Phenotypic Performance and Response to Selection for Body Weight Traits of Black Bengal Goat (BBG) in a Community Breeding Program

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ABSTRACT: This piece of work was conducted to investigate the genetic improvement of body weight (BW) in Black Bengal goat (BBG) *in-situ* through a community based breeding program under a low input production system. Data on a total of 466 individuals from three villages; *Gangatia, Borochala* and *Pachpai* at Bhaluka upazila in Mymensingh district from 2009 to 2015 with three progressive generations were taken for this work. Two breeding strategies (BS); mating among selected superior bucks and does (denoted as BS_1) and mating existing does with selected superior bucks (denoted as BS_2) were followed for mating plan of the community breeding program. A control or test group with mating among existing bucks and does (denoted as BS_3) were also observed to compare with treatment groups. Phenotypic performance and genetic parameters for BW traits were studied. Data were analyzed by SPSS 17.0 and VCE 4.2.5. The average BW at birth, 3-month, 6-month, sexual maturity, 9-month, and 12-month were 1.42±0.03, 5.14±0.07, 8.48±0.17, 9.88±0.16, 11.75±0.16 and 15.19±0.16 kg, respectively, having significant effect for sex (p<0.05-p<0.001), generation (p<0.001) and BS (p<0.001). The heritability estimates for BW traits were medium ranging from 0.45 to 0.57. The genetic correlation (r_g) and phenotypic correlation (r_p) for BW traits were positive with low to high strengths (0.02 to 0.99 for r_g and 0.17** to 0.99** for r_p). The average realized responses due to selection in three progressive generations for BW traits varied from 0.123 to 0.480 kg per generation. It may be concluded that community based breeding program with selected superior bucks and does is very rationale under low input production system, as it improved BW in progressive generations. However, estimates of heritability and r_g indicated further scope of improvement by continuous culling of inferior does and bucks in breeding program.

KEYWORDS: Black Bengal goat, community breeding, body weight, genetic parameter, response to selection.

INTRODUCTION

Goat is one of the potential small ruminants for the rural people of Bangladesh. However, goats are said to be "poor man's cow" as they are living resort for resource of poor rural people (MacHugh and Bradley, 2001). About 83% of total goats in Bangladesh are reared by small, marginal and landless farmers, 15% by medium, 2% by large farmers with almost zero input (BBS, 2010) and their mean flock size ranges from 2-5 (Amin, 2006). Owing to small size, goats can easily be handled and managed by women and children (Acharya and Bhattacharya, 1992). Goat also displays a unique ability to adapt and maintain themselves in harsh environments, having short generation intervals with a higher rate of prolificacy, lower feed and capital requirements (Iniguez, 2004) with less space. Therefore, goat keeping has become a subsidiary source of income to smallholders as well as landless peasants in the rural community.

Among other types of available goats, Black Bengal goats (BBG) are heritage and pride of Bangladesh due to their delicious meat, prolificacy and adaptability in terms of disease resistance and reproducibility to harsh environments. Despite having numbers of superior virtues, BBG also have some limitations too. They are inferior in some economic traits such as birth weight, growth rates, milk yield, and kid survivability (Amin *et al.,* 2001; Chowdhury *et al.,* 2002; Rokonuzzaman, 2000). Dam's poor milk yield even some times which are not sufficient to feed their kids has also been identified as determinant of slow pre-weaning growth and higher kid mortality (Husain, 1993). However, another limitation is not directly due to genetics of BBG, but rather than the system of breeding, often the poorest males are used for breeding, leading to negative selection response (Amin, 2014).

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Poor productions of both milk and meat of BBGs are due to their poor genetic makeup, improper nutrition and management. The interaction of genetics and nutrition is important and nutrition does not increase the production beyond the genetic potentialities (Islam *et al.,* 2009). But research shows that there exists substantial genetic variations among individuals in the production traits of BBG, indicating scope for increasing productivity through breeding approaches (Amin, 2014). Husain (1993) also argued that BBG is a high potential for its further improvement through selective breeding as there exists large within breed variations and there are individuals with outstanding performance even under field condition. But due to small body size, meat produced by this type of goat does not make a high economic return. As BBGs are being reared primarily for meat production, BW and growth rate could be considered as the most important factors.

MATERIALS AND METHODS

Location of the study

The study was conducted at a rural community level goat flocks of three different villages; *Gangatia*, *Borochala* and *Pachpai* at Bhaluka upazila (sub-district) in Mymensingh district of Bangladesh. Bhaluka is geographically located in between 24°16′ and 24°29′ N latitude and in between 90°14′ and 90°29′ E longitudes. The study area is located at 70 km north from the capital city, Dhaka.

Ecology and climate

The ecology of three villages of Bhaluka is more or less similar having temperature ranges from 12^0C (winter) to 33^0C (summer), and the annual rainfall averages 2147mm during the study period. High lands were available which were reddish in color, some forests present in *Pachpai* village. Grazing lands were available in *Gangatia*, *Borochala* and *Pachpai* village for the goat.

Selection of parents

Superior bucks and does were selected to establish foundation flocks in three village communities. The superior bucks were selected from Bangladesh Livestock Research Institute (BLRI), Department of livestock Services (DLS) and also from the existing village flocks based on physical appearance and BW, taking history from the goat owners. During selection of bucks, BW at 6-month ≥ 8 kg, good body conformation, dams yielded at least 250ml milk/day and kidded ≥ 2 kids in previous birth(s) were taken into consideration. Superior does were selected on the basis of adult body weight (preferably >15.0 kg), litter size (preferably multiple, ≥2 kids per kidding), daughter of a prolific dam who yielded at least 250 ml milk/day and kidded ≥2 kids in previous birth(s) and free from any kind of defects and diseases.

Husbandry practices

Traditional housing with semi-intensive management system was practiced by the BBG keeper farmers. The bucks and does were allowed to graze separately tethered by rope in naturally available pasture land and adjoining fields of the farmer's house. Goats were also provided with tree leaves, kitchen waste, leftover of family meals, table salt and cut and carry green grass *ad lib* during the day time. Goats were allowed to feed concentrate feed such as rice gruel, rice bran, broken rice, wheat bran etc. during pregnancy and lactation period @ 200 g/day. The breeding bucks were also fed whole gram @ 50 g/day in the morning. Fresh drinking water was also supplied for the goat *ad lib.* All goats under the project areas were vaccinated and de-wormed routinely against prevalent diseases and parasites.

Breeding and selection

For mating does with superior bucks, three "Buck Parks" in each village were established by the foreign aided project. Superior bucks were kept in the buck park most of the time except feeding and exercise for half an hour twice in a day. Two breeding strategy (BS) or interventions were followed as; mating among selected superior bucks and does (those supplied to the farmers by the project aid) denoted as BS_1, mating of existing does (owned by the community farmers) with selected superior bucks denoted as BS_2. A control or test group with mating among existing does and bucks, denoted as BS_3 was also observed to compare with other two intervention groups. Only superior males based on their BW were selected as sire to produce progeny in progressive generations.

Recording data

All animals were neck tagged and data sheet for each individual were maintained for recording data. The data was collected over 3 progressive generations from three flocks. There were a total of 657 individuals (101 males and 556 females) consisting 285 base populations (25 males and 260 females) and 372 progeny (76 males and 296 females) from three flocks in three progressive generations included in this study.

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Statistical model and data analysis

The study covered various economic BW traits of BBG in progressive generations. The animals were of different populations and ages as well as both parents and progeny groups. Therefore, data were sufficient un-balanceness and hierarchy in nature. So, statistical design of the study was essentially non-orthogonal factorial in nature. Descriptive statistics, analysis of variance and phenotypic correlations (Pearson's model) were performed using SPSS 17.0 (1998) software. The significance of independent variables (fixed or non-genetic factors) was tested by least-squares analyses of variance using the general linear model (GLM) procedure as given below:

$$Y_{ijklm} = \mu + S_i + G_j + B_k + F_l + e_{ijklm}$$

where, Y_{ijklm} = Record of mth kid belonging to i^{th} sex, born in j^{th} generation under k^{th} breeding strategy in l^{th} village flock.

μ = Overall population mean for BW traits;

S_i = Effect of ith sex (where i = male and female),

G_j = Effect of jth generation (where j = 1st generation, 2nd generation and 3rd generation),

B_k = Effect of kth breeding strategy (where k = BS_1, BS_2 and BS_3),

F_l = Effect of lth flock (where l = *Gangatia, Borochala and Pachpai*),

e_{ijklm} = Random residual error associated with Y_{ijkl} observation

Estimation of genetic parameters

The genetic parameters including (co)variance components, heritability and genetic correlations were estimated by using VCE 4.2.5 (Groeneveld, 1998) package with residual maximum likelihood (REML) approach. For REML analysis, animal model was used considering sex, generation, BS and flock as fixed effects. The general form of the animal model was as follows:

$Y = Xb + Za + Wc + e$

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, generation, BS and flock)

a = Unknown vector of breeding value

c = Unknown vector of permanent environmental effects

e = Vector of residual effect

Estimation of response to selection

The predicted or expected responses to selection in the progressive generations for the economic important traits were estimated using the following formula given by Falconer (1989):

$$R = i \times sd_p \times h^2$$

where, R = response to selection in the next generation for the trait;

i = selection intensity;

h^2 = heritability of the trait;

sd_p = phenotypic standard deviation of the trait.

The observed or actual response to selection was the difference of phenotypic mean between progeny of the selected parents and group of the selected parents.

RESULTS AND DISCUSSION

Body weight at different ages

The least squares means for BW at different ages in Black Bengal goat (BBG) as affected by sex, generation, breeding strategy (BS) and flock are illustrated in Table 1. Irrespective of sex, generation, BS and flock, the overall mean body weight (BW) at birth (BW0), 3-month (BW3), 6-month (BW6), sexual maturity (BWSM), 9-month (BW9) and 12-month (BW12) ages are 1.42±0.03, 5.14±0.07, 8.48±0.17, 9.88±0.16, 11.75±0.16 and 15.19±0.16 kg, respectively. Earlier, Majumder (2011) and Faruque *et al.* (2010) reported BW0 to be 1.3±0.02 and 1.28±0.11 kg for the same breed which agreed with our result. However, Haque (2014), Paul *et al.* (2011), Mia (2011) documented somewhat lower BW0 ranged from 0.98 to 1.20 kg. Mia (2011) and Paul *et al.* (2011) as obtained BW3 to be 5.12 and 5.22±0.33 kg in their studies which are in the line of our study. Somewhat lower BW3 of 4.67±0.15 and 4.88±0.22kg were also investigated by Islam (2014) and Haque (2014). Rahman (2007) and Haque (2014) found BW6 as to be 7.68 and 8.02±0.31 kg, respectively which are somewhat lower than our study. Faruque *et al.* (2010) obtained BWSM in BBG to be 9.62±0.76 and 9.34±0.62 kg for intensive and semi-intensive management system respectively. Ray *et al.* (2016) reported 9.47±0.53 kg BW at

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puberty for indigenous goat in northern Odisha which corroborates with this study. Haque (2014) and Mia (2011) in their studies obtained somewhat lower estimates of BW9 (10.56±0.41 and 10.92±2.72 kg) than our estimate. But, Paul *et al.* (2011) reported 12.05±0.47 kg BW9 in male BBG, which is slightly higher than our study. Haque (2014) and Mia (2011) in their same flock reported BW12 as 14.48±0.24 and 14.47±3.55 kg, respectively which are concomitant with this study. But, Paul *et al.* (2011) obtained BW12 to be 14.20±0.20 and 12.40±0.41kg for bucks and does which are likely lower to some extent as compare to our study. The variations of BW at different ages for the same genotype among researchers could be due to difference of population, sample size, feeding and management system or methods of analysis.

Sex significantly influenced live BW for all ages, and in all cases males were heavier than those of females. Earlier, Amin *et al.* (2001), Husain (1999), Mia (2011), Haque (2014), Paul *et al.* (2011) and Alam (2006) observed the same effect of sex on BW. Conversely, Haque (2014) and Mia (2011) found no significant differences for BW0 and BW3 between sexes. Actually, heavier weight in males compared to females is common phenomenon usually happened for most species of animals. This is due to genetic architecture of male and female controlled by specific genes.

Generation had highly significant (p<0.001) effect on BW at all ages with the trend of increasing gradually in later generations which is in general agreement with Haque (2014), Akhter *et al*. (2006) and Amin *et al*. (2001). This could be due to selection of superior parents in progressive generations.

Breeding strategy (BS) had significant role of variability BW in progressive generations. The progeny produced from BS_1 had significantly (p<0.001) higher BW at all ages than those progeny produced from BS_2 and BS_3. This was due to higher genetic potentiality of the parents that transmitted to their offspring. The published literatures regarding the effect of BS was not available to compare with our study, because community based breeding program giving intervention on selection and breeding among superior bucks and does was very rarely conducted earlier.

Flock had no significant (p>0.05) effect on BW at all ages. In general agreement, Islam (2014) did not find any variations of BW at 3 and 6-month of ages in BBG among different locations where the author worked. Conversely, Haque (2014) found significant variations of BW at 3, 6, 9 and 12-month of ages among three populations. Actually, variations for feeding and management in different populations could be the reason for differences of BW in the same genotype.

Table 1: Body weight of Black Bengal goat at different ages

Factor	Body weight (Mean±SE)					
	BW0	BW3	BW6	BWSM	BW9	BW12
Sex	***	*	***	***	**	***
Male	1.66±0.03 (101)	5.60±0.12 (099)	9.22±0.27 (099)	10.34±0.25 (073)	12.76±0.25 (099)	16.62±0.26 (099)
Female	1.17±0.02 (365)	5.01±0.08 (352)	7.74±0.14 (352)	09.41±0.12 (296)	10.74±0.13 (352)	13.76±0.13 (352)
Generation	***	***	***	***	***	***
G_0	1.30^c±0.03 (156)	4.94^c±0.13 (155)	7.76^c±0.18 (155)	09.30^c±0.16 (135)	10.72^c±0.17 (155)	13.68^c±0.17 (155)
G_1	1.38^c±0.03 (203)	4.90^c±0.10 (191)	8.09^c±0.17 (191)	09.66^c±0.14 (160)	11.28^c±0.15 (191)	14.45^c±0.15 (191)
G_2	1.43^b±0.04 (068)	5.54^b±0.17 (066)	8.76^b±0.27 (066)	10.18^b±0.22 (050)	12.18^b±0.24 (066)	15.74^b±0.25 (066)
G_3	1.55^a±0.06 (039)	6.42^a±0.26 (039)	9.32^a±0.37 (039)	10.36^a±0.35 (024)	12.82^a±0.34 (039)	16.88^a±0.35 (039)
BS	***	***	***	**	***	***
BS_1	1.56^a±0.04 (204)	5.91^a±0.09 (203)	9.80^a±0.17 (203)	10.36^a±0.17 (158)	13.64^a±0.16 (203)	17.17^a±0.16 (203)
BS_2	1.36^b±0.03 (184)	4.78^b±0.11 (180)	8.47^b±0.21 (180)	09.98^b±0.16 (160)	11.67^b±0.19 (180)	15.00^b±0.19 (180)
BS_3	1.33^c±0.06 (078)	3.76^c±0.11 (068)	7.17^c±0.36 (068)	09.28^c±0.33 (051)	9.95^c±0.33 (068)	13.41^c±0.34 (068)
Flock	NS	NS	NS	NS	NS	NS

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Gangatia	1.47^a±0.05 (154)	4.84^b±0.13 (155)	8.58^a±0.28 (155)	09.58^b±0.27 (130)	11.86^a±0.26 (155)	15.31±0.27 (155)
Borochala	1.39^b±0.03 (143)	5.03^b±0.13 (157)	8.31^b±0.15 (157)	09.98^b±0.12 (117)	11.87^a±0.13 (157)	15.00±0.14 (157)
Pachpai	1.38^b±0.05 (169)	5.59^a±0.11 (139)	8.56^a±0.33 (139)	10.07^a±0.29 (122)	11.52^b±0.31 (139)	15.26±0.31 (139)
Overall mean	1.42±0.03 (466)	5.14±0.07 (451)	8.48±0.17 (451)	9.88±0.16 (369)	11.75±0.16 (451)	15.19±0.16 (451)

BW0, BW3, BW6, BWSM, BW9 and BW12 denote body weights at birth, 3-month, 6-month; sexual maturity, 9-month and 12-month; BS denotes breeding strategy; G_0, foundation flock; G_1, generation 1; G_2, generation 2; G_3, generation 3; Figures in the parenthesis indicate number of observations; *, Significant at 5% level (p<0.05); ***, Significant at 0.1% level (p<0.001); means with uncommon superscripts within the same column differed significantly (p<0.05).

The graphical presentation of body weight changes for different ages of male and female kids are illustrated in Fig. 1 and Fig. 2, respectively. Body weight increased linearly with increasing ages. The figures also show the variations (range) of body weight within population of the same ages. However, variations of body weight within population of same ages increased gradually with advance of ages. The regression equations as shown in Fig. 1 and Fig. 2 indicate that body weight increased at a rate of 1.165 kg (R^2 = 0.91) and 1.030 kg (R^2 = 0.84) per month for male and female kids, respectively.
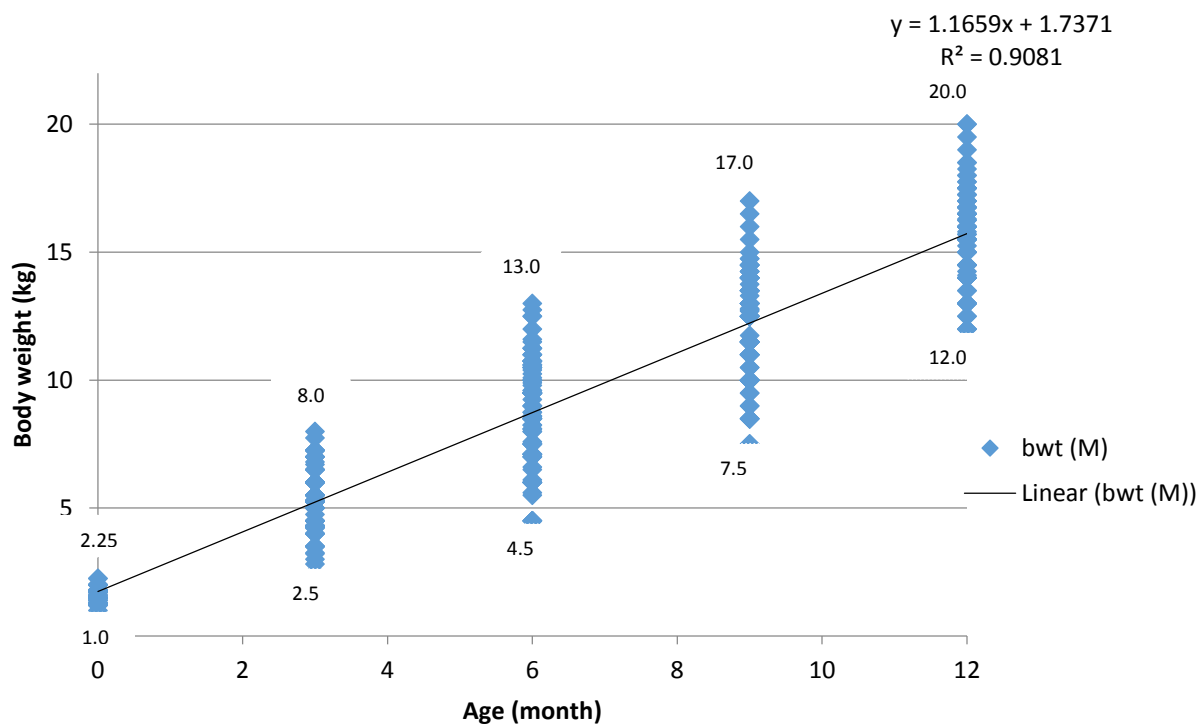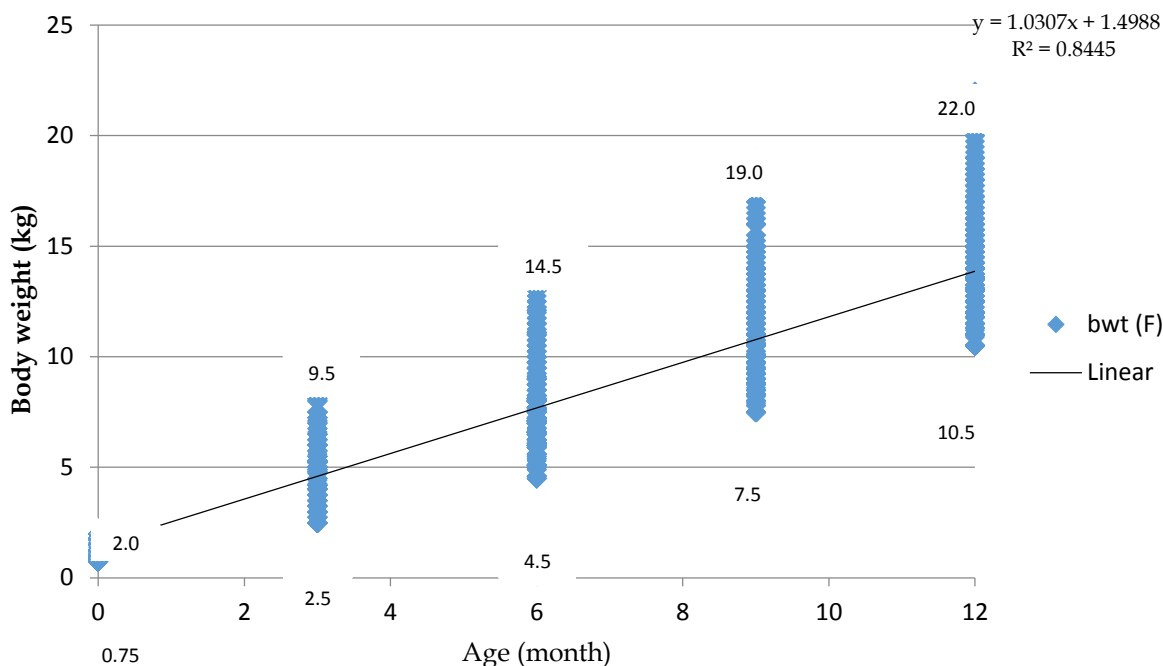

Fig. 1: Growth trend of male kids

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Fig. 2: Growth trend of female kids

Heritability estimates for BW traits

The variance components and heritability estimates for BW at different ages in BBG are illustrated in Table 2 which shows medium heritability estimates ranged from 0.45 to 0.57. Amin *et al.* (2001) in their study reported heritability estimates for birth, 3, 6, 9 and 12-month of ages to be 0.30±0.16, 0.57±0.27, 0.27±0.17, 0.27±0.19 and 0.35±0.24, respectively in the same breed. The magnitudes of heritability estimates in their study were medium, except that at 3-month which closely agrees by our estimates. Gupta *et al.* (2016) also reported medium heritability estimates of Mehsana goat of Gujarat at birth (0.16) and 3-month (0.29), but they obtained higher values for later ages. Mia *et al.* (2013) also reported medium estimates of heritability (0.45-0.49), while Haque *et al.* (2012) obtained medium to higher values (0.44-0.66) for those traits in BBG. Faruque *et al.* (2010) reported higher heritability estimates for birth weight (0.92) and 12-month body weight (0.88), but medium for 3, 6 and 9-month (0.48, 0.34 and 0.45, respectively). Ray *et al.* (2016) reported heritability of BW at sexual maturity of indigenous goat in India as 0.34±0.11 which is somewhat lower than our study.

Table 2: Variance components and heritability estimates for body BW traits

Body weight trait	Covariance component			h^2 (±SE)
	σ^2_a	σ^2_e	σ^2_p	
BW0	0.034	0.005	0.076	0.45±0.03
BW3	1.063	0.229	1.981	0.54±0.02
BW6	2.009	0.680	3.721	0.57±0.02
BWSM	2.048	0.143	3.636	0.56±0.03
BW9	1.852	0.662	3.752	0.49±0.03
BW12	1.848	0.459	3.535	0.52±0.02

BW0, BW3, BW6, BWSM, BW9, BW12 denote body weights at birth, 3, 6, sexual maturity, 9 and 12-month age; σ^2_a, additive genetic variance; σ^2_e, environmental variance; σ^2_p, total phenotypic variance; h^2, heritability; SE, standard error

The variable degrees of heritability estimates for BW traits in the same genotype as obtained by different authors might be due to effect of environment or maternal influence and also for number of observations. High maternal influence has a tendency to increase the component of environmental variance, thereby lowering heritability estimate. According to Van Vleck and Bradford (1965), the higher estimates of heritability could be attributed to some unknown factors biasing the heritability estimates from sire components upward. The heritability estimates as obtained in the study indicate that mass selection may be more useful for

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further genetic improvement of BW in BBG. However, early selection may be helpful for taking decision of selection or culling and to reduce feed and management cost of the farmers.

Genetic and phenotypic correlations among BW traits

The genetic (r_g) and phenotypic correlations (r_p) among BW at birth 3, 6, 9 and 12-month and were estimated and illustrated in Table 3 which indeed shows highly significant (p<0.01) correlations among most pairs of traits. The strengths of correlations are strongly positive, except BW0 with others. Actually, there are very little effects of environment on BW0 rather than weights at later ages and this could be the reason for lower correlations between BW0 with others. In general agreement, positive r_g and r_p between BW at different ages have been reported by Roy *et al.* (1997) and Singh (1997), while high and positive r_g and r_p between BW at different ages in Sirohi goats have been reported by Gowane *et al.* (2011). Mia *et al.* (2013) estimated r_g and r_p of BW among different ages for the same genotype and reported positive correlations ranging medium to high (r_g: 0.34-0.90 and r_p: 0.34-0.83) in magnitude which agreed well by our study.

The estimates of r_g and r_p showed no genetic antagonisms among the BW traits. Mia *et al.* (2013) and Al-Shorepy *et al.* (2002) found no antagonism among the BW traits in their studies, which are in consistent with our findings. Table 3 also shows that the correlations among BW at different ages decreased, as the time between measurements increased, except between BW0 with others, which could be explained by an auto correlation that would exist among the genetic and environmental effects associated with the successive measurements (Mia *et al.*, 2013). Mia *et al.* (2013) also observed the same trends and obtained strong correlations (r_g=0.90 and r_p=0.83) between BW9 and BW12.

Table 3: Genetic correlations (below diagonal) and phenotypic correlations (above diagonal) among BW traits

Traits	BW0	BW3	BW6	BW9	BW12
BW0	-	0.173**±0.046	0.316**±0.046	0.338**±0.045	0.384**±0.045
BW3	0.043±0.049	-	0.912**±0.025	0.888**±0.026	0.864**±0.028
BW6	0.017±0.049	0.896±0.023	-	0.988**±0.011	0.972**±0.015
BW9	0.052±0.049	0.882±0.025	0.995±0.010	-	0.984**±0.012
BW12	0.097±0.050	0.853±0.027	0.977±0.013	0.981±0.011	-

BW0, BW3, BW6, BW9, BW12 denote body weights at birth, 3, 6, 9 and 12-month age; **, significant at 1% (p<0.01)

The direction and degree of strength for r_g and r_p among BW traits indicate that genes controlling for one of the traits is simultaneously controlling for other traits collaterally. Thus, selection for genetic improvement of one trait will simultaneously improve for other traits as a correlated response. However, selection for BW based on birth weight will have very little chance of improvement for other traits as r_g and r_p between birth weight with BW at other ages is very low. Selection based on BW at 3-month and 6-month may be possible for further genetic improvement of these traits.

Response to selection for BW traits

The response or genetic progress per generation due to selection for BW traits in BBG are presented in Table 4.

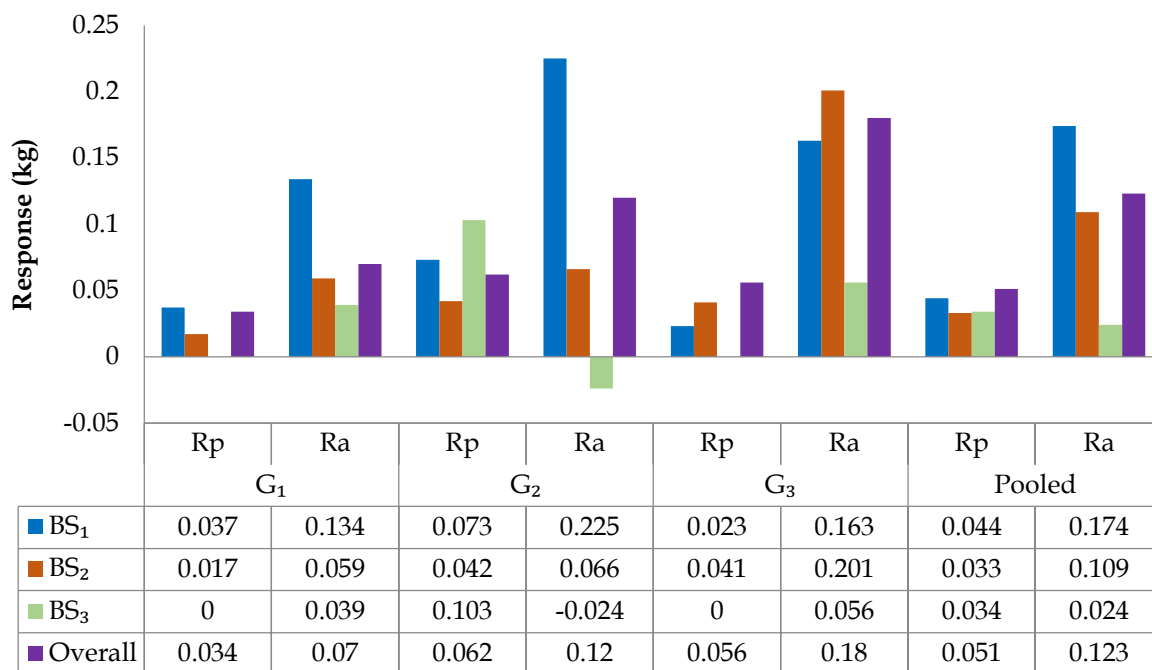**Table 4: Response to selection for body BW traits of BBG in different breeding strategy (BS)**

Traits	Response (R) to selection measured in kilogram per generation							
	BS$_1$		BS$_2$		BS$_3$		All population	
	R$_{Predicted}$	R$_{Actual}$	R$_{Predicted}$	R$_{Actual}$	R$_{Predicted}$	R$_{Actual}$	R$_{Predicted}$	R$_{Actual}$
BW0	0.044	0.174	0.033	0.109	-	0.024	0.051	0.123
BW3	0.213	0.783	0.199	0.297	-	-1.120	0.220	0.463
BW6	0.345	0.703	0.259	0.660	-	0.073	0.396	0.463
BW9	0.341	0.907	0.290	0.620	-	-0.037	0.433	0.480
BW12	0.347	0.703	0.260	0.683	-	-0.063	0.402	0.457

BW0, BW3, BW6, BW9, BW12 denote body weights at birth, 3, 6, 9 and 12-month age;
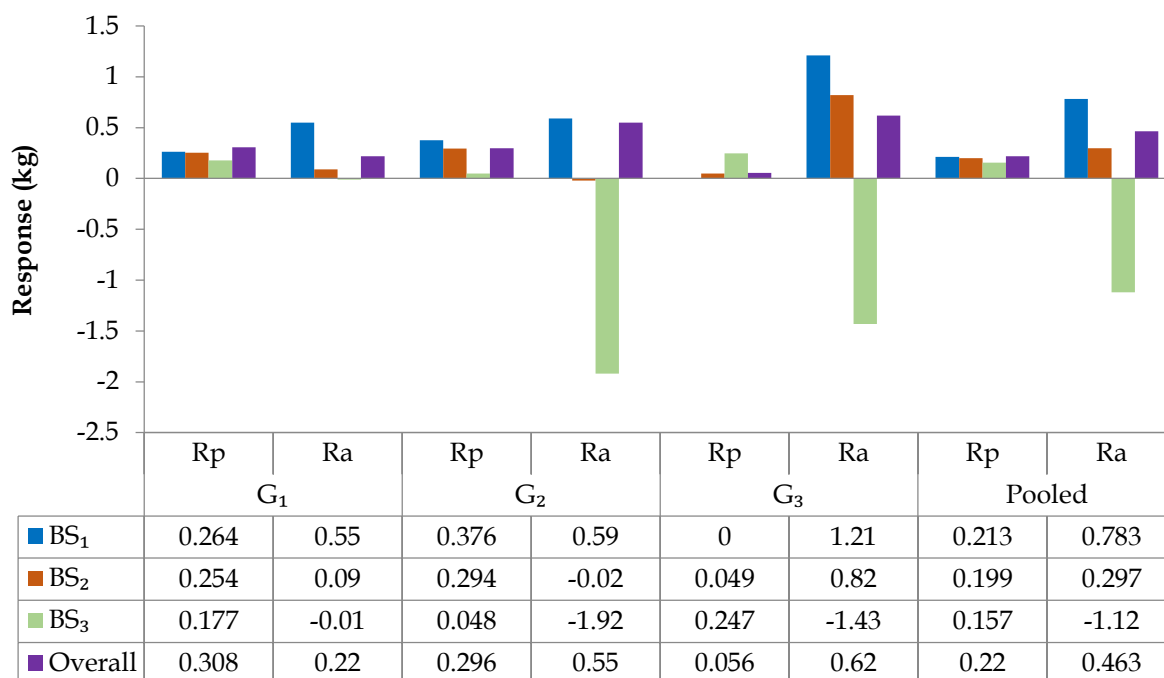
As shown in Table 4 that actual responses were always higher than responses predicted for all BW traits in first two BS. Genetic gains per generation for BW0, BW3, BW6, BW9 and BW12 in all population were predicted to increase by 0.051, 0.220, 0.396, 0.433 and 0.402 kg, respectively, while those actually increased by 0.123, 0.463, 0.463, 0.480 and 0.457 kg, respectively (Fig. 1 to

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Fig. 5). The results also revealed that actual responses for BW traits in BS_1 were higher than actual BW traits increased in BS_2 and BS_3. This could be due to superior parents mated in those population. Published literatures on response for BW traits in BBG are very scarce, as community goat breeding approach conducted earlier is seldom. However, Amin *et al.* (2001) studied direct selection response for BW at different ages in BBG for two progressive generations. They reported an average response per generation to be 0.09 kg for BW0, which is less than our study. On the other hand, their published report on selection response for BW3 (0.520 kg per generation) closely agrees with our estimate. Interestingly, they obtained selection response for BW6, BW9 and BW12 as to be 0.730, 1.05 and 1.69 kg, respectively which were higher as compared to our findings. The variations of magnitudes for response to selection between works could be due to many factors like selection intensity, genetic or maternal effect, environment, sample size, methods of estimation etc.
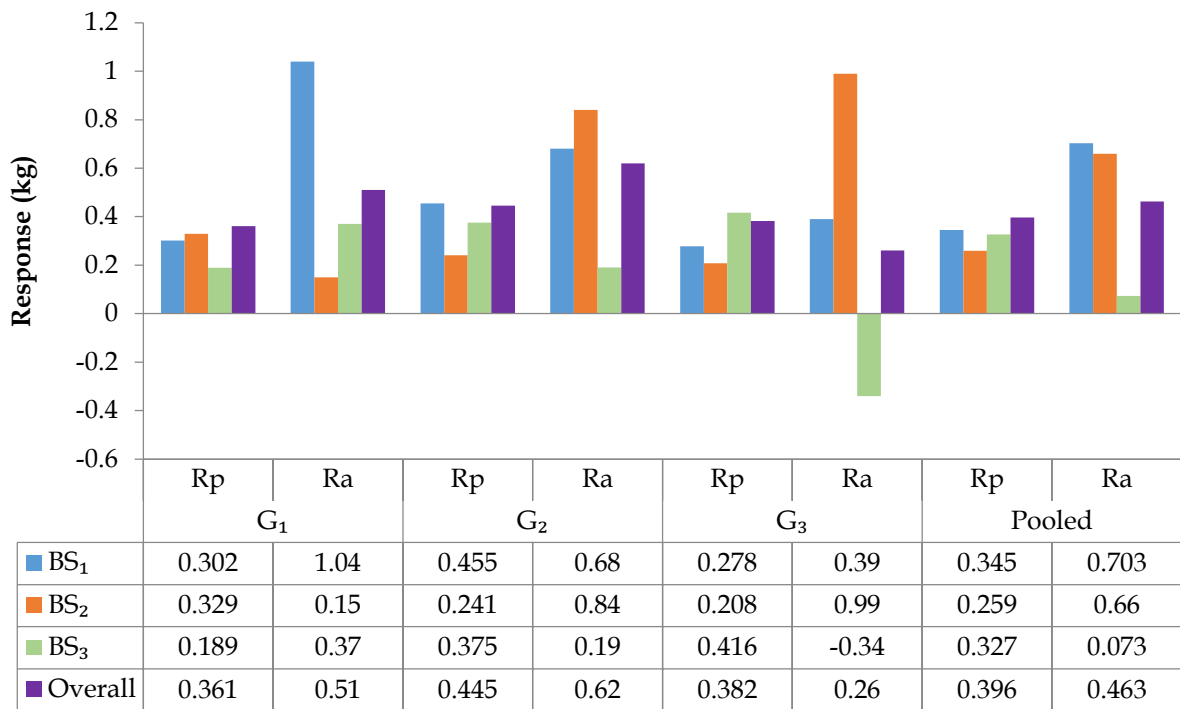

	Rp	Ra	Rp	Ra	Rp	Ra	Rp	Ra
	G_1		G_2		G_3		Pooled	
■ BS_1	0.037	0.134	0.073	0.225	0.023	0.163	0.044	0.174
■ BS_2	0.017	0.059	0.042	0.066	0.041	0.201	0.033	0.109
■ BS_3	0	0.039	0.103	-0.024	0	0.056	0.034	0.024
■ Overall	0.034	0.07	0.062	0.12	0.056	0.18	0.051	0.123

Fig. 1: Response to selection for birth weight (BS_1, breeding strategy 1; BS_2, breeding strategy 2; BS_3, breeding strategy 3; R_P, predicted response; R_a, actual response; G_1, generation 1; G_2, generation 2; G_3, generation 3)

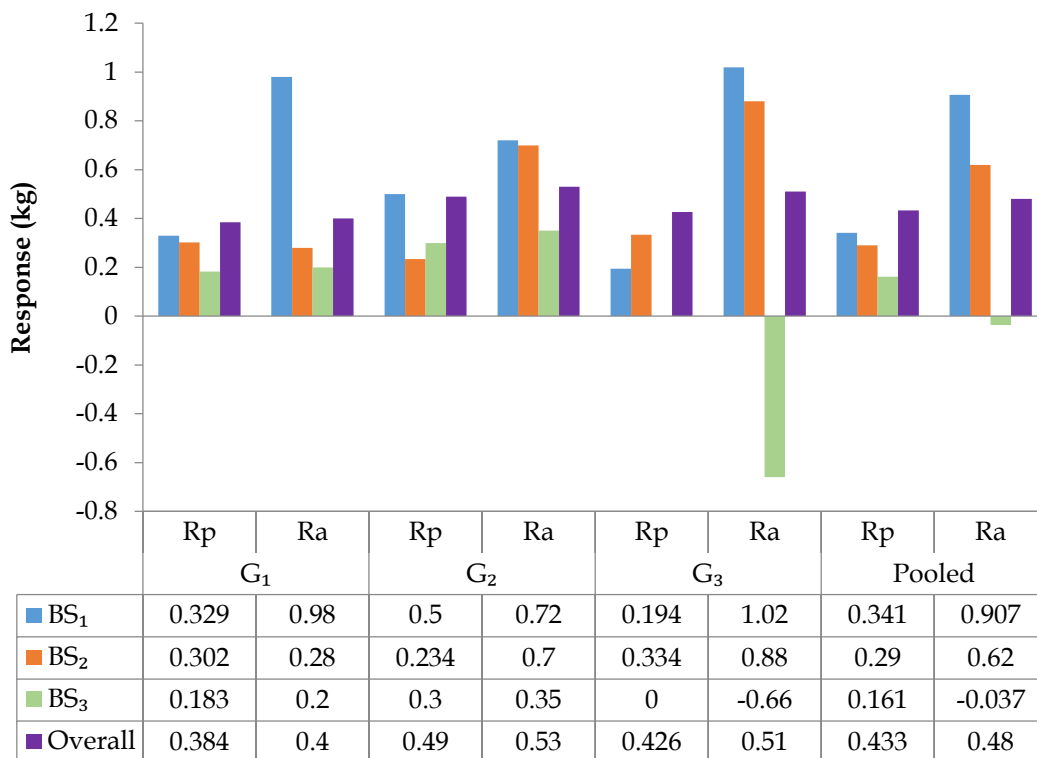|	Rp	Ra	Rp	Ra	Rp	Ra	Rp	Ra
	G_1		G_2		G_3		Pooled	
■ BS_1	0.264	0.55	0.376	0.59	0	1.21	0.213	0.783
■ BS_2	0.254	0.09	0.294	-0.02	0.049	0.82	0.199	0.297
■ BS_3	0.177	-0.01	0.048	-1.92	0.247	-1.43	0.157	-1.12
■ Overall	0.308	0.22	0.296	0.55	0.056	0.62	0.22	0.463

Fig. 2: Response to selection for 3-month body weight (BS_1, breeding strategy 1; BS_2, breeding strategy 2; BS_3, breeding strategy 3; R_P, predicted response; R_a, actual response; G_1, generation 1; G_2, generation 2; G_3, generation 3)

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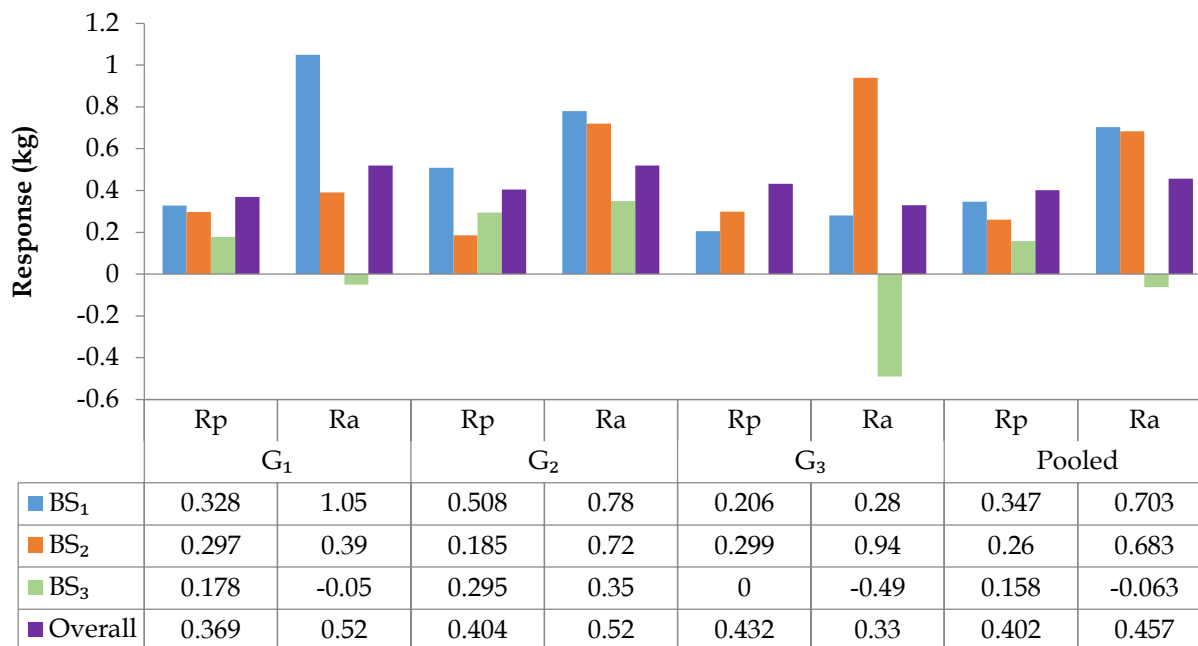

	Rp	Ra	Rp	Ra	Rp	Ra	Rp	Ra
	G_1		G_2		G_3		Pooled	
BS$_1$	0.302	1.04	0.455	0.68	0.278	0.39	0.345	0.703
BS$_2$	0.329	0.15	0.241	0.84	0.208	0.99	0.259	0.66
BS$_3$	0.189	0.37	0.375	0.19	0.416	-0.34	0.327	0.073
Overall	0.361	0.51	0.445	0.62	0.382	0.26	0.396	0.463

Fig. 3: Response to selection for 6-month body weight (BS$_1$, breeding strategy 1; BS$_2$, breeding strategy 2; BS$_3$, breeding strategy 3; R$_p$, predicted response; R$_a$, actual response; G$_1$, generation 1; G$_2$, generation 2; G$_3$, generation 3)

	Rp	Ra	Rp	Ra	Rp	Ra	Rp	Ra
	G_1		G_2		G_3		Pooled	
BS$_1$	0.329	0.98	0.5	0.72	0.194	1.02	0.341	0.907
BS$_2$	0.302	0.28	0.234	0.7	0.334	0.88	0.29	0.62
BS$_3$	0.183	0.2	0.3	0.35	0	-0.66	0.161	-0.037
Overall	0.384	0.4	0.49	0.53	0.426	0.51	0.433	0.48

Fig. 4: Response to selection for 9-month body weight (BS$_1$, breeding strategy 1; BS$_2$, breeding strategy 2; BS$_3$, breeding strategy 3; R$_p$, predicted response; R$_a$, actual response; G$_1$, generation 1; G$_2$, generation 2; G$_3$, generation 3)

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	Rp	Ra	Rp	Ra	Rp	Ra	Rp	Ra
	G_1		G_2		G_3		Pooled	
BS_1	0.328	1.05	0.508	0.78	0.206	0.28	0.347	0.703
BS_2	0.297	0.39	0.185	0.72	0.299	0.94	0.26	0.683
BS_3	0.178	-0.05	0.295	0.35	0	-0.49	0.158	-0.063
Overall	0.369	0.52	0.404	0.52	0.432	0.33	0.402	0.457

Fig. 5: Response to selection for 9-month body weight (BS_1, breeding strategy 1; BS_2, breeding strategy 2; BS_3, breeding strategy 3; R_p, predicted response; R_a, actual response; G_1, generation 1; G_2, generation 2; G_3, generation 3)

CONCLUSION

Community based breeding program with superior bucks and does, even only superior bucks enhanced BW in progressive generations. The estimates of heritability and genetic correlations for BW traits imply that genetic improvement for those traits are possible collaterally by selection of animals based on individual's own performance. However, genetic improvement of BW is also possible due to moderate estimates of heritability, but selection of animals solely based on birth weight may not result in simultaneous improvement of other BW traits.

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