic trends were positive for all traits and estimates of phenotypic and genetic correlation between growth traits were high, and in most cases; values were greater than the values from previous researchers. This might be due to closeness of animals mating to each other. Selection would be effective for either weight and would produce important correlated responses for all measurements of growth.

Findings of the present study indicated that genetic and phenotypic variations exist in growth traits which can be exploited in selection program. High heretabilities of these traits were also estimated. Strong genetic and phenotypic correlation among traits studied also indicated that selection for one trait will improve simultaneously other trait.

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