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Selection of Does Using Economic Merit Index for Further Genetic Improvement

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Abstract: The study was conducted to know the productive and reproductive traits of goats, estimates their genetic association and selection of the superior does. Data was collected from 170 goats of Jamunapari, Black Bengal and their cross (Jamunapari×Black Bengal) from the rural and Metro Politian areas of Bangladesh. The Economic Values (EVs) of different traits and profitability per doe per year were estimated using a linear model and Breeding Values (BVs) by animal model. Selection index was constructed as the sum of the product of BVs with the EVs of each trait. Jamunapari goat produced higher daily milk yield (0.65-0.68 kg) than Black Bengal and crossbred. Birth weight (1.68-1.86 kg) and liveweight (32-35 kg) of Jamunapari does were higher than other breeds but the litter size (2) and kidding interval (158-168 days) of Black Bengal goats were better. Heritability, genotypic and phenotypic correlations of all traits were positive for all breeds except liveweight and kidding interval was negative. The profitability of Black Bengal goats was higher than other breeds due to its regularity of kidding and larger litter size. Finally, according to the selection index the highest ranking does were selected as parents for the production of offspring.

Key words: Goats, traits, correlations, profitability and economic selection index, regularity, constructed

INTRODUCTION

Goat farming can be used as effective tool for poverty reduction as it require less investment and less feeding and management costs than large animal farming (Khan and Naznin, 2013). Goats of Bangladesh graze on barren and road-side land grass and feed with available least cost roughages like neem tree leaves, mango leaves, jackfruit leaves and concentrates; rice gruel, rice polish, cooked rice and sometimes various brans. There are some potential goat breeds available in Bangladesh such as Black Bengal, Jamunapari. In addition, different kinds of crossbred goats can be found for example, Jamunapari×Black Bengal, Beetal×Black Bengal, Beetal×Jamunapari (Prasad *et al*., 2005). The genetic erosion of these potential goats is occurring due to unsystematic breeding and to overcome it a structured genetic improvement programme should be undertaken with set up a specific breeding goal. Generally, the main goal of breeding-selection research is to create new generations which would exceed in their performance than the previous generation and demonstrate greater production effects in production of milk and meat (Pantelic *et al*., 2008). For construction of selection index the knowledge of the breeding value along with genetic and phenotypic correlation and heritabilities of different traits is essential. Several studies (Khan and Naznin, 2013; Khan and Khatun, 2013; Talukder *et al*. 2010) were conducted on the productive and reproductive parameters of available goats of Bangladesh. However, study on the associated traits ability that is correlations between economic traits research is very limited of these goat breeds. Genetic and phenotypic association/correlations have great importance in intermediary or indirect selection when changes in one trait are induced through selection on other trait between which a genetic correlation exists. Therefore, the present study was conducted with the objectives to study the different productive and reproductive traits of available breeds of goats; to estimate the genotypic and phenotypic association between different productive and reproductive traits and to choose the superior does using total merit for further genetic improvement.

MATERIALS AND METHODS

The study was conducted in rural and the Metro Politian Area (MPA) of Chittagong, Bangladesh under the Department of Genetics and Animal Breeding at Chittagong Veterinary and Animal Sciences University from October, 2013-September 2014. The farm houses and farmers who rear goats were selected from the both the studied areas by visiting frequently. A total of 170 goats of 3 genotypes were chosen from rural area (30 for

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Black Bengal, 30 Jamunapari and 25 crossbred (Jamuna pari×Black Bengal)) on the goat's age, body shape and size and live weight and similar number was chosen from MPA. The selected farmers were provided necessary training on goat rearing and record keeping in 3 months interval by the researchers. The selected goats were categorized based on their location and age under a breed. The goats were allowed for normal feeding and management conditions under the subsistence production system.

Productive and reproductive traits of different goat breeds: Record keeping was started from the date of conception up to parturition to know the litter size and from kidding to next batch of kidding to calculate the kidding interval. The weight of kids were weighed and recorded at birth and their subsequent live weight at a bi-weekly interval up to maturity. The live weight of the does was recorded in first heat and also at mature age. The age at first kidding was calculated from the difference between the days of first heat shown and birth date. Milk production per goat per lactation was collected as a test day basis in a weekly interval from individual doe. For milk yield data, kids were separated from their dams overnight (12 h) preceding the day of milk recording then the kids were allowed for milk consumption and the amount of milk production was estimated as the difference between the body weight before and after sucking of kid. The lactation length of each goat was calculated by counting from the date of kidding up to the date of milk withdrawal. Then, the lactation milk production was calculated by the product of average daily milk yield and lactation length.

Statistical analysis: Least square means were estimated for location and age under a breed and the data was analyzed by SAS (2008) using the following model:

$$Y_{ijkm} = \mu + L_i + A_k + B_l + e_{ijklm}$$

Where:

- Y_{ijkm} = The measurement of particular trait
- μ = The population mean
- L_i = The vector of ith location (i = 1 and 2) effects
- A_k = The effect of age (k = 1, 1.5, 2, 2.5 and 3)
- B_l = The random effect of lth breeds (l = 1, 2, 3)
- e_{ijkmn} = The random error associated with each record, distributed as $N(0, \sigma^2)$

The mean value was compared using the Least Significant Difference (LSD) test at p>0.05 level (Steel, 1997).

Estimated BLUP breeding values and phenotypic and genotypic correlations: The genetic association between traits was obtained using a multiple trait, animal model. The EBVs of different traits (birth weight, age and weight at sexual maturity, mature live weight, litter size, kidding rate and daily average milk yield and lactation milk production) were estimated from a multivariate analysis by AIREML (Johnson and Thomson, 1995). The animal model for analysis was as:

$$Y = Xb + Zu + e$$

Where:

- Y = The vector of all observations
- b = The vector of fixed effects considering the effect of location and does age
- u = The vector of breeding value of the animal's, random
- e = The vector of residual effects
- X and Z = The design matrix connecting to the fixed and random effect, respectively

There was no sire, dam and grand sire information only the individual does performance was considered in this analysis.

Economic evaluations: A deterministic linear model was used according to Khan *et al.* (2014) to estimate the profitability of does of different breeds. The economics were calculated based on average values of milk, taka 90 kg and meat, taka 500 kg and the expenses incurred feed costs, health, reproduction and fixed costs. The profit was derived as the difference between revenues and costs. The main components in this model were herd structure nutrition, biological and economics of the farm. The total Metabolisable Energy (ME) requirement per doe per year was the sum of ME requirement for maintenance, growth, pregnancy and production and was calculated according to AFRC. The milk production per lactation was considered as milk production per kidding interval and the milk yield (kg/year) was calculated as:

$$\text{Milk yield (kg/year)} = \text{Milk yield per lactation (kg)} \times 365/\text{Kidding interval}$$

Dry Matter (DM) requirements were calculated by the content of ME per kg DM. It was considered that does were consuming roughage from grazing, tree leaves and 0.20-0.50 kg concentrate mix (brans, oil cakes and grains) per day for all the does to fulfill their energy requirements. The feed cost (roughage and concentrate mix) for different genotypes were calculated at 0.15 US$ per kg DM. The profit was derived from the differences of the sale of milk and mutton and the cost of feed and fixed costs (operational cost).

In the model, the goat class was kids, yearlings and does. Doe replacement can be reared from the kids born within the flock. Generally, the kids are mated at 7-12 months of age to kid at 12-18 months of age. The farmers keep the does up to 5 years of age that is up to 7-8 lactations. The individual doe income was estimated after running the base model and the Economic Values (EVs) of different traits was obtained by re-running the base model after changing one unit of each trait while maintaining the other traits in the model at a constant level.

Construction of economic selection index or total merit: Economic value was estimated under the same situations and used to develop the total merit. Here, the total merit value of the selection objective was calculated as the sum of the product of BLUP estimated breeding values with the economic values of all traits (birth weight, mature body weight, litter size, kidding rate and lactation production. The total merit was expressed in dollar.

Finally, based on the total merit the does were ranked and top does were selected for further genetic improvement.

RESULTS AND DISCUSSION

Productive and reproductive performance of 3 different breeds of goat: The milk production performance of 3 different goat breeds in respect of age and locations are presented in Table 1. The Daily Average Milk Yield (DAMY) and Lactation Milk Production (LMP) did not differ with locations but the Lactation Lengths (LL) differed significantly (Table 1). Within location and between breeds significant differences were observed for DAMY and LMP. In breed comparison Jamunapari goat produced higher DAMY (0.65-0.68 kg/day) and LMP (90.75-98.23 kg) than Black Bengal (0.39-0.50 kg/day and 55-73 kg/lactation) and their crossbred (0.50-0.62 and 63-90 kg/lactation). But a different scenario was found for Lactation Length (LL), the Black Bengal goat had longer than other 2 breeds. Within location and breed between ages the DAMY and LMP and LLs also found to be differed ($p<0.05$) (Table 1).

The Litter Size (LS) and Kidding Interval (KI) of different breed did not differ in between location (Table 2). Within both farming conditions between breeds the LS was similar for all breeds but the KI was differed ($p<0.05$). The Black Bengal goat had shorter (158-169 days) KI than other breeds (Table 2). In both locations, the Jamunapari had intermediate KI. Within location and breeds between ages LS had not differed but KI differed significantly. The younger does have longer KI than older especially for Black Bengal and crossbred. However, for Jamunapari does ages had not shown any significant difference.

Growth performance of 3 different breeds of goat in respect of age and locations are presented in Table 3. The Birth Weight (BWT) of kids of all breeds did not differ with location (Table 3). However, within rural and MPA among 3 breed's significant differences for BWT was found.

For Age at Sexual Maturity (ASM) of all breed differed with locations. Under the rural condition the crossbred showed earlier maturity than other 2 breeds. But in the MPA all the breeds showed similar values for the ASM. For Weight at Sexual Maturity (WSM) location had not shown any differences for all the breeds. Within locations and within breed between age groups WSM was similar for all the does.

Heritabilities, genetic and phenotypic correlations: The heritabilities, genetic and phenotypic correlations of different traits for Jamunapari, Black Bengal and their crossbred goats are presented in Table 4. The heritability values for all traits for all 3 breeds were positive (Table 4). Birth weight had higher heritability values and KI was lower values.

The DAMY and LMP were positively correlated with all traits for all breeds except the WSM and MLWT the genetic correlations of this breed with milk yield showed negative for birth weight, WSM and MLWT. The phenotypic and genotypic correlations for birth weight were negative for ASM and WSM and all other trait had positive. The ASM was positively correlated with WSM and negatively correlated with other traits. But the WSM was positively correlated with MLWT and negatively correlated with other traits. Litter size had positively correlated with DAMY, LMP and BWT but negatively correlated with ASM and MLWT. Kidding interval had positively correlated with the DAMY and BWT, MLWT and LS but negatively correlated with ASM and WSM.

Economic evaluations of different genotypes: Table 5 shows the costs, revenues and profit of Jamunapari, Black Bengal and crossbred does on a per doe per year basis. The average net income of Black Bengal (US$ 49) was higher than Jamunapari (US$ 48) and crossbred (US$ 26) does (Table 5). Total revenue was dominated by the sale of milk (79-87%) and beef (13-20%). Feed costs accounted about 90% of the total costs. Black Bengal had the lowest Dry Matter (DM) requirements for maintenance, growth of

Table 1: Milk production performance of 3 different breeds of goat in respect of age and locations

			Traits					
Locations	Breed	Age	DAMY (kg)	LADAMY (kg)	LL (days)	LALL (days)	LMP (kg)	LALMP (kg)
Rural	BB	1	0.37±0.17(4)	0.56±0.157	175±11.4	151.36^{b}±3.39	65.05±18.9	84.30±13.15
		1.5	0.40±0.20(4)		182		86.6±0	
	Breed average		0.39^{a}±0.19		178.5^{b}±5.7		72.5±9.46	
	Crossbred	1.5	0.90^{b}(4)		122.5^{a}±7.55		111.40^{b}	
		2	0.70^{b}±0.20(6)		162.3^{b}±7.67		113.6^{b}±12.20	
		2.5	0.25^{a}±0.096(10)		121^{a}±4.47		43.98^{a}±10.44	
	Breed average		0.62^{b}±0.099		135.66^{a}±6.56		89.66±7.53	
	JP	1	0.57±0.233(4)		135±5.0		68.23±26.15	
		1.5	1.03±0.371(6)		141.67±1.66		141.03±54.89	
		2	0.50±0.173(8)		138.75±4.27		64.63±27.78	
		2.5	0.59±0.125(16)		139±3.65		82.58±3.55	
		3	0.70(3)		145		97.3±0	
	Breed average		0.68^{b}±0.181		139.89^{a}±2.93		90.75±22.47	
MPA	BB	1	0.80^{b}±0.11(4)	0.55±0.075	100.75^{a}	118.71^{a}±5.11	80.6^{b}	72.02±7.12
		1.5	0.20^{a}±0(3)		146^{b}		29.1^{a}	
	Breed average		0.50±0.05		123.38±0.38		54.85	
	Crossbred	1	0.60^{b}±0(4)		105^{ab}±15		92.8^{c}	
		1.5	0.30^{a}±0(2)		130^{a}		36^{a}	
		2	0.60^{b}±0.126(14)		101.44^{a}±6.34		60.13^{b}±15.02	
	Breed average		0.50±0.043		112.15±7.11		62.98±5.01	
	JP	1	0.70±0.10(4)		131.67±3.33		91.6^{a}±1.20	
		1.5	0.70±0.12(4)		125±5.0		131.27^{b}±20.4	
		2	0.55±0.189(8)		105±15.2		71.83^{a}±27.41	
	Breed average		0.65±0.133		120.56±7.84		98.23±16.35	

MPA = Metro Politan Area, BB = Black Bengal, JP = Jamunapari, Crossbred = JP×BB, DAMY = Daily Average Milk Yield, LL = Lactation Length, LMP = Lactation Production, LADAMY = Location Average Daily Milk Yield, LALL = Location Average Lactation Length, LALP = Location Average Lactation Production.The significant test showed between location, breed age within breed and between lactation within age and breed. Parenthesis indicates the number of goat studied. $^{a, b}$Means with different superscripts are different at 5% level of significance

Table 2: Kidding interval and litter size of 3 different breeds of goat in respect of age and locations

			Traits			
Locations	Breeds	Age (year)	LS (No.)	LALS (No.)	KI (days)	LAKI (days)
Rural	BB	1.0	2(4)	1.77±0.10	165±5.0	213.19^{b}±5.53
		1.5	2(4)		170	
	Breed average		2		168.5^{a}±2.5	
	crossbred	1.5	2(4)		255^{b}±5.00	
		2.0	1.33± 0.33(6)		250^{ab}±11.55	
		2.5	1.60±0.245(10)		240^{a}±4.40	
	Breed average		1.64±0.192		248.33^{c}±6.98	
	JP	1.0	2(4)		235±15.0	
		1.5	2(6)		226.67±6.67	
		2.0	1.75±0.25(8)		210±5.77	
		2.5	1.63±0.183(16)		208.75±4.79	
		3.0	1(6)		233.33±3.33	
	Breed average		1.68±0.087		222.75^{b}±7.12	
MPA	BB	1.0	2±0.11(4)	1.73±0.08	167.5^{b}±2.5	206.18^{a}±2.63
		1.5	2.0(2)		150^{a}	
	Breed average		2^{b}±0.06		158.75^{a}±1.25	
	Crossbred	1.0	2(4)		242.5±2.50	
		1.5	2(2)		220	
		2.0	1.57±0.202(14)		258.57±5.08	
	Breed average		1.86^{b}±0.07		240.36^{c}±3.79	
	JP	1.0	1(4)		210	
		1.5	1.5±0.29(4)		223.33±3.33	
		2.0	1.5(8)		225±5.2	
	Breed average		1.33^{a}±0.11		219.44^{b}±2.84	

MPA = Metro Politan Area, BB = Black Bengal, JP = Jamunapari, Crossbred = JP×BB, LS = Litter Size, KI = Kidding Interval, LALS = Location Average Litter Size, LAKI = Location Average Kidding Interval. The significant test showed between location, breed age within breed and between lactation within age and breed. Parenthesis indicates the number of goat studied. $^{a, b}$Means with different superscripts are different at 5% level of significance

replacements and lactation where Jamunapari had the highest total DM requirements and crossbred was at intermediate (Table 5). However, the Jamunapari had the highest milk and beef revenue that generated intermediate profit than other breeds.

The Economic Values (Evs) of different traits for 3 different breeds are also shown in Table 6. The EV of all traits for 3 different genotypes was positive and varied with breeds. However, the Evs for MLWT and KI were negative but the Black Bengal does showed positive EV for KI.

Table 3: Growth performance of 3 different breeds of goat in respect of age and locations

			Traits							
Locations	Breeds	Age	BWT (kg)	LABWT (kg)	ASM (days)	LAASM (days)	WSM (kg)	LAWSM (kg)	MLWT (kg)	LAML-WT(kg)
Rural	BB	1	1.25±0.12(4)	1.5±0.05	-	213.13±5.02	-	14.60±0.853	24±1.23	29.73±1.44
		1.5	1.45±0.05(4)	-	-	-	-	-	21.5±0.50	-
		2	1±0 (4)	-	-	-	-	-	-	-
		3	0.9	-	-	-	-	-	-	-
	Breed average	-	1.15^{a}±0.04	-	210.88^{ab}±5.82	-	13.63±1.76	-	22.75^{a}±0.87	-
	Crossbred	1.5	1.5± 0.11(4)	-	-	-	-		29.25±0.75	-
		2	1.57±0.04(6)				-		33.88±1.72	
		2.5	1.41±0.06(10)	-	-	-	-	-	32.8±0.967	
	Breed average	-	1.49^{b}±0.07	-	202.35^{a}±5.59	-	14.20±0.945	-	31.98^{b}±1.2	-
	JP	1	2(4)	-	-	-	-		32.2^{a}±3.06	-
		1.5	1.9(6)	-	-	-	-		33.6^{ab}±1.94	-
		2	1.8(8)	-	-	-	-		38^{b}±1.88	-
		2.5	1.77±0.125(16)		-			34^{ab}±2.35	-	-
	Breed average		1.86^{c}±0.04	-	226.17^{b}±3.65	-	15.96±0.705	-	34.45^{b}±2.3	-
MPA	BB	1	0.90±0.10(4)	1.47±0.05	-	217.47±5.41	-	13.91±0.642	25.5±0.50	29.71±1.08
		1.5	1.2±0(2)	-	-		-		24±0	-
	Breed average	-	1.05^{a}±0.05	-	213.5±4.8		12.75±0.85		24.75^{a}±0.25	-
	Crossbred	1	1.83±0.067(4)	-	-		-		31±1.54	-
		1.5	1.38±0.04(2)	-	-		-		34	-
		2	1.8(14)	-	-		-		34.57±1.58	-
	Breed average	-	1.67^{b}±0.04	-	217.03±3.35		14.83±0.215		33.19^{b}±1.1	-
	JP	1	1.55±0.03(4)	-	-		-		29.67±1.67	-
		1.5	1.81±0.10(4)	-	-		-		32.75±1.60	-
	Breed average		1.68^{b}±0.06	-	221.88±8.07		14.14±0.86		31.21^{b}±1.6	-

Traits and breed definition is same like Table 1 and 2. The significant test showed between location, breed age within breed and between lactation within age and breed. Parenthesis indicates the number of goat studied. $^{a, b}$Means with different superscripts are different at 5% level of significance

Table 4: Genotypic and phenotypic correlation between different traits of Jamunapari Black Bengal of their crossbred goat. Genetic correlation is shown bellow diagonal, heritability on the diagonal and phenotypic correlation above diagonal

Breeds	Code	MY	LMP	BWT	ASM	WSM	MLWT	LS	KI
Jamunapari	MY	**0.260**	0.990	0.049	0.056	-0.133	-0.188	0.357	0.019
	LMP	0.990	**0.320**	0.040	0.086	-0.129	-0.194	0.326	0.002
	BWT	-0.062	-0.129	**0.650**	-0.137	-0.144	0.111	0.303	0.250
	ASM	0.118	0.118	-0.136	**0.140**	0.406	-0.031	-0.047	-0.316
	WSM	-0.236	-0.204	-0.147	0.415	**0.400**	0.222	-0.211	-0.077
	MLWT	-0.247	-0.253	0.205	-0.061	0.429	**0.350**	-0.101	0.190
	LS	0.378	0.339	0.609	-0.265	-0.275	-0.171	**0.150**	0.027
	KI	0.046	0.006	0.512	-0.795	-0.164	0.094	-0.012	**0.060**
Crossbred	MY	**0.280**	0.979	0.126	0.188	-0.605	0.047	-0.155	0.135
	LMP	0.979	**0.370**	0.267	0.280	-0.642	-0.061	-0.129	0.104
	BWT	0.116	0.275	**0.600**	0.575	0.063	-0.141	-0.129	-0.423
	ASM	0.128	0.240	0.555	**0.120**	0.182	-0.332	-0.113	-0.378
	WSM	-0.505	-0.512	0.033	0.162	**0.360**	-0.144	0.020	-0.239
	MLWT	0.028	-0.068	-0.131	-0.320	-0.114	**0.380**	0.049	0.026
	LS	-0.121	-0.103	-0.191	-0.130	0.023	0.037	**0.110**	-0.162
	KI	0.111	0.070	-0.330	-0.318	-0.219	0.041	-0.150	**0.040**
Black Bengal	MY	**0.250**	0.887	-0.860	-0.756	-0.709	-0.106	-0.592	0.726
	LMP	0.887	**0.300**	-0.652	-0.777	-0.604	-0.233	-0.321	0.889
	BWT	-0.860	-0.652	**0.450**	0.159	0.287	-0.312	0.536	-0.201
	ASM	-0.756	-0.777	0.159	**0.110**	0.234	-0.014	0.295	-0.017
	WSM	-0.709	-0.604	0.287	0.234	**0.340**	0.256	0.218	-0.443
	MLWT	-0.106	-0.233	-0.312	-0.014	0.256	**0.330**	0.218	-0.210
	LS	-0.592	-0.321	0.536	0.295	0.625	0.218	**0.110**	-0.443
	KI	0.726	0.889	-0.201	-0.017	-0.555	-0.210	-0.443	**0.040**

Traits definition is same like Table 1-3

Estimated Breeding Values (EBVs) for the different traits: EBV's for different traits (BWT, MLWT, LS, KI and LMP) of 3 different breed's does' are shown in Table 7.

The EBVs were positive for Jamunapari and crossbred but it has some negative value for Black Bengal goat. The EBVs for MLWT had both positive and negative for

Table 5: Costs, revenues, profit for different traits of different breeds

	Breeds		
Traits	BB	JP	Crossbred
DM requirement per doe per year			
Doe (kg)	261.700	321.180	313.250
Yearling kid (kg)	27.750	35.150	33.890
Total (kg)	289.450	356.330	347.140
Price (US$)	44.530	54.820	53.410
Non feed cost			
Housing and others (US$)	2.560	2.560	2.560
Total expenditure (US$)	47.090	57.380	55.970
Revenue per doe per year			
Milk revenue (US$)	82.920	88.070	64.840
Mutton revenue (US$)	12.370	17.450	17.090
Manure (US$)	0.134	0.134	0.134
Grand total (US$)	95.420	105.660	82.070
Net income (US$)	48.330	48.280	26.100

1US$ = 78 BD Taka; Breed description is presented in Table 1

Table 6: Economic values (US$) for different traits of different breeds

	Breeds		
Traits	BB	JP	Crossbred
Lactation production	1.249	0.893	0.814
Lactation length	0.00000039	0.00000039	0.0000005
Birth weight	0.642	0.527	0.574
Mature body weight	-0.532	-0.422	-0.432
Gestation period	0.00000039	0.00000039	0.0000005
Litter size	2.378	1.066	0.825
Kidding interval	0.75	-0.383	-0.253

Breed description is presented in Table 1

all 3 breeds. The EBVs for LS of Jamunpari goat were similar but varied for other breeds. For KI the values were positive for Black Bengal but other 2 breeds possessed both positive and negative. The EBVs for LMP were positive for all 3 breeds but Jamunapari does were higher values than others.

Economic selection index or total merit: The economic selection index or total merit for different breeds is presented in Table 7. As an example, only top ranked 5 doe's economic selection index or total merit are presented (Table 7). The total economic merit for Jamunapari ranged from US$ 8.386-38.176 for crossbreds US$ 7.54-20.37 and for Black Bengal from US$ 8.411-US$15.1.

Productive and reproductive performance of 3 different breeds of goat: Jamunapari goat produced higher DAMY, LMP than Black Bengal and their crossbred. From the breed characteristics usually Jamunapari goat produces more milk than Black Bengal. As this breed produces more milk, therefore the farmers took special care and management to this breed. Bhowmik *et al.* (2014) observed similar results for this breed in their study. Location does not influence the milk yield of any breeds. This might be due to the production system; the farmers under MPA area fed rice, rice gruel and concentrate mix to their goats but rural people allow their goats for grazing in the field. On the other hand, the different ages of goats within breed produced different amount of milk. It was noticed that the 2 years Black Bengal goat produced higher milk than 1 and 3 years. Similar trends were also shown from Jamunapari goat. The variation of milk yield due to ages cause at the 2 years age, the goat become mature and more feed energy and protein are converted in to milk. The lactation numbers depend upon the ages and regularity of conceptions of goats. Therefore, usually 2-3 lactations produce more milk. Similar factors were responsible to produce more milk was reported by Olechnowicz and Sobek (2008).

The LL of goats differed with the location's this might be the rural farmers allow kids with does for longer period than MPA area. Within location among breed Black Bengal (123-179 days) goat had longer lactation than the Jamunapari (120-140 days) and crossbred (112-136 days). This might be due to the breed characteristics. Bhowmik *et al.* (2014) and Hassan *et al.* (2010) observed similar factors for these breed in their study. On the other hand, the LL also depends upon the age and lactation number within breed. It was noticed that the LL of 3 years goat was higher in Jamunapari and Black Bengal goat. But in crossbred the LL was higher in 2.5 years aged goat. The variation of LL due to ages cause at the 2.5 and 3 years ages due to the similar factors those are mentioned for milk yield differences. It was also observed that the LL was higher in third lactation in case of all the 3 breeds. Similar, factors were reported by Olechnowicz and Sobek (2008).

The LS and KI of different breed did not differ with locations. This might be due to the biological barrier traits and are specific for species. Black Bengal goat was higher (2) than Jamunapari (1.68) and crossbred goat (1.86) which indicates the reputation of Black Bengal goat for high fecundity. The variations were due to the differences of breed, feeding and mis managements of estrus. Khan and Khatun (2013) and Restall *et al.* (1988) observed litter size for Black Bengal goat was 1.50-1.17. However, Rout *et al.* (1999) observed the litter size for Jamunapari was 1.60 and Hassan *et al.* (2010) indicated that Jamunapari goats produce more twins and triplets. These researchers also mentioned that similar factors were responsible for the differences of kidding rate.

KI of Black Bengal goat was lowered that is the reproductive performance was better in Black Bengal goat than Jamunapari and crossbred. Khan and Khatun (2013) observed higher KI but Talukdar *et al.* (2010) found similar value with the current study. The KI was also dependent upon the age of the goats and also the length of post partum heat period. Season of previous kidding and period of kidding had significant effects on the

Table 7: BLUP estimated breeding values for different traits and economic selection index or total merit (US$) of 3 different goat breeds

Breeds	Animal ID	BVBWT	BVMLWT	BVLS	BVKI	BVLP	EINDEX	Rank
JP	1009901	0.039	1.024	0.061	-0.884	9.389	8.386	5
	1009904	0.039	-1.776	0.061	0.315	23.152	20.217	3
	1009912	0.000	-1.076	0.061	0.316	43.289	38.179	1
	1009917	0.000	1.023	0.061	1.516	23.152	19.737	4
	1009938	0.000	-1.076	0.061	0.315	30.489	26.749	2
Cross-bred	101020	0.057	0.260	-0.072	0.110	16.929	13.614	3
	101100	0.058	-0.031	0.038	0.510	9.174	7.537	5
	101330	0.000	-1.449	0.039	0.510	16.929	14.309	2
	101420	0.117	-3.349	0.000	0.000	10.062	9.705	4
	101570	0.058	2.350	0.037	-0.690	25.972	20.365	1
BB	101070	-0.109	-0.887	-0.082	0.325	6.719	8.842	3
	101380	-0.132	0.103	0.027	0.125	6.719	8.411	5
	101490	0.138	-0.887	0.027	0.325	9.854	13.177	2
	101510	-0.042	-0.887	0.000	0.000	11.744	15.112	1
	101680	-0.109	-0.226	-0.082	0.325	6.719	8.490	4

Breed and traits definition is same like Table 1-3

intervals between successive kidding. In second and third lactation, the KI was higher due to ages of the goats. Similar factors were responsible to increase KI reported by Bhowmik *et al.* (2014).

Growth performance: Under both locations the Mature Live Weight (MLWT) of Black Bengal goats was lighter (22-25 kg) than other 2 breeds and significantly differed ($p<0.05$) and the Jamunapari does posses heavier (32-35 kg) MLWT. Although, age had not been shown significantly different ($p>0.05$) but the for the Jamunapari breed 2-2.5 years older does were heavier than other does. The finding of the current study was similar with other researchers (Khan and Khatun, 2013; Paul *et al.*, 2011). However, Bhowmik *et al.* (2014) observed higher body weight for Jamunapari (45.47±3.78), Black Bengal (21.06±2.33 kg) and crossbred (35.72±2.97 kg), respectively than present study. The body weight of goats changed with the changes of age and lactation numbers within breeds.

Heritabilities, genetic and phenotypic correlations: The genetic and phenotypic correlations between body weight and milk traits were very far from those reported by Mavrogenis and Papachristoforou (2000) who reported very low correlations in Chios sheep and Damascus goat. Although, the phenotypic and genetic correlation of some traits were negative for example ASM and KI and WSM and milk yield but highest and positive phenotypic and genetic correlation was observed between DAMY and LMP for all 3 breeds. Similar results were obtained by Castaneda-Bustos *et al.* (2014) and Zhang *et al.* (2009) for milk production traits.

Economic evaluations of different genotypes: In the current model, the income was derived from the sale of milk, beef and manure and costs included only for feed and fixed costs. The milk payment for the farmers was based on milk volume only was used to calculate the profit. The net profit of Black Bengal does was higher than Jamunapari and crossbred does per doe per year. The differences of profitability were attributed to the differences of the prices of feed, milk, meat and the differences of breeds. Similar factors are responsible for the differences of profitability were reported by Khan *et al.* (2005, 2014) for dairy cows study. The higher profitability of Black Bengal goats was due to the shorter KI and larger LS for Black Bengal goats than other genotypes which leads to produces more calves than other genotypes and leads higher profit. The differences of feed Dry Matter (DM) consumed was found to be variable between breeds. The Jamunapari breeds is heavy so, its DM requirements were higher than other light breeds and this breeds contributed higher beef income in compare to others breeds. The body weight of the goat is important as it affects the profitability and thereby affect on feed requirements for maintenance as well as the value of the carcass. Similar findings were reported by Lopez-Villalobos *et al.* (2000) and Khan *et al.* (2014). In this current study, feed costs accounted for 90% of the total costs while the remaining percentage was accounted for other operational costs.

Under the rural condition of Bangladesh the farmers mainly feed their does on grassland and some farmers offer rice and rice gruel to their goat. The DM intakes and price per kg DM have also influenced the profitability which was also reported previously by Khan *et al.* (2014).

In the current study, the positive EVs for milk yield were attributed to the current milk payment system where the farmers were paid on the basis of milk volume only. The economic study for goats was very limited in literature. Lopes *et al.* (2012) conducted a similar study in Brazil and they obtained the positive EVs for milk yield (0.32-0.34 US$). The positive EVs were obtained for the traits BWT, LS, LL for all the breeds which were similar with Lopes *et al*. (2012). But KI had both positive and negative EVs. Reducing kidding interval improves farm profit because negative value indicated due to higher milk yield. Veerkamp *et al*. (2002) also observed the negative EVs for calving interval in cows. EVs of MLWT for different genotypes ranged from US$ 0.53-0.42 on per doe per year basis. Similar observations were reported by Khan *et al*. (2014, 2010) for dairy cows study. EVs for mature live weight were negative as a larger animal requires more energy for the maintenance of its body weight and that energy is unavailable for production purposes.

Estimated Breeding Values (EBVs) for the different traits: The EBVs of Black Bengal goat was found to be lower compared to other breeds for all the traits. The lowered breeding values might be influenced by a number of factors such as breed effect, stage of lactation and less number of records, etc. The similar effects for the differences of EBVs were reported by Hossain *et al*. (2004). Again, it is also well known that breeding values may differ on the basis of source(s) of information under an animal model and between selections within breed. Similar factors also reported to be responsible for the differences of breeding values of different traits by Khan *et al*. (2012). The breeding values for different traits of goats are very limited. Very few studies were conducted to estimate the BLUP breeding values with few traits, for example Li *et al*. (2000) conducted a study for estimates the breeding values for body weight and cashmere yield by multitrait animal model and they obtained similar values for body weight. Luo *et al*. (1997) conducted an experiment and they obtained estimated breeding value 7.2 kg for milk yield.

Economic selection index or total merit: The total merit value of the selection objective of milk production was calculated as the sum of the product of BLUP estimated breeding values with the Evs of all traits. This approach is similar to the method used by Khan *et al*. (2012) and Khan and Mazumdar (2011). In the economic selection index, there was a favorable combination between genetics and economics, therefore according to the economic selection index or total merit the highest ranking doe's selection as the parents for the production of offspring in the next generation could be more beneficial.

CONCLUSION

In the economic selection index, there was a favorable combination between genetics and economics, therefore according to the economic selection index or total merit the highest ranking doe's selection as the parents for the production of offspring in the next generation could be more beneficial. Such research will be helpful for researchers and academics to construct a multi-trait selection index for selecting the best mate. The farmers and policy makers can use this technique for making profitable goat farming with available breeds.

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