

Selection of Black Bengal bucks based on progeny performance

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Abstract

The present study was aimed for selection of Black Bengal bucks based on progeny performance by using accumulated data of the nucleus breeding flock of Black Bengal goats of the Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh. The traits considered were birth weight, weight at every 3-months interval up to 12 months, semen parameters and milk yield of progeny produced from 15 bucks. Data on 2013 progeny of 15 Black Bengal bucks were analyzed where all the dams were managed in same environment. Heritability estimates obtained for birth weight, 3, 6, 9 and 12-month weights of progeny were 0.38 ± 0.07 , 0.41 ± 0.09 , 0.55 ± 0.11 , 0.51 ± 0.11 and 0.48 ± 0.21 , respectively. The high heritability estimates of body weights indicated that there is a good opportunity for genetic improvement of this trait in a selection scheme. Heritability estimates obtained for semen volume, sperm concentration, sperm motility, sperm livability and normal sperm were 0.078, 0.018, 0.015, 0.066 and 0.035, respectively. The heritability estimates for milk yield in the present study was 0.33 ± 0.14 . Genetic and phenotypic correlations between body weights at different ages were 0.27 to 0.47 and 0.35 to 0.51 respectively. Among semen characteristics, phenotypic correlations ranged from moderately negative (-0.37) to moderately positive (0.46), whereas, genetic correlations ranged from slightly negative (-0.15) to moderately positive (0.45). Then breeding values for all the animals were estimated. Among 15, first 3 top bucks number 81, 54 and 83 for birth weight; buck number 81, 83 and 54 for body weight after twelve months of age and buck number 73, 50 and 54 for milk yield were ranked on the basis of their predicted breeding values. From this study, these top ranking bucks can be selected and conserved by means of preservation of frozen semen for long term sustainable development and that will also give opportunity for gene banking.

Keywords: Black Bengal Bucks; Growth traits; Semen parameters; Milk yield; Progeny

1. INTRODUCTION

Progeny testing is very important method of evaluating animals for genetic merit as parents. It is obvious that the only sound and reliable test of the breeding worth of an animal is the quality of its offspring. Progeny testing implies the estimation of the breeding value of an animal by the performance of its progeny. Nevertheless, by the recognition of the fact that the breeding value of an animal lies in the quality of its progeny, the breeder will be encouraged to select the breeding stock on a more rational basis than simply by its external appearance.

Black Bengal goats are dwarf goats and are known to be famous for the adaptability, fertility, prolificacy, delicacy of meat and superior skin quality (Islam, 2001). The Black Bengal goat is well adapted to hot and humid climate and usually produced twins and triplets (Singh et al., 1985). But there are severe shortfall of stud buck and quality frozen semen in all over the country. Unlike cattle, goat raisers castrate almost all of their male kids at their early age for economic and social reasons. Consequently, availability of quality breeding bucks becomes squeezed. Therefore, there remains no chance for judging breeding soundness and fertility of the buck (Hussain, 2004). Now it is well established that selection of good quality bucks and their widespread use could improve birth weight, body weight gain and milk yield of does which in turn may cause to reduce kid mortality to the reasonable extent and increasing overall production potential (Hussain, 2004).

Under selection, individuals with advantageous or "adaptive" traits tend to be more successful than their peers reproductively- meaning they contribute more offspring to the succeeding generation. When traits have a genetic basis, selection can increase the prevalence of those traits, because offspring will inherit those traits from their parents (Van Vleck et al., 1987). Heritability estimates of traits are important because the estimates will determine if genetic selection is possible and the speed at which progress can be made through selection (Aaron et al., 1987). Genetic correlations between traits are also important because they provide information as to how one trait will respond when selection is for another trait (Koots et al., 1994). Estimation of predicted breeding values and ranking of bucks based on progeny performance helps to easy selection of needed bucks for breeding program in a more applicable form (Bath et al., 1985). The use of expected progeny differences has been wide spread in beef cattle and resulted in tremendous gains in performance through targeted selection by

producers at all levels. The same gains can be achieved in the goat industry if these tools are made available.

As is known, animal breeders always try to select their best males for breeding with the aim that their progeny will be better than the population average. Deep frozen semen from 15 Black Bengal breeding bucks was used as sire line in the present study. In this study, bucks were ranked according to the predicted breeding values calculated using their progeny performance.

2. MATERIALS AND METHODS

2.1 Animal Management

A total of 2013 Black Bengal progeny of 15 Black Bengal Bucks in the nucleus breeding flock at the Artificial Insemination centre of Bangladesh Agricultural University (BAU) were used in this study. The bucks were between 19 to 34 months in age. The body weight and scrotal circumference (SC) of bucks were 19.0 to 25.0 kg and 17.0 to 22.0 cm respectively.

All animals were managed and raised under confinement as an intensive system. They were housed in individual pens (4×2.5 sq.ft) in a galvanized iron sheet shed with a wooden slatted floor raised above the ground level. The house was provided with necessary arrangements for feeding and watering and for sufficient access to fresh air. Semen was collected by Artificial Vagina method and made frozen semen by reducing temperature gradually. The bucks were kept under zero grazing management and stall fed twice daily on a diet consisting of Napier, German and/or Maize fodder *ad labium*. The feed was supplemented with commercial (Surma Feed, BRAC Feed Mill, Sreepur, Gazipur) in pellet form in the morning and again in the afternoon at the rate of 100gm/ buck. They were allowed for grazing and exercise for 1 to 2 hours daily. The breeding bucks were also supplied germinated gram (20gm/buck/day). Clean and safe water was made available at all the time. Throughout this study, almost identical ration was provided for each of the bucks. All bucks were vaccinated against *Peste des Petits Ruminants* (PPR) and dewormed routinely with Ivermectin thrice yearly.

All the breeding animal and progenies were identified with neckband tags in order to maintain their individual identity and pedigree. For each individual under study a record sheet with full details of each parameter along with pedigree information were maintained. New-born kids were allowed to suckle their mothers and were left with them up to 3 months of age. Kids were weaned at three month of age. Following weaning, kids were

offered 50-100 gm/head/day of the same commercial concentrate. All the female kids were kept in shed with their dams, but males over 3 months of age were housed separately in individual pen in the buck shed to avoid uncontrolled breeding. No castration was performed on the male kids.

2.2 Traits analyzed

The traits analyzed in this study were growth traits (birth weight, 3-month body weight, 6-month body weight, 9-month body weight and 12-month body weight), semen characteristics (semen volume, sperm concentration, mass motility, sperm livability and normal sperm) and milk yield of progeny.

2.2.1 Growth performance

2.2.1.1 Birth weight: The birth weight (kg) was recorded for all kids born alive within 12 hours of their birth with a top-loading balance.

2.2.1.2 Body weights up to twelve months of age:

From birth to twelve months of age body weight was taken by using a 30-kg digital balance with an accuracy of 10 gm. Body weights (kg) were recorded when the animal was stable in the morning before the animals were fed.

2.2.2 Semen characteristics

2.2.2.1 Semen volume: The volume of semen was measured directly with the help of graduated collection vial.

2.2.2.2 Mass motility: To observe the mass motility, one small drop of semen was placed on a clean pre-warmed (37°C) slide and examined under microscope without cover slip.

2.2.2.3 Concentration: The concentration of spermatozoa was determined by hemocytometer method according to Herman and Madden (1963).

2.2.2.4 Sperm livability: This is the relative estimation of the quality semen using eosin-nigrosin stain and counted as % of sperm livability.

2.2.2.5 Normal sperm: Rose-Bengal stain was used for counting of normal sperm and expressed in percentage.

2.3 Milk yield

Milk production records were calculated from individual test days made at fortnightly intervals. Kids were weaned at three month of age. Kids were kept separated from their dams overnight (12 hours) preceding the day of milk recording only. The milk consumption by the kid was estimated as the difference between the body weight before and after suckling of kid. The total amount of milk consumed by the kid was taken as the morning milk yield of the doe. The daily milk yield was then estimated for each doe multiplying morning milk yield by two.

2.4 Statistical analysis

Genetic parameters were estimated with Residual Maximum Likelihood (REML) procedure fitting an animal model using VCE 4.2.5 software (Groeneveld et al., 1998). The statistical package SAS (SAS, 1998) was used to carry out the phenotypic correlation analysis. The genetic correlations between traits were estimated using two-trait pair wise analyses. The model fitted for two-trait analyses were as follows:

$$y = Xb + Za + e$$

Where, y = vector of observations, b = vector of fixed effects, a = vector of random animal effects (direct genetic), X = incidence matrix for fixed effects, Z = incidence matrix for random effects, and e = vector of random residual effects. It was assumed that all effects in the models are independent and normally distributed.

The breeding value of 15 bucks for the traits was estimated on the basis of performance progeny by using Best Linear Unbiased Prediction (BLUP) methodology. The BLUP in turn was carried out by computer program prediction and estimation (PEST) proposed by Groeneveld et al., (1998). However, the matrix of variance components from the VCE results for each of the traits considering was used in the matrix for PEST program to estimate breeding values of each animal for each trait separately. The BLUP and PEST program were used to estimate the breeding values of bucks.

3. RESULTS

3.1 Variance components and heritability

3.1.1 Growth performance

Heritability estimates ranged from 0.38±0.068 to 0.55±0.105 for growth traits. Estimates of additive genetic variance (σ_a^2), residual variance (σ_e^2) and heritability with standard errors (h^2) of body weights (kg) at different ages of Black Bengal progeny are given in table 1.

Table1. Variance components and heritability of body weights (kg) at different ages of Black Bengal progeny

Body wt at	σ_a^2	σ_e^2	$h^2 \pm S.E.$
Birth	0.620	0.016	0.38±0.07
3 months	0.755	0.009	0.41±0.11
6 months	0.731	0.082	0.55±0.10
9 months	1.56	1.14	0.51±0.11
12 months	1.63	1.78	0.48±0.21

σ_a^2 , additive genetic variance; σ_e^2 , residual variance; h^2 , heritability

3.1.2 Semen characteristics

Additive genetic and residual variances and heritability estimates are listed in table 2. For all the semen parameters, the values of heritability were low and ranged from 0.015 to 0.117.

Table 2 Variance components and heritability for semen characteristics of Black Bengal progeny

Trait	σ_a^2	σ_e^2	h^2
volume (ml)	0.091	0.012	0.078
Sperm conc. (10^9 cells/ml)	0.244	0.039	0.118
Mass motility (%)	0.125	19.810	0.015
Sperm livability (%)	0.170	27.487	0.066
Normal sperm (%)	0.344	21.953	0.035

σ_a^2 , additive genetic variance; σ_e^2 , residual variance; h^2 , heritability

3.1.3 Milk yield

The estimated additive genetic and residual variances as well as heritability are presented in Table 3. The heritability estimate for milk yield in the present study was 0.33 ± 0.14 .

Table 3 Variance components and heritability for milk yield (g) of Black Bengal progeny

Trait	σ_a^2	σ_e^2	h^2
Test day milk yield	178.74	985.45	0.33 ± 0.14

σ_a^2 , additive genetic variance; σ_e^2 , residual variance; h^2 , heritability

3.2 Genetic and phenotypic correlations

3.2.1 Growth performance

Genetic and phenotypic correlations between body weights at different ages were positive to moderate in magnitude and statistically significant ($P < 0.05$). The minimum values of phenotypic (0.35) and genotypic (0.27) correlations were between birth weight and 3-month body weight. Whereas the maximum values were 0.51 and 0.47 between 6-month body weight and 9-month body weight. Estimates of genetic and phenotypic correlations among body weights (kg) at different ages of Black Bengal progeny are summarized in Table 4.

Table 4 Phenotypic (above diagonal) and genetic correlations (below diagonal) among body weights (kg) at different ages (months) of Black Bengal progeny

Body wt. at	Birth	3 m	6 m	9 m	12 m
Birth		0.35 ± 0.03	0.46 ± 0.12	0.41 ± 0.08	0.39 ± 0.14
3 m	0.27 ± 0.12		0.32* ± 0.05	0.44 ± 0.03	0.36 ± 0.06
6 m	0.35 ± 0.05	0.37 ± 0.13		0.51* ± 0.12	0.47* ± 0.08
9 m	0.39 ± 0.06	0.44 ± 0.08	0.47* ± 0.13		0.45 ± 0.21
12 m	0.32 ± 0.02	0.41 ± 0.15	0.46 ± 0.06	0.43 ± 0.20	

* $P < 0.05$; m-months

3.2.2 Semen characteristics

Estimates of phenotypic and genetic correlations among semen parameters are reported in Table 5. Phenotypic correlations ranged from moderately negative (-0.37) between semen volume and sperm concentration to moderately positive (0.46) in case of mass motility and normal sperm. However, genetic correlations ranged from slightly negative (-0.15) to moderately positive (0.45). Semen volume was negatively correlated with sperm concentration and mass motility. Sperm concentration was also negatively correlated with percent normal sperm and sperm livability. All of the other phenotypic and genetic correlations were positive.

Table 5 Phenotypic (above diagonal) and genetic (below diagonal) correlations among semen parameters in Black Bengal bucks

Semen Charact.	volume (ml)	Sperm conc. (10^9 /ml)	Mass motility (%)	Sperm livab. (%)	Normal sperm (%)
volume		-0.365	-0.001	0.077	0.447*
Sperm conc.	-0.058		0.445*	0.401*	-0.003
Mass motility	-0.001	0.380		0.417	0.462*
Sperm Livab.	0.318	-0.150	0.451*		0.211
Normal sperm	0.028	0.110	0.123	0.363	

* $P < 0.05$

3.3 Predicted breeding values and ranking of bucks

Bucks of the present study were ranked according to their PBV estimated from progeny performance as presented in Figures 1, 2 and 3.

3.3.1 Growth performance

Among 15 bucks, best one was Buck No. 81, followed by Buck No. 54 and 83 in order for birth weight (Figure 1) and the PBV of bucks for body weight after twelve months of age of their progeny Buck No. 81 ranked the highest in order, followed by Buck No. 83 and 54. The poorest performer was Buck No. 92 (Figure 2).

3.3.2 Milk yield

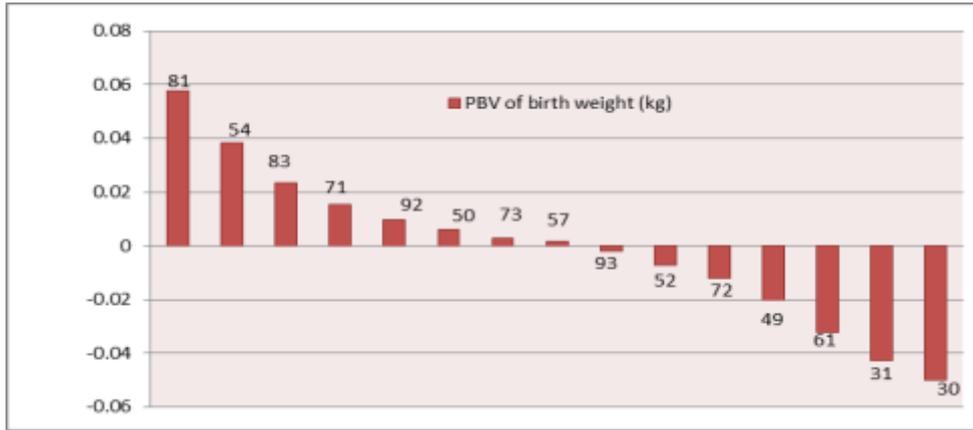
The PBV of bucks for progeny milk yield was ranged from -0.4516 to +0.4991. The highest breeding value of milk yield was found in the progeny of Buck No. 73, followed by Buck No. 50 and 54. The lowest breeding value of milk yield was found from the progeny of Buck No. 57, followed by Buck No. 61 and 72 (Figure 3).

4. DISCUSSION

4.1 Variance components and heritability

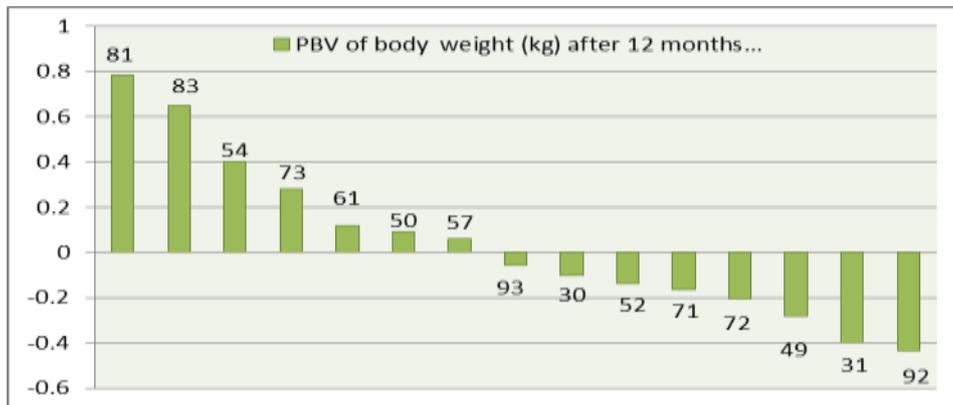
4.1.1 Growth performance

Heritability estimates for growth traits ranged from 0.33 to 0.55. The results showed in (Table 1) that the weight traits have high heritability. The



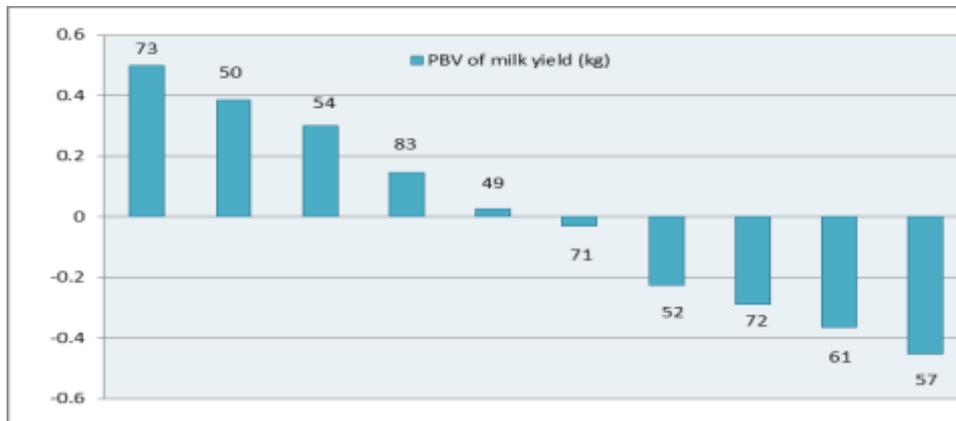
$h^2 = 0.38 \pm 0.068$; Buck identity number (81, 54, 83..... 30)

Figure 1 Predicted breeding values of bucks based on progeny birth weight



$h^2 = 0.48 \pm 0.21$; Buck identity number (81, 83, 54..... 92)

Figure 2 Predicted breeding values of bucks based on progeny body weight after 12 months of age



$h^2 = 0.33 \pm 0.14$; Buck identity number (73, 50, 54..... 57)

Figure 3 Predicted breeding values of bucks based on progeny milk yield

heritability estimate for birth weight obtained in the present study was comparable to those reported by Neopane (2000) of 0.53 in Hill goats in Nepal, Portolano et al. (2002) of 0.49 in the Sicilian

Girgentana goat and Bosso et al. (2007) of 0.50 in West African Dwarf goat.

Heritability estimates higher than the present study was reported by Mourad and Anous (1998) 0.68 for Common African and Alpine crossbred goats.

Moderate estimates was reported by Schoeman et al. (1997) 0.32-0.35 for Boer goats and Otuma and Osakwe (2008) of 0.41 in Nigerian Sahelian goat. Low estimates was reported by Amble et al. (1964) 0.19 in Beetal goats, Moulick and Syrstad (1970) 0.01 in Black Bengal goat, Tahir et al. (1995) 0.05 in Teddy goats of Pakistan and Niekerk et al. (1996) 0.17 in Boer goat.

High estimates of heritability indicated that the additive genetic variation exists which can be exploited by mass selection for improving these traits relatively quickly at birth or later at 3, 6, 9 and 12 months of age. The relatively higher estimates in this study could be due to, among other factors, the fact that maternal genetic effects were ignored in the model. But increasing heritability estimates with advancing age indicating that mothering ability decreases gradually. Several factors such as breed of the animal, genetic variation within population, management and environmental conditions, size of the data set, models fitted, method of estimation used in different studies, etc., would have affected the differences between estimations.

4.1.2 Semen characteristics

For all the semen parameters, the values of heritability were low and ranged from 0.015 to 0.117 (Table 2). Rege et al. (2000) found the heritability of volume to be 0.11 in 12 month old rams, which is slightly less than the estimate calculated in this study. Heritability estimates for overall motility have been reported in the literature by Knights et al. (1984) as 0.13. Smith et al. (1989) estimated heritability for percent normal sperm to be 0.07, which is slightly more than the estimate calculated in this study.

Moderate heritability for semen characteristics in our study are in agreement with the findings of Furstoss et al. (2009) who reported the heritability values for semen characteristics of young buck to be 0.12 to 0.24.

Due to low heritability estimates of semen characteristics in the present study, there was very less opportunity for genetic improvement through selection rather than environmental management. There seem to be scope for genetic improvement of sperm concentration in particular.

4.1.3 Milk yield

The heritability estimate for the test day milk yield in the present study was 0.33 showed in (Table 3). The heritability estimated for test day milk yield in Black Bengal goat was comparable with the heritability reported by Kominakis et al. (2000) for Skopelos goats in Greece, Delgado et al. (2006) for Murciano-Granadina goats in the highlands of Spain, Weppert and Hayes (2004) for Alpine, Saanen, Toggenburg and Nubian goats in Canada.

Early literature reviews for heritability of milk yield in dairy goats reported estimates ranging

from 0.16 to 0.60 with an average value of 0.32. Belichon et al. (1998) reported heritability of milk yield in Alpine and Saanen goat to be 0.34 and 0.32, respectively. However, Grossman et al. (1986) reported higher estimates of total milk yield heritability in Alpine, LaMancha, Nubian, Saanen and Toggenburg goat breeds being 0.42, 0.38, 0.45, 0.44 and 0.41, respectively.

Estimates of heritability of a trait can vary considerably from study to study depending upon breed, population sampled, environmental and management conditions, and errors, both random and systematic, in the estimation procedures (Kennedy et al. 1981). The Black Bengal goat showed moderate genetic variability and genetic improvement may be possible by selecting superior bucks based on progeny performance.

4.2 Genetic and phenotypic correlations

4.2.1 Growth performance

All the growth traits were positively correlated showed in (Table 4). The genetic and phenotypic correlations of birth weight with the body weights at subsequent ages ranged from low to medium. The genetic correlations of 3 months weight with the 6, 9 and 12 months weights were medium but phenotypic correlations ranged from high to medium and declined steadily at later stages. The 6 months weight had a positive genetic and phenotypic correlation with the 9 and 12 months body weight. Similarly, 9 months body weight had a positive genetic and phenotypic correlation with 12 months body weight.

Gowane et al. (2011) reported high and positive genetic and phenotypic correlations between body weights at different ages in Sirohi goat. Genetic and phenotypic correlations between body weights at various ages were large and positive in Jamunapari and indigenous × exotic goats. Singh et al. (1991) is in agreement with earlier findings reported estimates of the genetic (phenotypic) correlation between body weight at birth and 3-months were 0.78 (0.51) in the Black Bengal, 0.56 (0.47) in the Jamunapari, and 0.49 (0.51) in the Beetal × Black Bengal breeds.

The positive genetic correlations existing between body weight traits indicate that genetic improvement in any one of the traits could be made through indirect selection for correlated traits. High genetic correlation between 6WT and 9WT suggests that selection of animals at 6 months can be carried out instead of present practice of selection at 9 months.

4.2.2 Semen characteristics

Phenotypic correlations ranged from moderately negative (-0.365) to moderately positive (0.462). However, genetic correlations ranged from slightly negative (-0.15) to moderately positive (0.451) showed in (Table 5).

Karagiannidis et al. (2000) observed phenotypic correlation of 0.005 between semen volume and sperm concentration. A negative genetic relationship between volume and concentration was reported in many species. Correlation value found in this study (-0.422) is in close to the value observed in previous studies (-0.50) on Saanen bucks (Furstoss et al. 2009), (-0.38) on Ethiopian highland sheep (Rege et al., 2000), (-0.62) on boars (Smital et al. 2005) and (-0.47) on bulls (Ducrocq and Humblot, 1995).

Selection for increased mass motility has a positive effect on majority of semen characteristics except semen volume. The largest positive impact would be on normal spermatozoa. Sperm concentration had strong and favorable genetic correlations with mass motility. Thus, selection on this trait should have favorable correlated response in the mass motility. The majority of the semen characteristics had favorable genetic correlations with each other. All of the favorable genetic correlations are promising because they indicate that selection of bucks for a semen characteristic could benefit majority of the other semen characteristics in the male progeny.

4.3 Predicted breeding values and ranking of bucks

4.3.1 Growth performance

Breeding values of bucks for birth weight were ranged from -0.0423 to +0.0278 showed in Figure 1 and the PBV of bucks for progeny body weights after twelve months of age were ranked between -0.4366 to +0.8384 (Figure 2). Van Wyk et al. (1993) reported an annual increase in birth weight of 0.023 kg per year in the Elsenburg Dormer stud, whilst Duguma (2001) also reported an increment in the mean direct breeding value for birth weight in the Tygerhoek Merino flock. Realised increases in birth weight could be undesirable because, if they are excessive, they may result in negative consequences such as difficulties in lambing, and resultant parturient deaths. The mean annual breeding values of pre-weaning weight in the Ile de France breed increased from -0.3636 to 0.1203 kg between 1990 and 2007. El-Arian et al., (2008) showed that averaged breeding values for weaning weight increased at a rate of 0.3445 ± 0.02 kg per annum in the Ile de France breed, which translated to a commendable 1.21% per annum.

Wide range of breeding values was found for birth weight so that selection of bucks for the next generation would lead to higher genetic improvement in Black Bengal bucks in this flock. It was concluded that body weight after twelve months of age exhibited substantial genetic improvement during the evaluation period in this breed.

4.3.2 Milk yield

The PBV of bucks for milk yield of progeny ranged from -0.4516 to +0.4992 (Figure: 3). Breeding value prediction for dairy goats in Germany is still based on herd mate comparison within breeding society. According to Bagnicka et al. (2007), predicted breeding value of milk yield ranged from -0.214 to +0.247 in dairy goats in Poland. The data between 1987 and 2003 were obtained from six German breeding societies and found that breeding value ranging from -0.02 to +0.37 for milk yield based on a test day model (Zumbach et al. 2008).

Selection based on progeny testing of bucks is quite essential to obtain maximum genetic progress in a trait like milk production. Ranking of bucks for progeny milk yield is also a valuable tool in order to obtain an effective selection scheme.

5. CONCLUSIONS

For genetic improvement of Black Bengal goats scientific breeding should be ensured where selection of bucks is most important tools and it is possible by genetic evaluation of their progeny which gives more realistic results for selection response.

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