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# Growth Performance of Red Chittagong Cattle Based on Phenotypic and Genetic Parameters

**Hossain SMJ[1], Bhuiyan AKFH[2], Afroz MF[1]*, Kabir MA[1], Miraz MFH[1] and Habib M[3]**

[1]*Biotechnology Division, Bangladesh Livestock Research Institute, Bangladesh*
[2]*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Bangladesh*
[3]*Fodder Development Project, Bangladesh Livestock Research Institute, Bangladesh*

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***Corresponding author**

Afroz MF, MS in Animal Breeding and Genetics, Senior Scientific Officer, Biotechnology Division, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh,
Tel: 01717691889;
Email: famukta@yahoo.com



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**Abstract**

The study was conducted to investigate the phenotypic and genetic parameters of growth traits of Red Chittagong Cattle (RCC). The least squares mean of Birth Weight (BW) of RCC calves was 13.2±0.39 kg. Sex had significant effect on BW of calves but season, year and sire did not have any effect on the trait. The overall mean weaning weight (WW) of RCC calves was 48.3±1.86 kg having no significant influence for any of those factors. The overall mean Pre-Weaning Daily Weight Gain (WDG) of RCC calves was 166.5±2.47 g/day having only significant effect for year of birth, where early year born calves seemed to gain higher weight than that of later born calves. The heritability of growth traits was medium to high ranging from 0.62±0.08 to 0.91±0.04. The phenotypic and genetic correlations of BW with WW and WDG were 0.32±0.01 and 0.34±0.06 and 0.09±0.01 and 0.22±0.07, respectively. Birth weight had highly significant ($p<0.01$) phenotypic correlations with WW, but not with WDG. The phenotypic and genetic correlations between WW and WDG were 0.61±0.1 and 0.62±0.03, respectively. The WW had highly significant ($p<0.01$) and positive phenotypic correlation with WDG. Considering the performance potential of RCC both in in-situ and ex-situ through community farmers' participatory approaches there may be chance of improvement of genetic potentiality of RCC as indicated by their phenotypic variations and genetic parameters.

## Introduction

Among all other indigenous cattle genetic resources available in Bangladesh, Red Chittagong Cattle (RCC) is one of the promising variety of cattle discovered in 1990s had made themselves attractive for their distinct phenotypic characteristics and adaptable capabilities to the hot humid climatic environment and excellent reproductive efficiency. Revenue from the sale proceeds of an animal industry usually depends on animal's weight because meat production is the ultimate goal for this industry [1]. However, in dairy industry, birth weight of dairy heifer calves within a genetic group is an important indication of their future performance. It is also an important trait because calves with heavier weight at birth have higher post-natal survival. In mammals, growth is influenced by the genes of the individual, environment provided by the dam, and other environmental effects [2]. Including environmental factors and dam's effect in an appropriate analytical model can help to estimate variance components accurately.

Researches on this type of indigenous cattle regarding body weight and growth are very limited in our country as there is no recording system developed in our conventional rearing system. Recently, government and some other non-government organizations are giving some intervention on such potential indigenous cattle genetic resources for their sustainable utilization and conservation both in in-situ and ex-situ to adverse socio-economic and climatic condition of Bangladesh. Thus, a comprehensive study on growth performance of indigenous cattle is immensely needed for improving the breeding efficiency and formulating breeding strategy for their further improvement. Considering the above circumstances, the present study was conducted to know the phenotypic and genetic evaluation of RCC calves from their early life up to weaning period maintained under on-station and rural household's condition of Bangladesh.

## Materials and Methods

### Location, Topography and climate of the study area

This study was conducted taking data from two locations; in-situ and ex-situ. The data in in-situ were collected from RCC herd maintained at five upazilas in Chittagong district namely: Anwara, Chandanaish, Potiya, Raojan and Satkania and data in ex-situ were collected from the RCC nucleus herd maintained at Research Farm of Bangladesh Livestock Research Institute (BLRI), Savar, and Dhaka. Red Chittagong Cattle (RCC) are primarily found in the Chittagong district of Bangladesh

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belongs to agro-ecological zone-23 (AEZ-23) of Bangladesh, situated at the south east part of the country, bordered with a long coastal belt and stands on its western side with scenic blending of hills, valleys and coastal plain. The climate of the region is tropical in nature in where lowest and highest temperature varied from 14°C in winter to 34°C in summer, around 85% humidity from September through December and around 72% from September through February with an annual rainfall of 1900 millimeters.

The ex-situ RCC herd was maintained at the Research Farm of BLRI in Savar located at a distance of about 28 km to the northwest of Dhaka city belongs to AEZ-28 of Bangladesh which lies between 23.8583° North latitude to 90.2667° East longitude having a monsoonal season with an average annual temperature of 25°C (71°F) varied between 18°C (64.4°F) in January and 32°C (71°F) in May. Approximately 87% of the annual average rainfall of 2,123 millimeters (83.5 inch) occurs between May and October.

### Feeding and management

Under ex-situ conservation the animals were intensively managed in research farm of BLRI. Stall feeding was the main feature of feeding through limited grazing from 10 a.m. to 12 noon daily. They were fed two times at 7 to 8 a.m. and 3 to 4 p.m. Concentrate supplied was 1% of the body weight of the animals. Silage and green grasses were supplied ad lib. FMD vaccines applied two times a year with interval of six months, Anthrax and BQ vaccines were applied as per method prescribed by Department of Livestock Services. Deworming was done at a regular interval. All the cows and heifers were bred by RCC bulls. In the in situ herd animals were reared mostly extensively in day time through grazing. Very little amount of concentrates was supplied to the animals. Vaccination and deworming were applied seldom.

### Animals and data

The animal selection program was conducted with close linkage with BLRI and Central Artificial Insemination Laboratory (CAIL), Savar under Central Cattle Breeding and Dairy Farm (CCBDF), Savar, Dhaka. Body weight and growth performances of RCC both in in-situ and ex-situ were studied. The data including birth and weaning weight and pre-weaning growth of calves were taken using a weighing balance.

### Statistical model and data analyses

Calves were arranged in contemporary groups based on herd-year-season, sex and parity. Initially, the General Linear Model (GLM) procedure of SPSS 16 was used to adjust all fixed effects as well as to test all possible linear models. Least Significance Difference (LSD) [3] and Duncan's Multiple Range Test (DMRT) by [4] were used for mean comparisons.

The following generalized linear model was used in SPSS:

Yijklmn = μ + Hi + Sj +Nk + Rl + Fm + e ijklm

Where, Yijklmn = Dependent variables (BWT, WWT, WDG)

μ = Overall population mean for any of the said trait;

Hi = Effect of ith herd (where i = Site-1, Site-2, Site-3, Site 4 and Site-5 for in-situ and Site-6 for ex-situ),

Sj = Effect of jth sex (where j = male and female),

Nk = Effect of kth season of birth (where k = summer, rainy and winter),

Rl = Effect of lth year of birth (where l = 2008, 2009,.................2012),

Fm = Effect of mth sire of calf (where m = 1-10), and

e ijklm = Random residual error associated with Yijklm observation

### Estimation of genetic parameters

For genetic analyses, (co)variance components of each trait were estimated applying Residual Maximum Likelihood (REML) approach by VCE 4.2.5 computer package [5]. For REML analysis, animal model was used considering herd-year-season, sex and parity as fixed effects. The general animal model was of the form:

Y = Xb + Za + WC + e

Where, Y = Vector of observations

X, Z, and W = Known incidence matrices associated with levels of b, a and c with Y.

b = Unknown vector of fixed effects (i.e. sex, herd, year, season, parity)

a = Unknown vector of breeding value

c = Unknown vector of permanent environmental effects

e = Vector of residual effect

The analyses covered estimation of (co)variance components and genetic parameters which included heritability and genetic correlation between traits. For estimating variance components and genetic correlations between paired traits, multi-trait animal model was used by VCE 4.2.5 [5] with REML method. Phenotypic correlations with bi-variate analyses among growth traits were estimated by Pearson's product moment correlation using SPSS 16.0.

## Results and Discussion

### Birth weight of calves (BW)

The overall birth weight of RCC calves found in this study was 13.2±0.39 kg (Table 1) which closely agrees with the results of 10.8±0.67 and 12.39±2.50 kg, respectively for nondescript deshi cattle in their studies [6,7]. Habib [8], Habib et al., [9], Alam et al., [10] and Rabeya et al., [8-11] reported average birth weight of RCC calves in different herds as 15.85±0.38, 14.89±0.22, 14.89±0.25 and 15.00±0.59 kg, respectively which were higher than that of this study. The variations of birth weight among different works for the same genotype might be due to different herds, sample size, feeding and management systems practiced etc.

Table 1 shows that sex had significant ($p<0.01$) effect on birth weight of calves. Male calves had higher birth weight than those of female calves. The result agrees by the studies of [8,9,11] but not agrees with [12-14]. Season of birth had no significant effect ($p>0.05$) on birth weight, although calves born in winter had slightly higher birth weight than that of calves born in summer and rainy seasons. The result coincides by the earlier works of [9,11] for the same

**Table 1:** Least squares means and standard error of means of birth weight, weaning weight and growth up to weaning as affected by various factors.

| Factors[1] | Means ±SE | | |
|---|---|---|---|
| | Birth weight (kg) | Weaning weight (kg) | Weaning growth (g/d) |
| **Sex** | ** | NS | NS |
| Male | $13.9^{a}$±0.45 (60) | 48.3±2.04 (51) | 168.7±2.71 (51) |
| Female | $12.4^{b}$±0.49 (60) | 48.3±3.53 (52) | 164.3±3.35 (52) |
| Season | NS | NS | NS |
| Summer | 13.1±0.42 (56) | 47.1±1.95 (50) | $162.5^{b}$±2.58 (50) |
| Rainy | 13.1±0.62 (26) | 45.6±3.03 (22) | $161.7^{ab}$±4.01 (22) |
| Winter | 13.3±0.70 (38) | 52.1±3.24 (31) | $166.2^{a}$±4.29 (31) |
| Year | NS | NS | *** |
| 2008 | 13.4±0.83 (20) | 52.8±3.91 (19) | $186.9^{a}$±5.18 (19) |
| 2009 | 13.6±0.74 (31) | 53.0±3.46 (27) | $183.1^{a}$±4.58 (27) |
| 2010 | 11.6±0.76 (32) | 42.0±4.05 (20) | $154.9^{b}$±5.36 (20) |
| 2011 | 13.9±0.77 (25) | 45.0±3.50 (25) | $141.6^{c}$±4.64 (25) |
| 2012 | 13.3±1.15 (12) | 48.5±5.20 (12) | $150.9^{b}$±6.89 (12) |
| Sire | NS | NS | NS |
| 15 | $12.3^{ab}$±0.92 (13) | 44.0±4.36 (12) | $152.3^{b}$±5.77 (12) |
| 33 | $12.2^{ab}$±1.37 (07) | 51.1±6.28 (07) | $169.0^{a}$±8.31 (07) |
| 36 | $12.8^{ab}$±1.21 (08) | 43.9±5.51 (08) | $151.7^{b}$±7.29 (08) |
| 39 | $13.2^{ab}$±1.12 (11) | 41.1±5.35 (09) | $150.1^{b}$±7.08 (09) |
| 40 | $14.4^{ab}$±0.46 (61) | 49.2±2.19 (51) | $163.8^{bc}$±2.89 (51) |
| 72 | $13.4^{b}$±1.05 (09) | 52.9±5.74 (05) | $174.3^{bc}$±7.61 (05) |
| 81 | $14.0^{a}$±1.35 (06) | 54.2±6.05 (06) | $174.2^{bc}$±8.01 (06) |
| 94 | $13.0^{ab}$±1.28 (05) | 49.5±5.76 (05) | $172.4^{c}$±7.63 (05) |
| Minimum | 07.00 | 21.00 | 114.6 |
| Maximum | 21.00 | 81.00 | 215.4 |
| Overall mean | 13.2±0.39 (120) | 48.3±1.86 (103) | 166.5±2.47 (103) |

[1]Sex-sex of calf; Season-season of birth; Year- year of birth; Sire-sire of calf; **-significant at p<0.05; ***-significant at p<0.001; NS-non significant (p>0.05);
Least square means without a common superscript along the same column differed significantly (p<0.05);
Figures in the parenthesis indicate the number of observation.

genotype but in different places, but contradicts with [8] for RCC, [14] for N'Dama cattle in Gambia and [15] for Holstein calves in Turkey who found significant (p<0.05-p<0.01) variations of birth weight for season. Actually seasonal weight variation is related with the availability of feed.

Year of birth did not show any significant (p>0.05) variations for birth weight of calves (Table 1). This is in agreement with the earlier literatures reviewed by [9,11,13] for the same genotype while disagrees by others [8,16] who reported significant variations of birth weight among different years for crossbred calves in their studies. The variation of results reviewed by different workers might be due to different genotypes, herds, variations of feeding and management from year to year or sample size.

Sire had no significant effect (p>0.05) for birth weights of their progenies (Table 1). The previous results for this genotype in a nucleus herd studied by [8-9] found no significant variations of birth weight for sires of progeny. Although their results showing to be consistent but inconsistence with the result of [16] who reported significant (p<0.01) influence of sire on birth weight. The reason for insignificant difference of birth weight due to sire stated by [8] was due to same genetic potentiality within the same genotype or due to limited number of sires involved in the data.

## Weaning Weight (WW)

The overall mean weaning weight of RCC estimated in this study was 48.3±1.86 kg (Table 1). Although, literatures on this trait for RCC or other indigenous or local cattle are very scarce, but the result of this study is closely in the line of 46.75±3.14 kg reported by recent study of [8]. Rabeya et al., [11] worked on this trait in a nucleus herd for the same genotype and found it as 57.0±3.23 and 51.66±4.11 kg, respectively for male and female calves which are slightly higher than that of this study. In another study Dezfuli and Mashayekhi [17] worked on Iranian Najdi calves and found weaning weight as 53.67 kg for male and 48.82 kg for female with an overall mean of 49.56±13.10 kg, which is in agreement with this study.

The least squares analysis of variance showed that sex of calf had no significant (p>0.05) effect on weaning weight of calves (Table 1) which agrees well by [8,11] in their studies for the same genotype. Some other authors in different countries for different breeds [17,18,19] reported significant effect (p<0.05-p<0.001) of sex on this trait which contradicts by this study. Season of birth had no significant influence (p>0.05) on weaning weight of calves (Table 1). The result coincides with Habib [8] for the same cattle, Oliveira et al., [19] for Canchim cattle in Brazil, while not coincides with earlier works of [11,17,18], as they reported significant seasonal influence (p<0.05-p<0.001) on weaning weight in their studies. Actually, variations in temperature, precipitation and other environmental factors among seasons had little effect on the calves or on their dams at weaning. The variation of authors might be due to different genotypes, environment, sample size etc.

Table 1 shows that calves born in different years did not play significant effect (p>0.05) on their weaning weights which accords with [9] for RCC but disagrees with [17-19] as they found significant (p<0.05 to p<0.001) variations of weaning weight among different years. Sire had no significant source of variation for weaning weight of calves (Table 1). The result coincides with [8] for the same genotype, while in another study by [19] found significant effect (p<0.01) of weaning weight due to sire breed. Though, the genetic potentiality or phenotypic variations of bulls within the same breed were more or less same, so their transmittable inheritance did not influence their offspring significantly [8].

## Pre-Weaning Growth (WDG)

The overall mean pre-weaning daily weight gain of RCC calves found in this study was 166.5±2.47 g/day (Table 1). The growth rates for some tropical breeds are slower compared by temperate breeds [20]. The growth rate studies of RCC as well as local indigenous cattle in Bangladesh are very limited. However, Habib, Habib et al., Hossain and Routledge [7,8,12] estimated growth performance of RCC and local indigenous cattle which varied from 158 to190 gm daily. Habib [8] recently estimated pre-weaning growth of RCC as 157.53±15.91gm per day which is closely in the line of this study. Rabeya et al., [11] in another study showed average daily gain from birth to 180 day and birth to 365 for male and female calves of RCC to be 170.0±0.01 and 170.0±0.01gm and 170.0±0.01 and 180.0±0.01g, respectively which are also in the line of this study. Afroz et al., [21] reported slightly lower pre-weaning growth (148.5 g/d) for the same cattle in a nucleus herd.

The least squares analysis of variance showed that sex of calf had very little variation (p>0.05) for pre-weaning growth of RCC calves (Table 1). The result of this study is consonance with earlier works on RCC by [8,11]. In contrast, Krupa et al., and Oliveira et al., [18,19] reported significant effect (p<0.001- p<0.05) of sex on birth to 210 days' average daily gain in their literatures.

Season of birth had no significant influence (p>0.05) on pre-weaning growth of calves (Table 1). The result of this study is consistent with [8,11,19] for Conchim cattle in Brazil. Some studies attributed the effects of season to climatic variation and pasture availability throughout the year.

Table 1 shows that pre-weaning growth differed significantly (p<0.05) among different years which is in accordance with Oliveira et al., [19] who reported significant effect (p<0.05) of year on this trait. But the result disagrees with [8,11] as they found no significant (p<0.05) effect of year on this trait. However, the specific cause of a year effect is difficult to explain because of its confounding with climatic variation, pasture availability, paddocks, stocking rates and changes in herd management.

Sire had no significant effect (p>0.05) on pre-weaning growth of calves (Table 1). Habib [8] found significant effect (p<0.05) of sire on this trait which is controversial with this finding. Oliveira et al., [19] found significant effect (p<0.01) of pre-weaning daily weight gain due to sire breed for Canchim cattle in Brazil. The variations of findings among researchers might be due to different breed, environment, sample size etc.

## Heritability of birth weight

The heritability estimate of birth of RCC calves in this study (Table 2) is higher (0.74±0.06) and agrees with [22] who reported 0.52±0.80 and 0.64±0.56 for Friesian and Friesian×Local, respectively and Khan et al., [23] reported 0.57±0.03 for Sahiwal cattle. Although, found moderately higher heritability estimates for the same genotype but their values (ranged from 0.45 to 0.49) were comparatively lower than this study [8,10,11]. The variations of heritability estimates for birth weight from different authors might be due to different breed, environment, and range of data, methods and model used for estimation. The higher estimate of heritability suggests that selection of animals for this trait on the basis of animal's individual performance is a good indicator for greater genetic improvement.

## Heritability of weaning weight

The heritability of weaning weight in this study (Table 2) is very high (0.91±0.04) which means that genetic control on this trait is very high [24-26] reported weaning weight to be medium heritable trait ranging from 0.20 to 0.50. The heritability estimates of this trait for same genotype were reported lower values (0.22±0.08 and 0.47) by the earlier works of [8,11]. The variation of estimates between authors might be sample size or weight adjusted to 205 days. Though environment has very little influence on this trait, genetic gain for this trait will be more effective by selecting animals on their own phenotypic performance.

**Table 2:** Heritability of body weight traits of RCC calves.

| Traits | Variance matrices | | | | $h^2$± SE |
|---|---|---|---|---|---|
| | Additive genetic ($\sigma^2_A$) | Environmental ($\sigma^2_{PE}$) | Residual ($\sigma^2_E$) | Phenotypic ($\sigma^2_P$) | |
| Birth weight | 4.286 | 0.258 | 1.253 | 5.797 | 0.74±0.06 |
| Weaning weight | 108.35 | 2.525 | 8.359 | 119.234 | 0.91±0.04 |
| Pre-weaning growth | 156.153 | 25.377 | 71.512 | 253.042 | 0.62±0.08 |

*$h^2$ = heritability; SE = standard error of heritability.

**Table 3:** Genetic (below the diagonal) and phenotypic (above the diagonal) correlations among weight and growth traits.

| | Birth weight | Weaning weight | Pre-weaning growth |
|---|---|---|---|
| Birth weight | 1 | 0.32±0.01** | 0.09±0.01$^{NS}$ |
| Weaning weight | 0.34±0.06 | 1 | 0.61±0.1** |
| Pre-weaning growth | 0.22±0.07 | 0.62±0.03 | 1 |

**significant at p<0.01; NS-non significant (p>0.05).

### Heritability of pre-weaning growth

The heritability estimate of pre-weaning growth (Table 2) is moderately higher (0.62±0.08) and likely to be accurate enough for its lower standard error value. Reports on this type of cattle for this trait in our country had rarely been published, however [8,21,11] worked on this trait in another nucleus herd and found low to moderate (0.15±0.07and 0.49) values which were lower than this study. The variations of magnitude of heritability on this trait for the same genotype might be due to number of data taken for analyses among authors. The result of this study revealed the reliability of genetic improvement through selection of individual on the basis of their own phenotypic performance.

Genetic and phenotypic correlations among weight and growth traits. As can be seen in Table 3, the phenotypic correlations between pairs among traits are consistently high and significantly positive (0.32 and 0.61) except between birth weight and pre-weaning growth (0.09 and 0.22). Genetic correlations followed the same trend (0.34 and 0.62). Habib [8] in his recent study reported phenotypic and genetic correlations between birth weight with weaning weight and pre-weaning growth and between weaning weight and pre-weaning growth as 0.22** and 0.29, 0.04 and 0.12 and 0.98** and 0.98, respectively which is consistent with the nature of relationships between paired traits. The results of this study are also in agreement with other published literatures reviewed by [27-29]. In another study by Abdullah and Olutogun [29] reported phenotypic and genetic correlation of 0.58 and 0.53 for birth weight and weaning weight, 0.15 and 0.47 for birth weight and pre-weaning growth and 0.99 and 0.99 for pre-weaning growth and weaning weight, respectively for N'Dama calves in Nigeria, which partially agrees with this study. The high and positive correlations between most of the paired traits of weight and growth implies that they are all being controlled by similar genes and thus selection for any of these traits would lead simultaneous improvement for other traits.

## Conclusion

The results found in this study reveal that although body weight and growth of RCC calves are very low and slow compared to other crossbreds but comparable with other indigenous cattle in Bangladesh and some other countries. Further, the genetic improvements for these traits are also possible due to their higher estimates of heritability and correlated responses among weight and growth traits.

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