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Effects of genetic and environmental factors on productive performances of Hilly Brown Bengal goat at Naikhongchari

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ABSTRACT

The present experiment was studied to investigate the effect of genetic and non-genetic factors on productive performances of Hilly Brown Bengal (HBB) goats at the research farm. For this purpose, initially, a total of 69 does of different generations and 20 bucks and finally, a total of 76 does and 09 bucks were used to study productive parameters of HBB goat. The studied Animals were reared in a semi-intensive management system with natural breeding facilities. Goats were allowed to browse for 6-8 hours and mounting in hills with two times concentrates supplementation @ 1% of their body weight. Here three seasons, three generations were considered and parity was counted up to fifth. The data were statistically analyzed by using least-squares analyses of variance of the general linear model (GLM) procedure of the SPSS, 20.00. Sex of kids was significantly ($p<0.05$) affect the birth weight of kids, where male kids had higher birth weight (1.24 kg) than female kids (1.15 kg). Kids born in summer season had higher birth weight, litter weight, liter size, placental weight, kidding frequency, fortnightly body weight gain up to 6 months, pre and post-weaning gain with reduced mortality rate. Statistically, in summer season, approximately 11.22% and 3.45% heavier kids born, 9-10 g higher daily gain occurs in pre and post-weaning periods and 900-1100 g higher body weight at 3 months of age were found when compared with rainy and winter season respectively, where rainy season had highest body weight at 6 and 9 months of age. Highest percentage of total kidding (41.61%) was also found in summer season with reduced mortality rate (14%), while the highest mortality (64%) occurred in rainy season. Dams parity had significant ($p<0.01$) impact on production performances and kids mortality rate, where kids litter weight (1.60 to 2.35 kg), litter size (1.38 to 2.08) and placental weight (246.85 to 263.77 g) were increased linearly with the increment of parity up to four, while kids mortality were reduced from 36.57 to 8.44% with the increment of parity up to 5th. Results suggested that the trends of multiple births (twin and triplet) were increased with the advancement of parity, where twin and triplet kid composition increased linearly from 21 to 68% and 0 to 18% among the total kids born, respectively, while single kid percentage reduced from 79 to 14%. Best productive performances of goats were attained in 1st generation with its highest value of kids' birth weight, weaning weight, litter weight and litter size. There had significant effect ($p<0.01$) of birth type on kids birth weight, body weight changes and placental weight, where single kid had 30.85% heavier birth weight than the quadruplet with highest placental weight (219.77 to 257.45 g), while highest dams post-partum weight losses (4.8 kg) occurred in triple kidded does. Reduced kid mortality from 36.56 to 1.76% and 51 to 18% can be obtained with the increment of kids' birth weight and age, respectively.

***Key Words**: Hilly Brown Bengal Goat, Productive Performances and Non-genetic Factors*

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I. Introduction

Bangladesh, a tropical agro-based country, has the third largest concentrations of goat genotypes, with a population of about 26.43 million, which represents almost 47.26 and 6.41 % of total ruminant and livestock population, respectively (Department of livestock Services, (DLS, 2018). According to FAO, (2017), the Black Bengal Goat (BBG) genotypes comprises more than 90% of the total goat population having variety of coat color, e.g. black, black and white, brown, brown and white and white coat color and majority of these goats possess black coat color (69%) with only 5-7% brown (Habib et al., 2019; Bhuyain, 2013; Chowdhury et al., 2002). HBB goat, a variety of BBG, is available in the hilly districts of Bangladesh (Talukder et al., 2016). They are reputed for their hardness and thriving capabilities to any adverse conditions, which also make them energetic for mounting in hills. Moreover, these kinds of dwarf type goats are known to be famous for its high adaptability, fertility, prolificacy, delicious meat and skin quality. Having these phenomena and are available in hilly parts of Bangladesh they are known as Hilly Brown Bengal (HBB) goat. Talukder et al. (2010) reported that growth rate of HBB goat kids is an average of 53 gm/day at the first 3 months of age and then gradually decreases. The adult body weight of hilly goat is 20.95 kg. There are very few works on HBB goat genotypes and genetic and phenotypic parameters are not well documented in the hilly areas. Thought, it is very crucial for understanding the detailed knowledge of genetic variation within and among different breeds (Yeo et. al., 2000) which can lead to developing indigenous animal genetic resources

Again, the majority of the tribal people, who live in the hilly forests with primitive ways of life, are practiced traditional agriculture with predominant integrated farming system of crop production together with homestead garden, livestock, horticulture and forestry (Alam et. al., 1993). Therefore, introduction of above mentioned HBB goats can play a dynamic role in the integrated farming system practiced in the hilly districts. The HBB goats no doubt a promising treasure of Bangladesh but is going to be extinct. With the view of above circumstances, Bangladesh Livestock Research Institute has undertaken a program to develop HBB goat in hilly regions. The objective of the study is to know the effect of season, parity and generation of dams on productive performances of HBB goats at hilly area's farm level in Naikhongchari, Bandarban.

II. Materials and Methods

Experiment location

This research work was conducted at the Bangladesh Livestock Research Institute (BLRI) Regional Station, Naikhonchari, Bandarban, Research farm.

Experiment duration

The experiment was carried out for a4 year's tenure. The data used in the experiment were from the "Community based hilly goat development program at hilly regions at Naikhongchari" project conducted at Bangladesh Livestock Research Institute, Regional Station, Naikhongchari, Bandarban.

Animals used

For the first time, year 2012, a total of 69 doe of HBB goats of different generations (Foundation = 07, Generation one = 32, Generation two = 23 and Generation three = 07) and 7 bucks (First generation) and finally, year 2016, a total of 76 does of different generations (Foundation = 08, Generation one = 24, Generation two = 32, Generation three = 11 and Generation four = 01) and 9 bucks (07 = First generation, Generation two = 01 and generation four =01) were reared to study the productive performances. At time of project operation, these goats primarily were collected from different hilly areas of Bandarban. The phenotypic characteristics viz. body size, conformation, weight, age, their

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ancestral history on production and reproduction and also on dam performance was the basis of selection. Also, for female selection, the criteria of twinning and triplets kidding dam were considered.

Housing

In the first phase of the project, goats housed on the wooden floor and tin shed houses with the wooden wall. Then in second phase of the project, goats were transferred to a permanent house with slated platform of 1m above from the ground. All goats were kept separately following sex and age groups to prevent random mating and to facilitate easy data collection.

Breeding

To improve economically important traits**,** a natural breeding program was performed in every morning. Barking, swelling and mucus discharge of vulva, jumping on other animals, off-feed and any other physical sign of heat were observed with a buck. Female in estrous were mated with the buck naturally according to mating chart that has been planned previously.

Feeding and rearing system

Females were allowed to browse for 6 hours (from 10 AM to 4 PM) with a 1-hour rest (1:00 PM to 2:00 PM). Kids up to three months of age were allowed to graze with their mother. Bucks were allowed to graze for 2 hours (from 8 AM to 10 AM) in morning and 1 hour in afternoon. Goats were supplied a concentrated mixture containing 17% CP, 11 MJ ME/kg DM provided twice daily in the morning and evening @ 1% of their body weight respectively for different categories as pregnant and milking does, dry goats, growers, kids and bucks. All goats were kept in different groups based on sex (heifer and whether), physiology and body weight for easy feeding operations.

Health care and diseases

Considering cold and dry season, experimental kids were kept in a specially designed brooding pen with temperature control facilities, feeding and watering provision and with adequate bedding materials. They were vaccinated against PPR (Peste Des Petits Ruminants) two times in a year, while kids were also vaccinated against PPR from their two months of age. De-worming program was applied every three months in a year and animals were dipped in 0.5% melatheon solution for each month. Another required treatment and management were provided against specific diseases according to the suggestion of the Veterinarian assigned. Sick animals or kids, stunted growth, unthrifty condition, and any severe skin diseases were also regularly treated and culled.

Factors considering

The year was divided into 3 seasons. In this study, seasons were described according to some previous research work (Paul et al., 2016; Faruque et al., 2010). These were season-1 (March-June), season-2 (July- October) and season-3 (November-February). The goats in experiment were studied up to fourth parity in three generations.

Productive data

The effect of sex, season, parity and generation on kid's birth weight (kg), kids weaning weight (kg), kid litter weight (kg), litter size and placental weight (g) were studied. Pre-weaning gain (g/day), post-weaning gain (g/day), body weight gain per day (g), rate of body weight gain (%), kid mortality (%) before weaning, mortality at 4-9 months of age, mortality up to maturity etc were also recorded. In addition, live weight at kidding (kg), fortnightly live weight changes before kidding (kg), live weight just after kidding (kg), and loss of live weight just after kidding (kg) and fortnightly live weight changes after kidding (kg) were recorded during the study periods. Record keeping: All the experimental goats were ear-tagged individually. Flock book, shed book, kid book, mating book, health book, feed book was used for record keeping.

Statistical Analysis

Data on production and reproduction were recorded in an individual data sheet for each of the animals. Then, the data was statistically analyzed by using compare mean with one way ANOVA and univariate analysis of variance procedure of SPSS 20.0 package. The difference between treatment means was examined by using Duncan Multiple Range Test (DMRT).

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III. Results and Discussion

Effect of sex, birth type BT, parity, season and generation on productive performances

The effect of sex, birth type (BT), parity (P), season (S) and generation (G) on growth performances of HBB goat are presented in Table 01 and Table 02. In this study, birth type count single to quadruplet, season divided into summer (S-1), rainy (S-2) and winter (S-3), parity count up to five with three generations (G-1, G-2 and G-3).

Kids Birth Weight (KBW)

KBW (kg) had a significant variation with sex ($p<0.05$), BT ($p<0.01$) and S ($p<0.05$) but not varied with P and G, which varied from 0.94 to 1.24 kg regardless of factors affecting their weight (Table 01 and Table 02). In this study, the male KBW was significantly higher than the female kids irrespective of P, S and G. Talukder et al. (2016) stated similar KBW, with an average weight of 1.20 kg. Relatively higher birth weight in male kid (1.15-1.38 Kg) than female (0.98-1.20 kg), was observed in this goat breed, described by many authors (Afroz et al., 2020; Moni and Samad, 2019; Talukder et al., 2016; Faruque et al., 2016; Jalil et al., 2016; Bowmik et al. 2014; Mahal et al. 2013) with average birth weight, ranging from 0.89 to 1.28 kg. Unlike the present findings, Shoshe et al. (2019) reported in a survey on BBG with higher male and female birth weight (1.56 and 1.38 kg, respectively). Hassan et al. (2007) also noted that the average birth weight of Black Bengal goat was 1.60 ± 0.50 kg, which is higher than the results of the present study. In this study, the single KBW was about 30.85% heavier than the quadruplet, while kids born in rainy season were 11.22% and 7.88% lighter than the kids born in summer and winter season, respectively irrespective of sex. These findings were also supported by some authors (Moni and Samad, 2019; Hasan et al., 2014) indicated that kids born within October to January had higher birth weight as compared to the kids born in other seasons. Although, Hasan et al. (2015), stated more or less similar results of non-significant seasonal variation on BBG, with the highest KBW was obtained S2 and S1. Single born kids had higher birth weight than twins and triplets. In this study, numerically KBW was increased with an increase of parity up to three, then it decreased by only 2.58%. The authors found similar results in his previous study (Talukder et al., 2016) with HBB goat, reporting highest KBW (kg) was 1.23 in single BT followed by twin (1.20), triplet (1.10) and quadruplet (0.93). Talukder et al. (2016) and Talukder et al. (2010) also demonstrated the effects of parity on KBW of HBB goats, showed increasing trends with increasing parity up to fifth. These findings were also supported by some authors (Afroz et al., 2020; Jalil et al., 2016; Hossain et al. 2004) where birth weight of BBG was found higher in third parity or fifth parity. However, these results obtained depended on the various feeding and management aspects, in which the researchers studied.

Table 01. Effect of Sex and Birth Type on productive performances of HBB goat

Factors	Parameters		
	KBW, kg ± SD	KWW, kg± SD	PW, g± SD
Sex			
M	1.24^{a}±0.18 (22)	6.08^{a}±0.83 (13)	-
F	1.15^{b}±0.11 (22)	5.76^{b}±0.67 (16)	-
Sig.	*	NS	
Birth type			
Single	1.23^{a}±0.13 (52)	-	219.77^{c} ±6.33 (16)
Twin	1.15^{ab}±0.14 (68)	-	239.28^{b} ±7.98 (26)
Triplet	1.02^{bc}±0.17 (28)	-	246.38^{b} ±4.63 (5)
Quadruplet	0.94^{c}±0.22 (2)	-	257.45^{a} ±5.62 (2)
Sig.	**		**

Sig=Significance; KBW, Kids birth weight; KWW, Kids weaning weight; PW, Placental weight without fluid; M, Male; F, Female; Figure in the parenthesis indicates the number of observation. Means with different superscripts within the same column differ significantly. **=Significant at 1% ($p<0.01$) level of probability, NS=Non significant ($p>0.05$).

Kids Weaning weight (KWW)

None of the factors studied had significant variation on KWW which was ranging from 5.34 to 6.08 kg (Table 01 and Table 02). In this study, male kids weaned with heavier weight than female kids, while the kids of 1st generation (G) weaned with higher body weight followed by 2nd and 3rd G. Results also showed kids born in summer season had lower weaning weight (5.37±.67) than rainy (5.57±.87) and

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winter (5.85±.47) season, while kids of 1st parity weaned with lower weight than 2nd and 3rd parity. In this study, the weaning weight of HBB goat was similar to black Bengal goat which was observed by Talukder et al. (2016); Khan and Naznin, (2013) but lower than Khan and Khatun (2013). They reported the average weaning weight of goats 5.26, 5.34 and 6.75 kg, respectively. According to Shoshe et al. (2019), male and female KWW of BBG was 5.35 and 4.96 kg, which was lower than the present findings. Unlike the present findings, Jalil et al. (2016) reported the highest KWW (kg) at G_2 (5.34) followed by G_3, G_1 and G_0 with an average of 4.88.

Kids litter weight (KLW) and litter size (LS)

KLW and LS had significant variation with P ($p<0.01$) and G ($p<0.05$) of their dam but had no S effect (Table 02). Significantly higher KLW and LS was observed in 1st G (1.60±0.50 and 1.38±0.51 kg) than in 2nd (1.22±0.27 and 1.08±0.28 kg) and 3rd G (1.23±0.33 and 1.08±0.2 8kg) in this study. Results indicate that, KLW and LS were increased significantly from 1st to 4th p where in 4th P approximately 47% and 50% higher KLW and LS were found than 1st P, respectively. Jalil et al. (2016) obtained highest LS in 1st G on BBG by comparing up to 4th G, which was similar to present findings. These results also similar to previous findings (Jalil et al., 2016; Hasan et al., 2015; Hasan et al., 2014; Chowdhury et al. 2002; Hossain et al. 2004) in which LS of BBG was increased with parity up to three or sixth, ranging from 1 to 4, depending on their feeding and management systems. Studying the effect of season on BBG, Moni and Samad (2019) and Hasan et al. (2015) found highest LS in S1 compared with S2 and S3, ranging 1-4, 1-3 and 1-3 respectively. On the other hand, Moulick et al. (1996) reported an average litter size of 2.1 in BBG.

Table 02. Effect of seasons, parity and generation on productive performances of HBB goat

Factors	Parameters				
	KBW, kg± SD	KWW, kg± SD	KLW, kg± SD	LS± SD	PW, g± SD
Season					
1	1.21^{a}±.08 (13)	5.37±.67 (13)	1.97± .77 (10)	1.30±.48 (10)	245.60^{a}±12.7 (10)
2	1.09^{b}±.15 (11)	5.57±.87 (10)	1.85±.63 (9)	1.20±.42 (10)	224.44^{b}±24.4 (10)
3	1.17^{ab}±0.1 (12)	5.85±.47 (12)	1.87±.62 (10)	1.20±.42 (10)	230.60^{ab}±10.4(10)
Sig.	*	NS	NS	NS	*
Parity					
1	1.16±.14 (18)	5.88±.98 (18)	1.60^{c}±.50 (13)	1.38^{c}±.51 (13)	246.85^{c}±9.3 (13)
2	1.17±.17 (21)	5.98±1.1 (21)	1.90^{bc}±.64 (13)	1.62^{bc}±.51 (13)	256.08^{b}±7.9 (13)
3	1.20±.13 (23)	6.06±.92 (23)	2.11^{ab}±.61 (13)	1.77^{ab}±.44 (13)	257.23^{b}±6.6 (13)
4	1.13±.14 (27)	5.50±.89 (27)	2.35^{a}±.37 (13)	2.08^{a}±.28 (13)	263.77^{a}±4.6(13)
Sig.	NS	NS	**	**	**
Generation					
1	1.16±.14 (18)	5.88±.98 (18)	1.60^{a} ±.50 (13)	1.38^{a}±.51 (13)	246.85^{a}±9.3 (13)
2	1.13±.10 (14)	5.85±.81 (14)	1.22^{b} ±.27 (13)	1.08^{b}±.28(13)	224.15^{b}±20.2(13)
3	1.15±.11 (14)	5.34±.65 (14)	1.23 ^{b} ±.33 (13)	1.08^{b}±.28 (13)	240.14^{a}±6.44(14)
Sig.	NS	NS	*	*	**

Sig=Significance; KBW, Kids birth weight; KWW, Kids weaning weight; KLW, Kids litter weight; LS, litter size, PW, Placental weight without fluid; M, Male; F, Female; SD, Standard deviation; Figure in the parenthesis indicates the number of observation. Means with different superscripts within the same column differ significantly. **=Significant at 1% ($p<0.01$) level of probability, NS=Non significant ($p>0.05$).

Placental weight without fluid (PW)

The PW in Hilly Brown Bengal (HBB) goat was found approximately 219.77- 263.77 g which significantly varied ($p<0.01$) of all the factors and linearly increased with BT and P from 219.77 to 257.45 g and 246.85 to 263.77 g, respectively. the results obtained may be due to the highest body weight of single kids than quadruplet kids and with the highest KLW and LS. In summer season PW was found to highest than winter and rainy season because summer season had higher KBW, KLW and LS than any other seasons. In this study, PW obtained highest in G-1 when compared with G-3 and G-2, due to the higher value of KBW, KLW and LS.

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Effect of season on body weight gain

The body weight gain of HBB goat during pre-weaning and post-weaning period, 3-month, 6-month and 9-month age were influenced significantly by seasonal variation (Table 03). Significantly ($p<0.05$) highest pre-weaning (49.86g/day) and post-weaning gain (39.90g/day) were obtained in summer compared with winter and rainy season. Similarly, season had a significant effect on body weight gain at weaning until growing adult (9 months of age). Highest body weight obtained in 3-month of age during summer season followed by winter and rainy but in the age of 6 and 9-month period bodyweight increased up to the rainy season and then falls in winter. The effect of season may be explained partly by the climatic conditions, hence, feeding practices in different seasons for dams and offspring were similar. Previous studies Singh and Yadava (1997) observed significant effect of season on body weights at 3 and 6 months of age whereas no significant effect at 9 months of age in Boar goats. Afroz et al. (2020) was also studied the seasonal effect on three coat color varieties of BBG, reported highest 3 and 6 months body weight gained in summer followed by winter and rainy season. Although, these results were higher than the present findings and is partially supported by present findings. Season of birth plays an important role in next bodyweight gain indirectly through its influence on the dam's nutrition, amount of milk available before weaning and effect of quality and quantity of pasture available to the post-weaned kids (Mahal et al., 2013).

Table 03. Effect of season on average daily gain at different age groups of HBB goat

Parameters	Seasons			SEM	Sig.
	Summer	Rainy	Winter		
Pre-weaning (0-90d) gain (g/d)	49.86^{a}	39.00^{b}	39.55^{b}	1.16	**
Post-weaning (91-180d) gain (g/d)	39.90^{a}	36.32^{ab}	28.57^{b}	1.68	*
3-month body weight (kg)	5.73^{a}	4.62^{b}	4.79^{b}	0.11	**
6-month body weight (Kg)	6.93^{b}	7.89^{a}	7.88^{a}	0.15	*
9- month body weight (Kg)	9.34^{b}	11.31^{a}	9.21^{b}	0.22	**

Sig=Significance; SEM=Standard Error of mean; Means with different superscripts within the same column differ significantly. **=Significant at 1% ($p<0.01$) level of probability, NS=Non significant ($p>0.05$).

Bodyweight changes of dam

Dams body weight changes in pre and post-partum weight was varied significantly (($p<0.01$ & $p<0.05$) and tented to be higher in triplet kidded does than twin and single (Table 04). The average pre and post-partum weight changes from 24.06 to 28.9 kg and 20.88 to 24.67 kg, respectively. The loss of live weight just after kidding was also found higher ($p<0.01$) in triplet kidded (4.80 kg) does than twin (2.56 kg) and single (1.75 kg), indicated that this post-partum loss may be due to higher KLW and placental weight with its fluid contents (Sarkar et al., 2008).

Table 04. Effect of birth type on body weight changes (Kg) and placental weight (g)

Reproductive Parameters	Birth type			SEM	P-value.
	Triplet (n=5)	Twin (n=26)	Single (n=16)		
Live wt. at kidding (Kg)	28.90^{a}	24.06^{b}	24.20^{b}	0.418	**
Live wt. just after kidding (Kg)	24.67^{a}	21.75^{ab}	20.88^{b}	0.472	*
Lose of Live wt. after Kidding (kg)	4.80^{a}	2.67^{b}	1.75^{c}	0.144	**

Sig=Significance; SEM= Standard Error of mean; Figure in the parenthesis indicates the number of observation. Means with different superscripts within the same column differ significantly. **=Significant at 1% ($p<0.01$) level of probability, NS=Non significant ($p>0.05$).

Frequency of kidding

During the experimental seasons (2016), a total of 137 kids were born from 82 does (Table 05). The percentages of male kids born (52.55%) were higher than female kid born (47.45%) during all three seasons except winter. In the experimental year out of total kids born, 57 (41.61%) was born duringhot and dry months (March-June), 41 (29.94%) during hot and wet months (July to October) and 39 (28.47%) during cold and dry months (November to February). However, in the studied year highest percentage of total kidding was found in September (24.09%) followed by April (21.90%), December (21.17%) and so on. Out of 137 kidding records from 82 does, 60 (44%) was single kid, 68 (49%) was twin kids, 8 (6%) were triplet kids and only 1 doe kidded four kids during the experimental year (Figure 01). They reported average weaning weight of goats 5.26, 5.34 and 6.75kg, respectively. Chowdhury et al. (2002) showed that peak incidence of kidding occurred from July to September in Black Bengal goat

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but Amble et al. (1964) stated it happened in March to April, which showed more or less similar results in the present study.

Table 05. Frequency of kidding during different experimental months

Season	Months	Total does kidded	Total kids born	Male (M)	Female (F)	% of M kids	% of F kids	% of total (M+F) kidding
Summer	March	6	9	6	3	66.67	33.33	6.57
	April	18	30	18	12	60.00	40.00	21.90
	May	2	3	1	2	33.33	66.67	2.19
	June	11	15	5	10	33.33	66.67	10.95
Total								41.61
Rainy	July	1	2	1	1	50.00	50.00	1.46
	August	1	3	2	1	66.67	33.33	2.19
	September	20	33	19	14	57.58	42.42	24.09
	October	2	3	1	2	33.33	66.67	2.19
Total								29.93
Winter	November	1	2	2	1	50.00	50.00	1.46
	December	15	29	14	15	48.28	51.72	21.17
	January	3	6	2	4	33.33	66.67	4.38
	February	2	2	2	0	100.00	0.00	1.46
Total								28.47
Grand Total		82	137	72	65	52.55	47.45	100.00

Effect of parity on birth type

Effect of parity on birth type was shown in Figure 02. In the first parity, single and twin kid comprised 79 % and 21 % of total kid born, respectively. However, in the 3rd, 4th and 5th parity twin and triplet type birth were 66, 6, 70, 11, and 68, 18%, respectively. In this study, the trends of multiple births were increased advancement of parity which was supported by some other studies (Hasan et al. 2014; Hossain et al. 2004). This might be due to more bodyweight of does and the enlargement of uterine size after parturition of first parity kids.

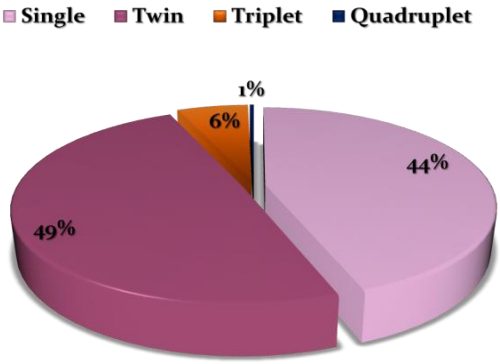

Figure 01. Frequency of birth composition

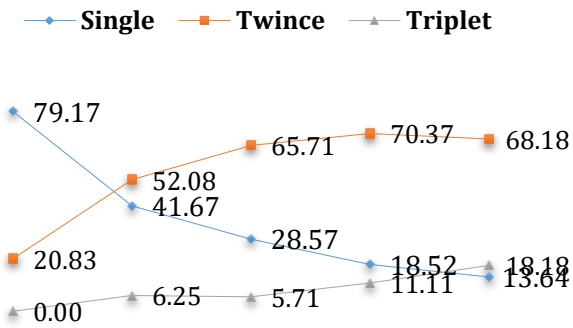

Figure 02. Effect of parity on birth type

Fortnightly growth rate of HBB goat

The fortnightly body weight changes of HBB goat up to 9 months age in different seasons were presented in Figure 03. Figure 03 showed that, up to 9 months of age HBB goat attained 9.40, 11.43 and 9.04kg weight in summer, rainy and winter season, respectively. The summer season revealed highest body weight changes up to 5 months of age, after that it was next to the rainy and winter season. Those kids born in summer season exhibited highest body weight changes within 3 months of age (weaning age) then it falls into the rainy season with its slow growth rate, but in winter again it gains faster. The figure also showed that those kids born in rainy and winter seasons their body weight changes occur linearly up to the 6 months of age, after that rainy season showed straight pattern and winter season goes

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downward. This pattern of bodyweight changes was suggested that kids born in winter season fall in rainy season after 6-7 months of their age and growth rate retired.

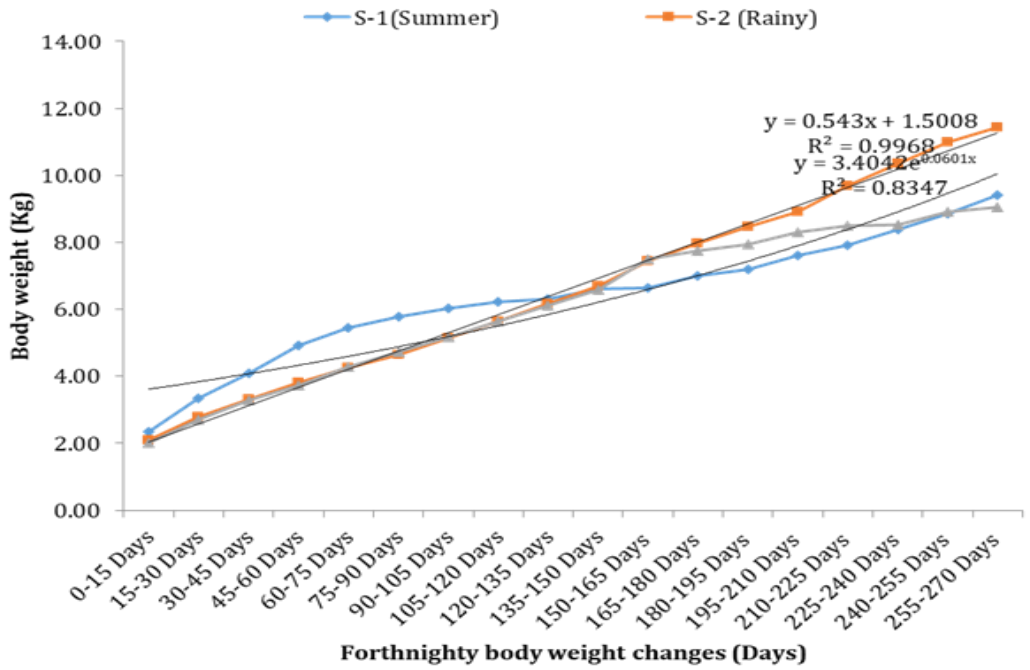

Figure 03. The fortnightly body weight changes of HBB goat in different seasons

Factors affected the kid mortality

Effect of age: A kid age extremely affected kid mortality. In this study, kids were divided into three age groups as less than equal 3 months, from 4 to 9 months and more than equal 10 months of age each having 36, 22 and 13 observations of kids death respectively. Kid age at less than equal 3 months had highest kid mortality (51%), which decreased exponentially with the maturation of kids (Figure 04)

Effect of season: Three seasons namely summer (S1), rainy (S2) and winter (S3) having 11, 41 and 19 death records in each season respectively. Rainy season had significantly higher kid mortality (64%) than winter or summer season. S2 had approximately five times and three times higher kid mortality than S1 and S3 season respectively (Figure 05). Similar results were observed by some other authors (Kashem et al., 2011; Ershaduzzaman et al., 2007), who reported the highest number of growing kids died in the S2 (40.6%) followed by S3 (19.4%) and S1 (14.7%).

Effect of birth weight on kid mortality: Birth weight of kids were categorized according to their weight in six groups as less than 1.10, 1.11-1.20, 1.21-1.30, 1.31-1.40, 1.41-1.50, and more than 1.51 kg each having 83, 72, 40, 23, 5 and 4 kids respectively. Kids weighing less than 1.10 kg birth weight had 36.56% mortality which decreased (R^2=0.95, $p<0.01$) linearly up to 1.76% with the increase in kid birth weight (Figure 06). Hossain et al. (2004) observed kid mortality decreased 41 to 6% with kids body weight increase which was little higher than present findings. Similar results were also found by Ershaduzzaman et al. (2007) and Husain (1993).

Effect of parity on kid mortality: Kid mortality (≤ 3 months of age) of HBB goat was recorded and calculated for the study periods in the Research farm of BLRI Regional Station, Naikhongchari, Bandarban. There were 63, 63, 54, 45 and 36 mortality numbers of population records on 1st, 2nd, 3rd, 4th and 5th parity, respectively. Kid mortality decreased (R^2=0.99, $p<0.01$) exponentially from 36.57 to 8.44% with an increase in parity number (Figure 07). At 1st parity, kid mortality was 36.57%, which reduced to 8.44% at the 5th parity. These results were more or less similar to some previous findings (Chowdhury et al. 2002; Hossain et al., 2004). They observed kid mortality decreased 22 to 8% with parity increase which was little lower than present findings. Unlike the present findings, Hasan et al., (2015), studied parity effect on BBG and observed highest mortality in the 2nd parity than 1st one. However, Ershaduzzaman et al. (2007) had found non-significant variation of kid's mortality with parity.

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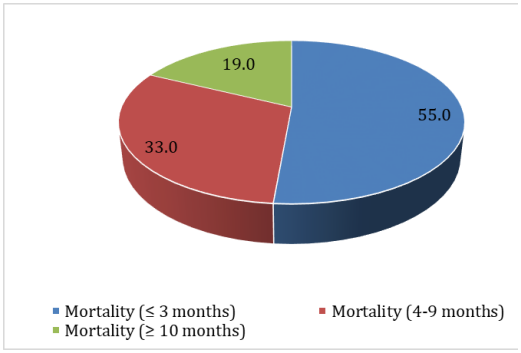

Figure 04. Effect of age of kid on mortality

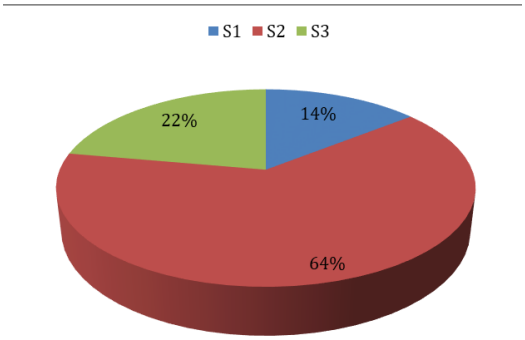

Figure 05. Effect of season on kid mortality

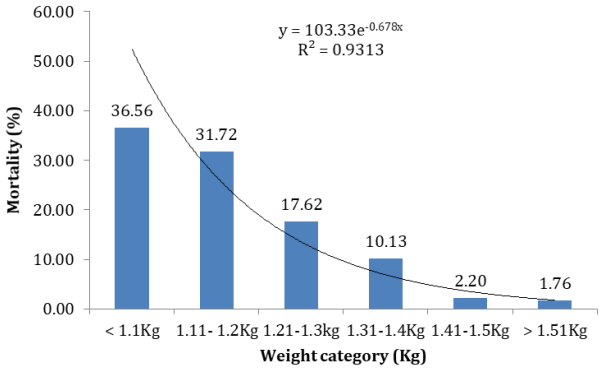

Figure 06. Effect of birth weight on kid mortality

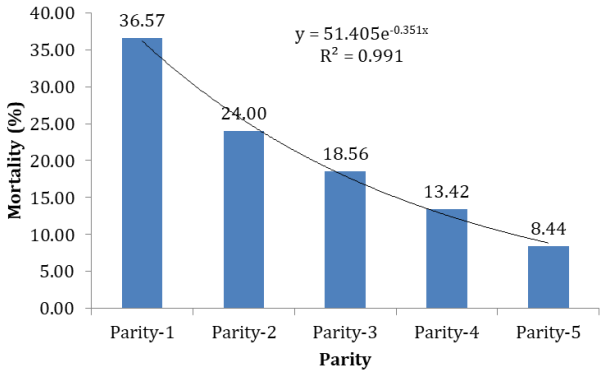

Figure 07. Effect of parity on kid mortality

V. Conclusion

This study summarized that seasonal variation had a significant impact on kid's birth weight, kidding frequency and daily body weight gain in different age groups of Hilly Brown Bengal goat, with variable kid mortality rates. Kids' birth weight to 9 months of age, daily body weight gains and kidding percentage were higher during summer seasons, with its minimum mortality percentages. However, kids birth weight, litter weight, weaning weight, litter size and birth composition were increased with its lower mortality rate by increasing parity up to 4th or 5th. The trends of multiple births (twin and triplet) were increased with the advancement of parity. Best productive performances of goats were attained in first generation. There had also a significant effect of birth type on body weight changes and placental weight, where highest post-partum losses occur in triple kidded does with highest placental weight. Reduced kid mortality can be obtained with the increment of kid's birth weight and age of kids.

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