Black Bengal goat husbandry-An appraisal of productive and reproductive performance under intensive management system

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Abstract

Black Bengal goats are mainly reared by economically weak farmers under extensive /semi-intensive systems. This breed is very famous for excellent quality meat and high valued skin. At present, phenomenon of gradual shrinkage of grazing land is forcing farmers to adopt goat rearing by intensive management system (IMS). Therefore, assessment of production performance of goats under IMS would help to devise better management for higher profits. Goats managed under IMS revealed that from birth, body weight of animals increased linearly up to 2 ½ years of age, thereafter, body weight did not show any significant changes. Body weight was stabilized between 2-3 years of age. From birth to 3 months age body weight enhanced by 164%, subsequently by 152% from 3 to 6 months age, then by 14 and 28% in next 3 months intervals, which warranted targeting better management during 6-12 months of age to achieve more body mass production. Seasons non-significantly ($P>0.05$) influenced growth rate (g/day), highest in summer (30.78±5.30) and lowest in rainy (24.15±2.10). Male kids had higher ($P<0.01$) growth rate (29.72±2.62) than females kids (24.73±2.95). Reproduction showed higher proportions of female birth (60.17%) as compared to male (39.83%). Goats had reproductive efficiency of 50.98% singles, 43.14% twins and 5.88% triplets under IMS. The in-house production environment of IMS was stressful being THI 86-90 in summer and rainy seasons, and 77-80 in winter seasons. The flooring hygiene (1-4 scale) of goat houses in IMS ranged from 3.18±0.08 to 3.72±0.06 in wooden to concrete floors. It was recommended that targeting for higher growth rates during 6-12 months of age and increase in proportions of multiple births might enhance productivity and profitability of Black Bengal goat farming under IMS.

Key words: Growth rate; Reproductive performance; Physiological response; Kidding

Introduction

Black Bengal goats (BBG) are very prized small ruminant species because of their potential attributes viz. higher prolificacy, adaptability to wide range of climatic conditions, disease resistivity, early sexual maturity, fertility, fecundity, capacity to utilize and survive in poor natural vegetations, crop residues with or without supplementations, excellent meat and skin quality (Devendra and Burns, 1983; Acharya, 1987; Nandi et al., 2011). Goat rearing is a rural enterprise for socio-economically poor people and this breed is mainly reared by the most vulnerable sections of the society in the entire eastern parts of India, Bangladesh and adjoining areas. BBG is mainly managed under extensive production system by small, marginal and landless farmers (86.30% in India, Nandi et al., 2011; 80% in Bangladesh, Islam et al., 2016). In West Bengal mostly women (91.3%; Nandi et al., 2011) of the farming families rear this goat. In a recent trend, the gradual shrinkage of grazing area, fallow lands, pastures, natural vegetations increase in cropping intensity and urbanizations are forcing goat-farmers shifting from extensive system to adopt intensive management system (IMS). Under field conditions, gradual depletion of genetic pool of BBG is taking place due to indiscriminate breeding, lack of proper AI service using potential BBG sires, crossbreeding with Jamunapari and other breeds to cover up poor growth rates of BBG (Dayal et al., 2016). However, in organized farms pure BBG are maintained under IMS and breeding problems are rationally avoided. Therefore, assessment of production performance of Black Bengal goats under IMS would help to devise better management of BBG for higher profits. For this purpose, micro-environment of the production system, animals cardinal physiological parameters, levels of animals' comfort/stress, health and hygiene under IMS need to be analyzed along with production and reproduction performances. Evaluation of production environment and performance under IMS can be of help in development of strategic improvement policies, expansion of frameworks for future development and increase in the effectiveness of BBG for more profitable rural enterprise. The main objective of present study was to assess micro-environment of the intensive production system, physiological response of animals therein, hygiene, production and reproduction performances of BBG under IMS to formulate better management practices on goat rearing.

Materials and Methods

Present study was conducted at Black Bengal Goat Unit, ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani West Bengal, Nadia, India. Records of Black Bengal goats (N=120) kept during the periods from year 2020-2021 were analyzed in this study.

Micro-environment inside the goat shed was recorded daily at morning (8:00-8:30 am) and afternoon (2:30-3:00pm). The air temperature (ºC), humidity (%), maximum and minimum temperatures (ºC) inside the goat shed were recorded as per standard procedures (IMD, 1970).

Goats were kept under intensive production environment. The roof of goat shed was a double slope truss covered by galvanized color coated roofing sheets. Goat shed had solid cement concrete walls on four sides covering $1/3^{rd}$ of roof height and rest $2/3^{rd}$ covered by iron nets. One open paddock, lengthwise 1/3 covered by roofing sheets and 2/3 uncovered, was used for general movement of goats during day time. The floor of house was made of cement concrete and two wooden slabs were kept on the floor. The goat shed had two pens, side by side.

Goats were group fed in the stalls under intensive management system. Seasonal green fodder (Maize, Jowar, Hybrid Napier in *Kharif* and Oats, Berseem in *Rabi* seasons) were fed *ad libitum* at morning and afternoon with concentrate supplementation of 200-250 gm per adult goats per day. Kids were weaned at 75-90 days of age. Kids were provided concentrate 50g per day at 2-3 months of age and gradually increased to 200 g/day by 6-7 months of age. The chemical composition (%) of concentrate was as follows: moisture-11, crude protein-22, crude fibre-10, ether extract-4, acid insoluble ash-3, common slat-1, calcium-0.8, phosphorus-0.5 and vitamin A- 7000 IU/kg.

Routine breeding practice of the farm was AI, however, in repeat breeders natural mating were also done. Empty stomach body weights of animals were recorded at monthly intervals. Other records viz. kidding, production and reproduction performance was recorded in this study from the regular registers maintained in the farm.

Prolificacy of goats was calculated as follows:

Prolificacy (%) = (Number of kids born/Number of does delivered) × 100

Rectal temperature (ºC), pulse rate (beats/min) and respiration rate (breath/min) of goats was recorded at fortnight intervals at morning keeping minimum possible disturbances to the animals. Dirtiness score of floor (1-4 scale; Jørgensen and Bøe, 2009) was evaluated by one person every morning before cleaning of the shed.

All the data obtained from registers / recorded during the study periods were organized, structured and analyzed using ANOVA through SPSS (V.26.0) software. The means differences were compared by Tukey's post hoc test. The level of significance was set at $p<0.05$ and $p<0.01$.

Results and Discussion

Micro-environment of the goat shed

Analysis of the micro-environment inside the goat shed revealed that production environment was predominantly hot and humid (Table 1). The thermal humidity index (THI) was quite high. Similar in-house THI levels (74.4-88.6) had been reported in hot-humid summer conditions of Kerala (Yamin et al., 2022). Although, goat had versatility to cope with adverse climatic conditions through adaptable strategies (Silanikove, 2000; Silanikove and Koluman, 2015), however, they also suffered from heat stress beyond their comfort zone of 13–27 ºC of ambient temperature (Mishra, 2009). The existing goat-shed roof was made up of polymer coated colored galvanized roofing sheet. The thermal humidity index of both summer and rainy season was very high and findings indicated that goats' in-house environment was stressful. The climate of the study region is basically hot-humid, 48% of mornings and 88% of afternoons environment of the year were stressful for dairy cows (Mandal et al., 2021a, 2021b) and found to reduce productivity, affect behaviour and welfare of animals (Mandal et al., 2016; Kumar and Mandal, 2022).

Hygiene score of the goat shed under IMS

The floor hygiene conditions (1-4 scale) in IMS ranged from 3.18±0.08 to 3.77±0.06 in wooden slab to concrete floors of goat houses. In first goat pen the dirtiness score of wooden slab was less (3.18±0.08) as compared to concrete floor (3.72±0.06). Similarly in second goat pen the dirtiness score of wooden slab (3.16±0.07) was lesser than that of concrete floor (3.77±0.06). Less dirtiness on wooden slabs was due to easy removal urine through the wooden slats and thus wood surface remained dry as compared to concrete floor. Goats' floor preference was tested by observing their availability on a particular floor by counting their numbers. It was observed that more than 80% goats showed preference for wooden slabs as compared to concrete floor. Hygienic score of floors indicated their suitability of uses under IMS for goat rearing.

Body weights and growth rate of Black Bengal Goats

Age-wise variations in body weights were given in Table 2. Similar range of body weights of BBG had been reported from other organized farms (Dayal et al., 2016). Lower body weights of BBG than the present report at 3 months and 6 months of age had been reported under filed conditions (Islam et al., 2016). Under extensive system higher growth performance of BBG was also reported (Debbarma et al., 2018). Presently reported birth weight of BBG was within the range as reported earlier (0.8-1.8 kg; Hossain, 2021). Body weights of goats increased linearly from birth to 2 ½ years of age, thereafter, body weights did not show any significant changes. Thus body weights of BBG seemed to be stabilized between 2-3 years of age. From birth to 3 months age body weights enhanced by 164%, subsequent enhancement of 152% from 3 to 6 months age, then by 14 % between 6-9 months and 28% in next 3 months. Results indicated that better management at 6-12 months age must be targeted to achieve higher body weights of BBG for meat production under IMS.

Growth rates of Black Bengal Goats (up to 12 months age) were presented in Tables 3. Seasons did not show significant differences on growth rates; however, males showed higher trends of growth rates as compared to females. Seasons non-significantly ($P>0.05$) influenced growth rates (g/day); being highest in summer (30.78±5.30) and lowest in rainy (24.15±2.10) seasons. Male kids had higher ($P<0.05$) growth rates (29.72±2.62) than female kids (24.73±2.95). A number genetic and non-genetic factors (Singh et al., 1991), polymorphism in growth hormone (GH) gene (Dayal et al., 2016), behaviour factors like mother-kid interactions (Mandal et al., 2022) had been reported to affect growth performance of BBG. Impact of behavioural factors on growth rate of BBG had scantily been investigated and kids with poor mother-kid bonding had 15% lesser body weight at 11 months of age as compare to their herd mates. Inferior mother-kid bonded doe produced 36% less milk as compared to flock mates (Mandal et al., 2022). In the present findings, growth rate of BBG became very sluggish at 6-12 months age. This age is the time of puberty, onset of estrus, first breeding of females, pre-marketing age of castrated males and therefore, this time required more attentions for future profitability under IMS. Some of the genotype (Growth hormone polymorphism) of BBG was found to have 65% more weight at both 6 and 9 months of age than others (Dayal et al., 2016). Therefore, selection and propagation of those genotypes of BBG might be useful to achieve higher growth rates during 6-12 months of age for more body mass production.

Cardinal physiological parameters

Cardinal physiological parameters (Table 4) did not differ significantly among males and females. Age of goat significantly differentiated rectal temperature (°F), pulse rate (beats/minute) and respiration rate (breaths/minute). All the parameters were higher in young goats as compared to adults. Physiological parameters of BBG under IMS were within the normal ranges and similar to the values reported earlier under coastal climatic conditions of Odisha (Behera et al., 2016). However, lesser values were reported from Chhotanagpur plateau of Jharkhand (Murmu et al., 2021). These differences might be due to variations in local climate and housing

management of animals. In the present study physiological parameters were estimated in most thermo-comfortable situations (morning), therefore, those values could be considered as basal reference for estimation of thermal adaptability of BBG under intensive management conditions. Significant difference ($P<0.01$) in cardinal physiological parameters between young and adult BBG indicated that separate estimators of heat stress index for adults and young might be necessary to evaluate the thermal-comfort under IMS. However, the same might not be necessary as per sex of animals, because male/female goats showed very limited variability ($P>0.05$) in their body vital parameters.

Table 1: Micro-environment of the goat shed under intensive management system

	Morning (8-00 to 8-30am)		Afternoon (2-30 to 3-00pm)		Morning	Afternoon	Minimum Temp (°C)	Maximum Temp (°C)
Seasons	Temperature (°C)	Humidity %	Temperature (°C)	Humidity %	THI	THI		
Rainy	32.96 ± 0.34	75.11 ± 0.64	35.18 ± 0.30	77.82 ± 0.46	86.69 ± 0.53	90.72 ± 0.5	29.95 ± 0.37	35.35 ± 0.32
Winter	26.85 ± 0.39	72.21 ± 0.57	29.50 ± 0.24	70.12 ± 0.48	76.81 ± 0.57	80.58 ± 0.36	21.56 ± 0.44	29.78 ± 0.26
Summer	32.70 ± 0.41	76.43 ± 0.58	34.66 ± 0.38	78.41 ± 0.35	86.56 ± 0.65	90.02 ± 0.62	27.14 ± 0.43	35.23 ± 0.43
Overall	29.74 ± 0.32	73.74 ± 0.4	32.15 ± 0.26	73.86 ± 0.42	81.51 ± 0.51	85.34 ± 0.45	25.25 ± 0.39	32.42 ± 0.27

Table 2. Body weight of Black Bengal goats in different ages under intensive housing system

Age in months (m)	Body Weight (Kg)	Enhancement by %
At Birth	1.14^{a} ± 0.15	
2m (1-3)	3.01^{b} ± 0.17	164
5m (4-6)	7.60^{c} ± 0.55	152
8m (7-9)	8.69^{d} ± 0.23	14
11m (10-12)	11.16^{de} ± 0.26	28
15m (13-18)	13.23^{ef} ± 0.26	19
21m (19-24)	16.40^{g} ± 0.18	24
27m (25-30)	21.99^{h} ± 0.50	34
33m (31-36)	21.85^{h} ± 0.85	-1
>37m	21.22^{h} ± 0.47	-3

Table 3. Growth rate (g/day) of Black Bengal Goats in different seasons under IMS

Season	Growth rate (g/day)		
	Male	Female	Pooled
Rainy (July-October)	26.94±2.53	21.36±3.37	24.15 ± 2.10
Winter (November-February)	30.15±2.11	23.50±2.45	26.82 ± 1.62
Summer (March-June)	32.22±7.14	29.33±7.83	30.78 ± 5.30
Overall	29.72 ± 2.62	24.73 ± 2.95	

Table 4: Variation in vital physiological parameters in the intensive housing system

Particulars	**Male**	**Female**	Sig
Rectal Temperature (°F)	101.53±0.10	101.35±0.07	NS
Pulse rate (beats/minute)	68.84±0.98	71.23±0.74	NS
Respiration rate (breaths /minute)	17.93±0.38	17.80±0.28	NS
	Young (<12m)	**Adult (>12m)**	
Rectal Temperature (°F)	101.70^{a}±0.09	101.18^{b}±0.09	**
Pulse rate (beats/minute)	71.50^{a}±0.87	68.63^{b}±0.87	**
Respiration rate (breaths /minute)	18.85^{a}±0.33	16.88^{b}±0.34	**

Observation 8-45am to 9-30am; NS Non-significant; ** P<0.01

Reproduction and kidding performance

At kidding, the male: female ratio was 1:1.5 in this study. Year round kidding performance of BBG under IMS was depicted in Fig 1. The occurrences of estrus in BBG were observed in all the months of the year, however, predominant months were August to October. Year round kidding performance (Fig. 1) showed that highest kidding

occurred in the month March, followed by January, February, November and September. During those 5 months period 68% kidding of the year took place. Season-wise analysis revealed that winter had the highest, and rainy and summer had lowest but almost similar rates of kidding. Therefore, under intensive management system BBG were not typically seasonal breeder, what usually termed that goats are seasonal breeders. They were observed as seasonally polyestrous animals and displayed skewed seasonality patterns of breeding in this study.

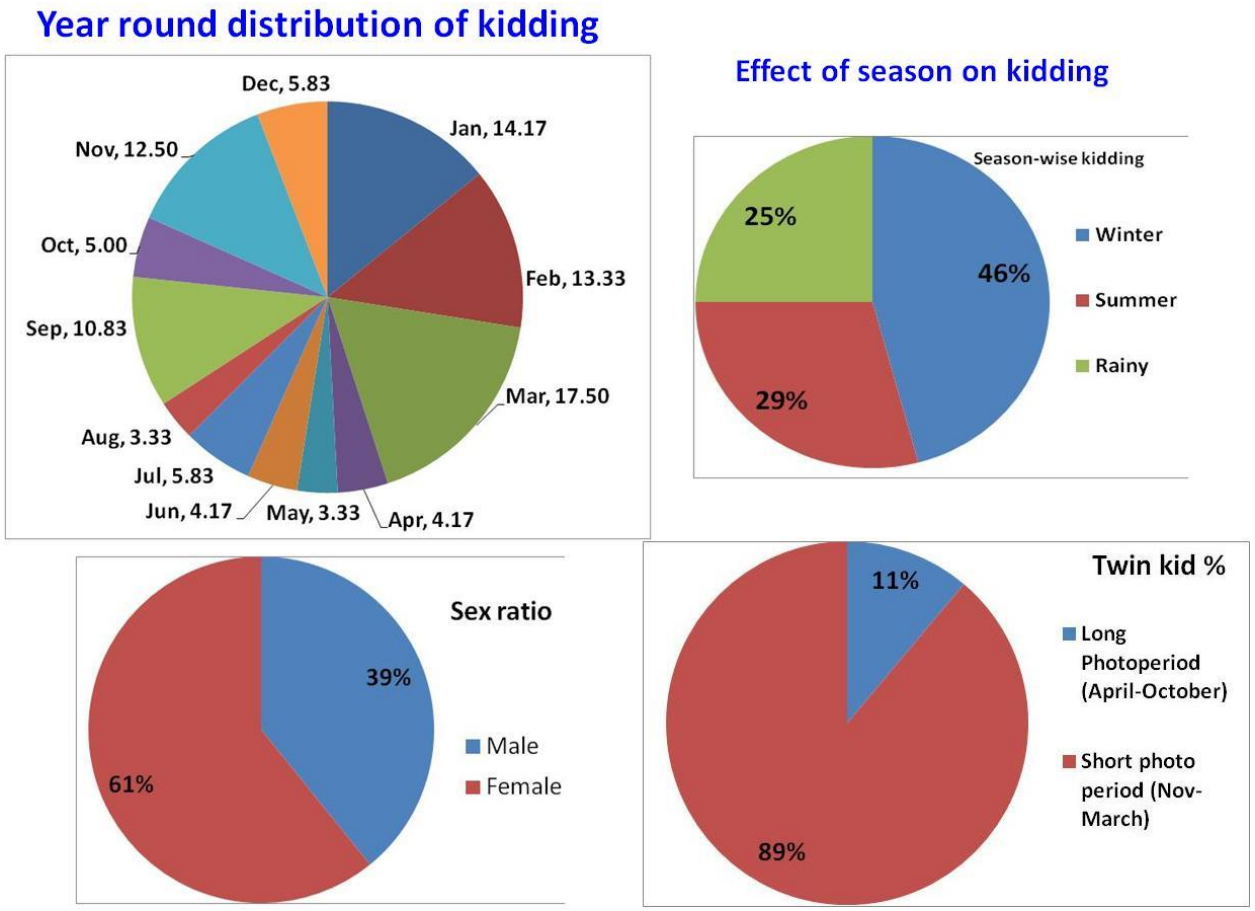

Fig.1. Year round kidding performance of Black Bengal goats

Reproduction showed higher portions of female birth (60.17%) as compared to male (39.83%). Ideally sex ratio should be 50:50, and reasons for this deviation might be due to small population investigated in the present study. Goats had reproductive efficiency of 50.98% singles, 43.14% twins and 5.88% triplets born under IMS. Under field conditions reported single, twin and triplet were 31.61%, 61.70% and 6.69%, respectively (Haldar et al., 2014). The overall prolificacy (%) of BBG under IMS was 155%. The prolificacy increased over the parities, being 122% in 1st, 200% in 2nd and 216% in ≥3rd parities. In contrast, higher prolificacy rate (175%) in BBG was reported from field conditions under extensive and semi-intensive system of management (Haldar et al., 2014).

Overall basis, present investigation showed that under IMS system body weight and growth performance of BBG were better than extensive/semi-intensive system of management, however, prolificacy was little lesser than that of field conditions (extensive/semi-intensive system). The reasons might be attributed to better management, feed quality, balanced ration under IMS that had enhanced the growth rate and body mass production performance. In contrast, farmers' own trait preference for higher prolificacy allowed keeping the most prolific does at home and selection of their progenies for further breeding over generations to obtain more kid crops (more total biomass) might have accentuated higher prolificacy trait under field conditions. In case of male, the fast growing males reach (after castration) the market first for profit and poor growing males (intact) remain in herd/community as breeding bucks, which might partially explained for diminished growth rates and body weights of BBG under field conditions. Under filed condition imbalanced ration is also an important reason for low growth rate. However, further studies are required to ascertain whether or not total kid-crop production (more biomass) from higher prolificacy can economically compensate lesser body weight under field conditions and IMS, vice versa.

Conclusion

Productions performances of BBG were higher and prolificacy was marginally lower in IMS as compared to the reports of field conditions. Targeting for higher growth rates in goats at 6-12 months age and increase in proportions of multiple births might enhance productivity and profitability of Black Bengal goat farming under IMS. Cardinal physiological parameters significantly differed by young and adult goats, however, not by male and female sexes. Black Bengal goats displayed skewed seasonality of breeding, however, goats kidded round the year with variable proportions over the months under IMS.

Conflict of interest

The authors declare no conflict of interest.

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