MEDDOCS Open Access Publisher

ISSN: 2640-1223

Journal of Veterinary Medicine and Animal Sciences

Open Access | Research Article

# Effect of Different Management Systems on the Performance of Black Bengal Goat for Sustainable and Profitable Farming

***Nibash Debbarma[1]; Avijit Haldar[2]; Santanu Bera[3]; Tridib Debnath[4]; Avishek Paul[5]; Sandip Chakraborty[6]*; Kuldeep Dhama[7]***

*[1]Assistant Professor, Department of Livestock Production Management, CVSc and AH, RK Nagar, Tripura (W), India.*

*[2]Principal Scientist, ICAR- ATARI, Salt Lake, Kolkata, West Bengal, India.*

*[3]Assistant Professor and Head, Department of LPM, Faculty of Veterinary and Animal Sciences, WBUAFS, Kolkata, India.*

*[4]Veterinary Officer, Department of ARDD, Govt of Tripura, India.*

*[5]Assistant Professor, Department of Veterinary Physiology and Biochemistry, CVSc and AH, RK Nagar, Agartala, Tripura (W), India.*

*[6]Assistant Professor, Department of Veterinary Microbiology, CVSc and AH, RK Nagar, Agartala Tripura (W), India.*

*[7]Principal Scientist, Division of Pathology, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India.*

***Corresponding Author(s): Sandip Chakraborty**

Assistant Professor, Department of Veterinary Microbiology, CVSc and AH, RK Nagar, Agartala Tripura (W), India.

Email: chakrabortysandip22@gmail.com

Received: Mar 17, 2022

Accepted: Mar 29, 2022

Published Online: Mar 31, 2022

Journal: Journal of Veterinary Medicine and Animal Sciences

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/



**Keywords:** Goat; Black Bengal; Management systems; Tripura; Economy.

**Abstract**

The present study was undertaken to investigate the changes in body weight, body measurements, reproductive parameters, hemato biochemical variables, faecal parasitic load and incidence of disease rate in black Bengal female goats (n=60) managed under extensive, semi-intensive and intensive system for evaluating the sustainability and economic viability. The partial budget analysis was done to determine the profitability of farming among the 3 different management systems. The result showed a significant improvement ($p<0.05$) in physical parameters like body weight (kg), height at wither (cm), heart girth (cm), early attainment of puberty with a higher rate ($p<0.05$) of prolificacy and kidding among the goats managed under an extensive system of management. The percentage of PCV, plasma glucose and total protein level was found significantly higher ($p<0.05$) in goats of intensive system but the cholesterol level was found more in goats of extensive system of management. The outdoor high humidity and temperate has affected the incidence of parasitic infestation and also the occurrence of diseases like diarrhoea and mastitis among the goats of an extensive system. However, the assessment of economic budget analysis showed a good net profit return from goats reared under extensive system compared to the other systems of management. Overall, the present study suggested that black Bengal goat rearing under the extensive system is a better choice for providing a substantial source of income to farmers with low budget input.

**Cite this article:** Debbarma N, Haldar A, Bera S, DebnathT, Paul A, et al. Effect of Different Management Systems on the Performance of Black Bengal Goat for Sustainable and Profitable Farming. J Vet Med Animal Sci. 2022; 5(1): 1112.

## Introduction

In India goat production is a livestock enterprise with least cost input and thus it becomes a choice (naturally) of livelihood option for the rural population by and large. In our country in pastoral agriculture scenario during the phase of emergency goats act as a source of income in terms of cash immediately. Moreover, goat farming contributes to household food security. In India in 2019 the total population of goat was found to be 148.88 million (as per the 20$^{th}$ livestock census). This shows an 10.1 percent increase as compared to the previous census. It has been estimated that goats contribute 27.8 percent of the total livestock in India (DAHD, Govt. of India). Black Bengal is a meat type breed of goat renowned worldwide and is considered as a blessing particularly for Tripura, a small state of the north-eastern region of India. They are famous for their skin as well as chevon. In Tripura pastures (natural) as well as grasses and wild leaves are found in abundance making rearing of goat lucrative due to the economical benefit. But proper attention has not been given to organized farming of goat for utilization of it to generate income. Due to the hardy nature; resistance to diseases and better adaptability Black Bengal goats can reproduce and thereby thrive well under various type of climatic conditions [1]. They can be reared easily on barren lands; roadsides as well as under intensive or semi-intensive systems [2]. In the villages stall-feeding with grasses available locally from grazing lands or fodder trees are evident. The impact of various management systems on growth as well as quality of carcass and their interaction with sex of a breed named Murciano-Granadina was studied on 61 kids previously [3]. For identification of the prospects and shortcomings in order to improve the goat farming productivity (economically) intensive and extensive systems had been compared in Sri Lanka [4]. Marginal and jobless youths are encouraged to start organized entrepreneurship by goat rearing due to the increasing price of chevon in markets locally; thereby helping them to exploit the market-oriented opportunities ultimately with the aim to meet the ever increasing demand of chevon in Tripura. Keeping in view the facts, an attempt has been made in the present research programme to test the efficiency, sustainability and profitability of goat rearing under various farming systems model viz., extensive, semi-intensive and intensive system.

## Material and methods

### Location of the experiment

The study was conducted in the goat farm of ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Agartala, Tripura, which lies approximately between latitude 22 560 and 240 32' North and longitude 910 10' and 920 21' East. The climate of Tripura is generally hot and humid depending upon the elevation, varies from sub-tropical humid at lower hills and valleys to alpine cold at higher altitudes with average annual rainfall varies from 841 mm to 4500 mm.

### Experimental Animals and duration of study

A total 60 Black Bengal female goats were used for the study. The animals were selected randomly and equally distributed in three groups and in each group 20 numbers of female goats (n= 20) were reared with 2 bucks at the ratio of 10:1 (female: male). Three groups were maintained under three different management systems, viz., extensive, semi-intensive and intensive. The data recording like weight of animals, birth weight and weight at different age were done for females and kids. The investigation was carried out for a period of one year from the month of June to May.

### Management of animal under different farming system

All the animals were treated against internal and external parasites by deworming and dipping before they were assigned to different groups and vaccination for diseases like Goat pox, FMD and PPR was also carried out. The animals were provided with night shelter having well-ventilated and raised bamboo floor with asbestos roof.

**Extensive system of management:** In this treatment group all, the animals were let loose from 8.00 am to 4.00 pm for grazing. The animals were not supplemented with any sort of feeds, fodders or concentrates during the experimental period.

**Semi-intensive system of management:** In this system, the animals were allowed to graze or let loose in the morning hour i.e., from 8.00 am to 12.00 pm and the rest of the day, animals were provided with tree leaves viz. mulberry leaves, jackfruit leaves, signal grasses and local grasses as and when available. The goats were also supplemented with pelleted concentrate ration having 18 % CP @ 150 g/head/day during the lean period i.e. winter season (December - February) and summer season (March - May).

**Intensive system of management:** Here, the animals were provided with tree leaves, signal grasses and local grasses, as and when available, at the indoor condition throughout the experiment. And the goats were also supplemented with pelleted concentrate ration having 18 % CP @ 150 g/head/day during the lean period i.e. winter season (December - February) and summer season (March - May). During lean seasons animals were also provided with chopped maize fodder and banana leaves.

### On-farm flock monitoring and investigation of body measurements and reproductive characteristics of experimental animal

Body weights of the experimental animals were recorded (in kg) at monthly interval during the experimental period by a digital spring balance and accordingly growth rate was calculated by statistical method. All the body measurements like height at withers, heart girth and body length were taken on standing position with the help of measuring tape.

Reproductive characteristics of does like age at puberty by observing the sign of heat or oestrous, body weight at onset of puberty, litter size at birth, birth weight of kids, type of birth, sex ratio, kidding interval and prolificacy rate of the does during the experimental period of one year were calculated and expressed statistically.

### Investigation of hemato-biochemical parameters of the experimental animals

The blood samples were collected from each animal in the early morning on last week of every experimental month. Total 5 ml blood samples were collected from healthy goats using heparin (10 IU/ml) as anticoagulant by jugular vein puncture under sterile conditions in order to estimate haemoglobin and PCV. The blood samples collected at the farm yard were brought to the laboratory by maintaining cold chain. The blood samples then were centrifuged in laboratory at 3000 RPM for 15 minutes to separate blood plasma and stored at -20 °C for further biochemical investigations.

The blood haemoglobin was estimated from anticoagulated blood by standard Sahli's acid haematin method and results were expressed in g/dl of blood (gm %). The estimation of blood PCV was obtained by centrifuging heparinized blood in a graduated tube until corpuscles were packed down to a constant volume. The volume of packed cell was then expressed as a percentage of the original volume of blood.

The various blood biochemical parameters like glucose, cholesterol, total protein, albumin, globulin, Albumin-Globulin ratio (A/G), Alkaline Phosphatise (ALP) the plasma of animals were estimated by using diagnostic kits as per manufacturer's instruction following standard protocols using a UV-Vis Spectrophotometer (PC Based Double Beam Spectrophotometer 2202, Systronics, India).

**Investigation of gastro-intestinal helminth infestations & incidence of diseases in experimental animals**

The fresh faecal sample from experimental animals were collected per recta in the middle month of every season viz. rainy season (July), autumn (October), winter season (January) and summer season (April) and transported to laboratory for further analysis. The faecal sample were initially subjected for gross examination which includes the colour, consistency, presence of blood, mucous, tapeworm segments and dead worms. McMaster's egg counting technique was employed for faecal egg count and expressed as eggs per gram (EPG) of faeces [5].

The incidences of diseases in the different groups of animal were recorded throughout the experimental year and the numbers of affected animals were also recorded and expressed in percentage. The mortality rate and causes of mortality of the animals were recorded group wise after the post mortem examination of death carcasses and were expressed in percentage.

**Economic analysis**

Partial budgeting is a method of organizing experimental data and information about the cost and benefit from some changes in the technologies used on the farm. It involves tabulating the costs and benefits of a small change in the farm practice. The partial budget analysis was done to determine the profitability in different management system of goat rearing in the agro-climatic conditions of Tripura. The partial budget analysis involved calculation of the variable cost and benefits.

At the beginning of the experiment, market prices of goats were assessed from local livestock markets at different places of Tripura. At the end of the experiment, weight gain and kids born of goats in the different management groups were evaluated. Thereafter, experienced goat dealers estimated the possible selling price of each experimental goat. The estimated buying and selling price difference of the goats in each management system before and after the experiment was considered as Total Return (TR) in the analysis. For the calculation of the variable costs, the expenditures incurred on feeds were taken into consideration. The costs of the feeds were computed by multiplying the actual feed intake for the whole feeding period with the prevailing prices. The prevailing prices of the feeds included in the transportation cost incurred to transport them to the experimental site. The labour cost was assumed to be constant across the treatment groups.

Partial budget measures profit or losses, which are the net benefits or differences between gains and losses for the proposed change. The amount of money left when Total Variable Cost (TVC) is subtracted from Total Return (TR):

$$NI = TR-TVC$$

The Change in Net Income (ΔNI) was calculated as the difference between the change in Total Return (ΔTR) and the change in T Variable Cost (ΔTVC) as follows:

$$\Delta NI = \Delta TR - \Delta TVC$$

The Marginal Rate of Return (MRR) measures the increase in Net Income (ΔNI) associated with each additional unit of expenditure (ΔTVC) and was calculated as:

$$MRR = (\Delta NI/\Delta TVC) \times 100$$

**Statistical Methodology**

The statistical analysis was done by using Statistical Package for the Social Sciences (SPSS 7.5) by one way ANOVA. Results were expressed as the mean ± Standard error (SE). A difference with value $p<0.05$ was considered statistically significant.

## Results

**Meteorological observations during the experimental period**

The record of the meteorological variables for one year in terms of Max and Min environment temperature and the Temperature, Humidity Index (THI) during the time of experiment is presented in **Figure 1 and 2**. During the experimental period, the environmental temperature ranged from 6.4 °C to 36.2 °C and the THI ranged from 57.34 to 77.68. The rainfall received during the whole experimental period was 2595.80 mm and the average rainfall was 216.31 mm.

**Findings of body weight (kg) and body measurement changes of Black Bengal goats under different system of management**

The mean growth and body measurements of Black Bengal goats under different management systems has been given in **Table 1**. It was observed that there was significantly higher ($p<0.05$) body weight gain of goats managed under extensive system as compare to other farming system. The detailed month wise body weight gain of goats under different management systems for the entire experimental year has been presented in supplementary table 1. At the beginning of the study from 2$^{nd}$ to 3$^{rd}$ month, there was no significant difference ($p>0.05$) of body weight gain of the goats maintained under different management system however, at the later part of experiment i.e. 9th to 12$^{th}$ month of age, the goats reared under extensive management system showed higher ($p<0.05$) body weight gain as compared semi-intensive and intensive management system.

The various body measurement changes such as height at withers, heart girth and body length of Black Bengal goats managed under different farming systems has been given in **Table 1**. The mean height at withers (cm) of goats under extensive and intensive management systems were significantly ($p<0.05$) higher than the goats reared under semi-intensive management system. Whereas, the mean heart girth (cm) of goats were significantly greater ($p<0.05$) only in extensive farming as compared to intensive and semi-intensive management system. However, there was no significant differences in body length (cm) was observed between the different management systems of goat. The month wise analysis of body measurements changes (**Table 2**) showed that there was a significant ($p<0.01$) increase in the

mean height at withers (cm) of goats from 9th and 12th month, mean heart girth (cm) from 4th to 12th month and mean body length (cm) from 3rd to 12th months of age in goats under the extensive system than that of goats reared under semi-intensive and intensive management system.

Analysis of haemato-biochemical parameters in Black Bengal goats under different management systems

The analysis of different hemato-biochemical parameters in Black Bengal managed under different management systems has been presented in **Table 1**. The haematological findings showed that there was no definite pattern of significant changes in blood Hb level among the various management systems over the months in black Bengal goat during the experimental period (Table 2). However, the mean PCV (%) was significantly higher ($p<0.05$) in goats under intensive management system as compared to semi-intensive. The findings of blood biochemical analysis of goats reported that the mean plasma glucose (mg/dl) and total plasma protein (gm/dl) level was found to be significantly higher ($p<0.05$) in goats of intensive management systems as compare to rest. However, the mean plasma cholesterol (mg/dl) was again significantly higher ($p<0.05$) in both extensive and semi-intensive management systems as compare to intensive system. But, no significant difference ($p>0.05$) was observed in the mean plasma albumin, globulin and A/G ratio and plasma ALP (KA units) concentration in goats among the different management systems.

**Reproductive and productive traits of Black Bengal goats under different management systems**

The study revealed that there was no significant ($p>0.05$) difference of age (days) at puberty and prolificacy rate for the semi-intensive and intensive system of management but significantly lower age at puberty and higher prolificacy rate ($p<0.05$) was observed in goats under the extensive system of management. Although, other productive traits like no. of kidding (%), percentage of single or twin birth rate was higher in extensive system but no significant difference was observed among the management systems (**Table 3**).

**Incidence of parasitic infestations in Black Bengal goats under different management systems**

The occurrence of parasitic infestation in goats of different system of management has been presented in **Table 4**. It was observed from the study that during the rainy season the prevalence of strongyles were highest in the intensive system (42.85%) followed by a semi-intensive and extensive system. The incidence of coccidiosis was again recorded highest in the extensive group (46.6%) followed by semi-intensive and intensive groups both in rainy and summer season. But, in autumn season there were no incidences of any parasites.

**Incidence of diseases and mortality pattern in goats under different management systems**

The incidence of diseases in goats under different management systems covering different seasons are presented in **Table 5**. In the present study, incidence of diseases revealed that contagious ecthyma, diarrhoea, foot rot, corneal opacity of the eyes, alopecia and bloat were the important disease problems in Tripura. The present study showed that the contagious ecthyma was a major disease outbreak during the autumn season irrespective of management system. Prevalence of diarrhoea (12.5%) and incidence of mastitis in lactating goats was observed only in extensive groups during the rainy and winter season respectively, whereas the incidence of foot rot (15%) was observed only in the intensive system of management from beginning of the experiment. The incidence of corneal opacity was observed only in the semi-intensive groups during rainy season and autumn season and alopecia was a flock problem rather than an individual problem. Whenever the infection gets introduced in a flock, it spreads very fast due to the habit of huddling together, which was only observed in goats managed under intensive management system.

**Partial budget analysis of goat farming under different management systems**

The partial budget analysis was conducted to assess the economic benefit of different management systems of Black Bengal goats reared under extensive, semi-intensive and intensive management systems. The partial budget analysis of goat farming under different management system are presented in **Table 6**. The analysis indicated that goats under extensive system gave a maximum return in comparison to the semi-intensive and intensive system from 2nd months of rearing onwards. On the other hand, the net return generated from the semi-intensive and intensive system remained same at 4th, 5th, 8th, 10th, 11th and 12th months of rearing. The share of variable input cost for purchase of goats, labour and veterinary aids in extensive system are 91%, 8.6% and 0.4%, respectively. And the share of variable input cost for purchase of goats, labour, feed and veterinary aids in semi-intensive and intensive systems are 88.8%, 8.5%, 2.45% and 0.2%, respectively. Gross expenditures and net return from sale of goats did not vary much between the semi-intensive and intensive management systems.

**Table 1:** The average (Mean ± SEM) Growth, Body measurements and hemato-biochemical parameters in black Bengal goat among the different management systems.

| Parameters | Management System (Mean ± SEM) | | | Significance (p value) |
|---|---|---|---|---|
| | Extensive | Semi-intensive | Intensive | |
| Body Weight (Kg) | $5.815 \pm 0.27^{A}$ | $4.905 \pm 0.25^{B}$ | $5.215 \pm 0.18^{AB}$ | $p< 0.05$ |
| Height at withers (cm) | $39.571 \pm 1.62^{A}$ | $35.833 \pm 1.29^{B}$ | $38.927 \pm 1.48^{A}$ | $p< 0.05$ |
| Heart girth (cm) | $45.138 \pm 1.13^{A}$ | $41.291 \pm 1.41^{B}$ | $42.277 \pm 0.94^{B}$ | $p< 0.05$ |
| Body length (cm) | 40.844 ± 0.84 | 38.355 ± 1.44 | 38.322 ± 0.77 | ns |
| Haemoglobin (gm/dl) | 8.575 ± 0.22 | 8.245 ± 0.42 | 8.459 ± 0.52 | ns |
| PCV (%) | $27.427 \pm 0.51^{AB}$ | $24.951 \pm 1.47^{B}$ | $29.436 \pm 1.72^{A}$ | $p< 0.05$ |
| Plasma Glucose (mg/dl) | $44.371 \pm 3.14^{B}$ | $46.926 \pm 5.41^{B}$ | $52.952 \pm 6.24^{A}$ | $p< 0.05$ |
| Plasma Total Protein (gm/dl) | $6.735 \pm 0.35^{AB}$ | $6.409 \pm 0.33^{B}$ | $6.885 \pm 0.43^{A}$ | $p< 0.05$ |

| | | | | |
|---|---|---|---|---|
| Plasma Albumin (gm/dl) | 3.122 ± 0.19 | 3.378 ± 0.19 | 3.200 ±0.27 | ns |
| Plasma Globulin (gm/dl) | 3.413 ± 0.42 | 3.043 ± 0.32 | 3.438 ± 0.38 | ns |
| A/G ratio | 0.98 ±0.13 | 1.156 ± 0.09 | 0.911 ± 0.04 | ns |
| Plasma Cholesterol (mg/dl) | 75.270 ± 5.17$^{A}$ | 70.966 ± 4.36$^{A}$ | 65.074 ± 4.23$^{B}$ | p< 0.05 |
| Plasma ALP (KA units) | 1.709 ± 0.38 | 1.861 ± 0.40 | 1.784 ± 0.53 | ns |

**Note:** Values within a row with different uppercase letters (A, B, C) differ significantly between groups i.e. Extensive, Semi-intensive and Intensive.

**Table 2:** Comparison of various parameters in different systems of rearing BB goats.

| Parameters | Farming System | 2M | 3M | 4M | 5M | 6M | 7M | 8M | 9M | 10M | 11M | 12M | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Body Weight (Kg) | EXT | 2.467 ± 0.069 | 3.053 ± 0.061 | 3.800$^{a}$ ± 0.155 | 4.567$^{a}$ ± 0.097 | 5.367$^{a}$ ± 0.286 | 5.922$^{a}$ ± 0.308 | 6.456 ± 0.385 | 7.200$^{a}$ ± 0.385 | 7.833$^{a}$ ± 0.445 | 8.278$^{a}$ ± 0.438 | 9.022$^{a}$ ± 0.376 | 5.815$^{a}$± 0.27 |
| | SINT | 2.343 ± 0.037 | 2.886 ± 0.046 | 3.200$^{b}$ ± 0.031 | 3.814$^{b}$ ± 0.158 | 3.857$^{b}$ ± 0.458 | 4.900$^{b}$ ± 0.141 | 5.557 ± 0.188 | 5.829$^{b}$ ± 0.394 | 6.629$^{b}$ ± 0.394 | 7.229$^{ab}$ ± 0.411 | 7.714$^{b}$ ± 0.476 | 4.905$^{b}$ ± 0.25 |
| | INT | 2.350 ± 0.076 | 2.900 ± 0.073 | 3.750$^{a}$ ± 0.102 | 4.433$^{a}$ ± 0.178 | 5.117$^{a}$ ± 0.178 | 5.717$^{a}$ ± 0.232 | 6.050 ± 0.306 | 6.400$^{ab}$ ± 0.265 | 6.550$^{b}$ ± 0.213 | 6.883$^{b}$ ± 0.186 | 7.217$^{b}$ ± 0.230 | 5.215$^{ab}$ ± 0.18 |
| Height at withers (cm) | EXT | 32.71$^{a}$ ± 1.30 | 34.42$^{a}$ ± 1.54 | 38.28$^{a}$ ± 1.69 | 33.28$^{b}$ ± 4.35 | 38.57$^{a}$ ± 2.13 | 40.00$^{a}$ ± 1.57 | 40.57$^{a}$ ± 1.25 | 42.28$^{a}$ ± 1.49 | 44.57$^{a}$ ± 0.57 | 44.57$^{a}$ ± 0.97 | 46.00$^{a}$ ± 0.93 | 39.571 $^{a}$± .62 |
| | SINT | 28.16$^{b}$ ± 0.60 | 29.16$^{b}$ ± 0.48 | 32.33$^{c}$ ± 0.76 | 32.16$^{c}$ ± 0.60 | 33.50$^{b}$ ± 0.89 | 35.83$^{b}$ ± 0.95 | 37.83$^{b}$ ± 1.62 | 40.66$^{b}$ ± 2.44 | 41.00$^{b}$ ± 2.10 | 41.66$^{c}$ ± 1.69 | 41.83$^{c}$ ± 2.04 | 35.833 $^{b}$± .29 |
| | INT | 32.50$^{a}$ ± 0.56 | 34.00$^{a}$ ± 0.58 | 34.00$^{b}$ ± 0.45 | 37.66$^{a}$ ± 1.71 | 38.50$^{a}$ ± 1.43 | 38.83$^{a}$ ± 2.10 | 40.00$^{a}$ ± 1.81 | 40.50$^{b}$ ± 2.14 | 40.83$^{b}$ ± 1.68 | 43.33$^{b}$ ± 1.05 | 43.66$^{b}$ ± 1.05 | 38.927 $^{a}$± .48 |
| Heart girth (cm) | EXT | 36.25$^{b}$ ± 0.87 | 37.41$^{b}$ ± 1.23 | 42.58$^{a}$ ± 1.17 | 43.16$^{a}$ ± 2.04 | 43.83$^{a}$ ± 1.70 | 43.83$^{a}$ ± 1.92 | 46.41$^{a}$ ± 1.58 | 48.25$^{a}$ ± 1.58 | 51.00$^{a}$ ± 1.03 | 52.31$^{a}$ ± 0.91 | 51.66$^{a}$ ± 0.67 | 45.138 $^{a}$ ±1.13 |
| | SINT | 30.20$^{c}$ ± 1.39 | 32.60$^{c}$ ± 1.03 | 34.40$^{c}$ ± 1.44 | 38.00$^{c}$ ± 1.10 | 39.80$^{c}$ ± 8.29 | 41.80$^{b}$ ± 1.66 | 45.20$^{b}$ ± 2.94 | 45.60$^{b}$ ± 1.54 | 48.20$^{b}$ ± 2.42 | 48.80$^{b}$ ± 2.40 | 49.20$^{b}$ ± 2.27 | 41.291$^{b}$ ± 1.41 |
| | INT | 38.50$^{a}$ ± 0.50 | 39.50$^{a}$ ± 0.50 | 41.20$^{b}$ ± 1.69 | 42.20$^{b}$ ± 1.36 | 41.25$^{b}$ ± 1.24 | 41.40$^{b}$ ± 0.68 | 41.60$^{c}$ ± 0.68 | 43.20$^{c}$ ± 0.73 | 44.00$^{c}$ ± 1.67 | 46.00$^{c}$ ± 0.63 | 46.00$^{c}$ ± 0.63 | 42.277$^{b}$ ± 0.94 |
| Body length (cm) | EXT | 31.50$^{b}$ ± 0.66 | 36.00$^{a}$ ± 0.93 | 39.00$^{a}$ ± 1.91 | 39.66$^{a}$ ± 1.17 | 40.00$^{a}$ ± 1.26 | 40.17$^{a}$ ± 0.70 | 40.33$^{a}$ ± 1.36 | 42.75$^{a}$ ± 1.14 | 45.33$^{a}$ ± 0.67 | 46.00$^{a}$ ± 0.45 | 49.00$^{a}$ ± 0.58 | 40.844 ± 0.84 |
| | SINT | 31.40$^{b}$ ± 0.51 | 32.40$^{b}$ ± 0.68 | 34.00$^{c}$ ± 0.71 | 37.40$^{c}$ ± 1.54 | 38.00$^{b}$ ± 2.07 | 39.40$^{b}$ ± 1.72 | 40.20$^{a}$ ± 2.15 | 41.60$^{b}$ ± 2.75 | 42.60$^{b}$ ± 2.44 | 42.20$^{b}$ ± 2.67 | 42.60$^{b}$ ± 2.11 | 38.355 ± 1.44 |
| | INT | 34.25$^{a}$ ± 0.86 | 36.25$^{a}$ ± 0.49 | 36.50$^{b}$ ± 0.81 | 38.20$^{b}$ ± 1.39 | 38.00$^{b}$ ± 0.89 | 38.40$^{c}$ ± 0.51 | 39.20$^{b}$ ± 0.58 | 39.60$^{c}$ ± 0.87 | 39.75$^{c}$ ± 0.97 | 40.50$^{c}$ ± 0.47 | 41.00$^{c}$ ± 0.63 | 38.332 ± 0.77 |
| Blood Hb (gm/dl) | EXT | 7.95$^{b}$ ± 0.21 | 8.31$^{b}$ ± 0.11 | 8.10$^{a}$ ± 0.34 | 8.56$^{a}$ ± 0.30 | 9.45$^{a}$ ± 0.68 | 8.85$^{b}$ ± 0.20 | 9.15$^{a}$ ± 0.09 | 9.07$^{a}$ ± 0.17 | 8.42$^{a}$ ± 0.13 | 7.85$^{b}$ ± 0.10 | 8.58$^{b}$ ± 0.72 | 8.575 ± 0.22 |
| | SINT | 8.57$^{a}$ ± 0.65 | 9.08$^{a}$ ± 0.49 | 7.58$^{b}$ ± 0.44 | 7.56$^{b}$ ± 0.15 | 7.90$^{c}$ ± 0.31 | 7.94$^{c}$ ± 0.25 | 8.68$^{b}$ ± 0.48 | 8.02$^{b}$ ± 0.51 | 7.92$^{b}$ ± 0.37 | 8.60$^{a}$ ± 0.86 | 9.02$^{a}$ ± 1.10 | 8.245 ± 0.42 |
| | INT | 8.74$^{a}$ ± 0.95 | 9.40$^{a}$ ± 0.93 | 7.40$^{b}$ ± 0.48 | 8.20$^{a}$ ± 0.37 | 8.00$^{b}$ ± 0.52 | 9.44$^{a}$ ± 0.71 | 8.76$^{b}$ ± 0.46 | 8.84$^{b}$ ± 0.55 | 8.64$^{a}$ ± 0.22 | 7.43$^{b}$ ± 0.21 | 7.50$^{c}$ ± 0.27 | 8.459 ± 0.52 |
| PCV (%) | EXT | 29.00 ± 0.71 | 29.00 ± 1.00 | 29.20 ± 1.28 | 26.20 ± 1.66 | 27.20 ± 1.39 | 24.00 ± 0.84 | 29.20 ± 2.62 | 27.20 ± 0.37 | 28.60 ± 2.11 | 26.40 ± 0.24 | 26.20 ± 0.92 | 27.427$^{ab}$± 0.51 |
| | SINT | 31.50 ± 0.76 | 27.33 ± 0.71 | 35.50 ± 30.71 | 25.33 ± 0.71 | 24.16 ± 0.65 | 21.33 ± 1.20 | 20.33 ± 2.32 | 22.83 ± 1.97 | 22.33 ± 1.33 | 19.33 ± 2.04 | 24.50 ± 3.15 | 24.951$^{b}$ ± 1.47 |
| | INT | 34.00 ± 1.67 | 34.00 ± 1.67 | 31.60 ± 1.44 | 32.00 ± 2.17 | 27.40 ± 3.20 | 23.80 ± 2.18 | 24.00 ± 2.19 | 27.00 ± 2.55 | 28.00 ± 0.63 | 32.00 ± 0.63 | 30.00 ± 0.63 | 29.436$^{a}$± 1.72 |
| Plasma Glucose (mg/dl) | EXT | 42.00$^{b}$ ± 2.26 | 43.94$^{b}$ ± 7.57 | 41.74$^{b}$ ± 3.64 | 29.48$^{c}$ ± 2.55 | 38.49$^{c}$ ± 5.92 | 31.56$^{c}$ ± 2.30 | 59.38$^{a}$ ± 6.74 | 59.69$^{a}$ ± 6.23 | 49.83$^{b}$ ± 6.64 | 26.97$^{c}$ ± 2.44 | 31.02$^{c}$ ± 1.54 | 44.371$^{b}$ ± 3.14 |
| | SINT | 59.90$^{a}$ ± 9.68 | 51.53$^{a}$ ± 7.65 | 63.79$^{a}$ ± 4.01 | 37.54$^{b}$ ± 3.38 | 42.21$^{b}$ ± 8.38 | 36.72$^{b}$ ± 6.92 | 41.01$^{c}$ ± 1.02 | 35.99$^{b}$ ± 3.66 | 50.83$^{b}$ ± 6.42 | 48.22$^{b}$ ± 14.24 | 43.82$^{b}$ ± 4.58 | 46.926$^{b}$± 5.41 |
| | INT | 59.40$^{a}$ ± 8.19 | 50.66$^{a}$ ± 5.55 | 63.24$^{a}$ ± 3.35 | 53.86$^{a}$ ± 0.87 | 54.66$^{a}$ ± 1.35 | 64.86$^{a}$ ± 10.47 | 44.03$^{b}$ ± 5.13 | 36.94$^{b}$ ± 9.35 | 52.97$^{a}$ ± 13.92 | 52.84$^{a}$ ± 3.87 | 54.04$^{a}$ ± 11.69 | 52.952$^{a}$± 6.24 |
| Total Protein (gm/dl) | EXT | 5.40$^{c}$ ± 0.27 | 8.67$^{a}$ ± 0.24 | 6.49$^{b}$ ± 0.32 | 6.16 ± 0.50 | 8.01$^{a}$ ± 0.67 | 4.92$^{b}$ ± 0.94 | 6.74$^{a}$ ± 0.73 | 6.80 ± 0.62 | 6.74$^{b}$ ± 0.06 | 7.16 ± 0.46 | 6.56 ± 0.73 | 6.735$^{ab}$ ± 0.35 |
| | SINT | 6.54$^{b}$ ± 0.30 | 7.15$^{b}$ ± 0.51 | 7.34$^{a}$ ± 0.25 | 6.36 ± 0.10 | 6.12$^{b}$ ± 0.07 | 5.72$^{a}$ ± 0.35 | 5.52$^{b}$ ± 0.51 | 6.42 ± 0.51 | 5.65$^{c}$ ± 0.86 | 7.23 ± 0.22 | 6.28 ± 0.71 | 6.409$^{b}$ ± 0.33 |
| | INT | 7.41$^{a}$ ± 0.58 | 7.40$^{b}$ ± 0.49 | 7.45$^{a}$ ± 0.23 | 6.23 ± 0.30 | 6.69$^{b}$ ± 1.07 | 4.47$^{b}$ ± 0.38 | 6.85$^{a}$ ± 0.01 | 6.42 ± 0.52 | 8.85$^{a}$ ± 0.25 | 7.35 ± 0.18 | 6.70 ± 0.68 | 6.885$^{a}$ ± 0.43 |
| Plasma Albumin (gm/dl) | EXT | 4.30 ± 0.19 | 3.58 ± 0.09 | 4.01$^{a}$ ± 0.16 | 2.89 ± 0.32 | 2.55$^{b}$ ± 0.35 | 2.19 ± 0.26 | 2.90 ± 0.17 | 3.72 ± 0.08 | 3.14$^{b}$ ± 0.16 | 2.79$^{b}$ ± 0.16 | 2.86$^{b}$ ± 0.21 | 3.122 ± 0.19 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SINT | 3.84 ± 0.12 | 3.64 ± 0.11 | 3.27$^{b}$ ± 0.05 | 2.92 ± 0.06 | 2.87$^{b}$ ± 0.15 | 2.86 ± 0.09 | 2.86 ± 0.08 | 3.15 ± 0.20 | 4.07$^{a}$ ± 0.45 | 3.82$^{a}$ ± 0.40 | 3.74$^{a}$ ± 0.37 | 3.378 ± 0.19 |
| | INT | 4.13 ± 0.08 | 3.45 ± 0.24 | 3.90$^{b}$ ± 0.20 | 2.93 ± 0.51 | 3.11$^{a}$ ± 0.31 | 2.29 ± 0.70 | 3.07 ± 0.17 | 3.36 ± 0.19 | 3.03$^{b}$ ± 0.21 | 3.33$^{a}$ ± 0.32 | 2.59$^{b}$ ± 0.10 | 3.200 ± 0.27 |
| **Plasma Globulin (gm/dl)** | EXT | 2.19$^{b}$ ± 0.64 | 3.67$^{b}$ ± 0.69 | 2.44$^{b}$ ± 0.34 | 3.06 ± 0.69 | 4.35$^{a}$ ± 0.86 | 2.83 ± 1.03 | 3.71$^{a}$ ± 0.67 | 3.21$^{a}$ ± 0.73 | 4.46$^{a}$ ± 0.14 | 4.33$^{a}$ ± 0.25 | 4.20$^{a}$ ± 0.79 | 3.413 ± 0.42 |
| | SINT | 3.02$^{a}$ ± 0.18 | 3.87$^{b}$ ± 0.37 | 3.39$^{a}$ ± 0.21 | 3.43 ± 0.10 | 3.46$^{b}$ ± 0.12 | 2.72 ± 0.41 | 2.39$^{b}$ ± 0.49 | 2.85$^{b}$ ± 0.33 | 2.15$^{c}$ ± 0.48 | 3.42$^{b}$ ± 0.45 | 2.45$^{c}$ ± 0.94 | 3.043 ± 0.32 |
| | INT | 3.20$^{a}$ ± 0.51 | 4.11$^{a}$ ± 0.67 | 3.68$^{a}$ ± 0.09 | 3.37 ± 0.80 | 3.72$^{b}$ ± 1.20 | 2.44 ± 0.46 | 3.67$^{a}$ ± 0.18 | 3.27$^{a}$ ± 0.60 | 3.55$^{b}$ ± 0.28 | 4.27$^{a}$ ± 0.26 | 3.65$^{b}$ ± 0.68 | 3.438 ± 0.38 |
| **A/G Ratio** | EXT | 1.96 | 0.97 | 1.64 | 0.94 | 0.59 | 0.77 | 0.78 | 1.15 | 0.7 | 0.64 | 0.68 | 0.98 ± 0.13 |
| | SINT | 1.27 | 0.94 | 0.96 | 0.85 | 0.83 | 1.05 | 1.19 | 1.1 | 1.89 | 1.12 | 1.52 | 1.156 ± 0.09 |
| | INT | 1.29 | 0.84 | 1.05 | 0.87 | 0.84 | 0.94 | 0.84 | 1.02 | 0.85 | 0.78 | 0.71 | 0.911 ± 0.04 |
| **Plasma Cholesterol (mg/dl)** | EXT | 92.93$^{a}$ ± 4.02 | 86.01$^{a}$ ± 4.42 | 74.43$^{b}$ ± 4.80 | 62.62$^{a}$ ± 7.44 | 77.71$^{a}$ ± 16.15 | 75.53$^{a}$ ± 14.55 | 79.29$^{a}$ ± 10.88 | 87.27$^{a}$ ± 5.74 | 76.24$^{a}$ ± 6.51 | 66.42$^{b}$ ± 3.48 | 54.34$^{c}$ ± 6.07 | 75.270$^{a}$± 5.17 |
| | SINT | 85.04$^{b}$ ± 1.35 | 65.28$^{b}$ ± 2.94 | 76.27$^{a}$ ± 2.50 | 62.84$^{a}$ ± 2.12 | 79.24$^{a}$ ± 3.37 | 76.61$^{a}$ ± 4.59 | 61.53$^{c}$ ± 9.52 | 66.37$^{b}$ ± 5.82 | 58.04$^{b}$ ± 9.61 | 73.33$^{a}$ ± 8.83 | 76.39$^{a}$ ± 8.14 | 70.966 $^{a}$± 4.36 |
| | INT | 85.04$^{b}$ ± 1.35 | 65.28$^{b}$ ± 2.94 | 76.27$^{a}$ ± 2.50 | 57.12$^{b}$ ± 3.33 | 51.06$^{b}$ ± 4.52 | 74.74$^{b}$ ± 6.86 | 63.33$^{b}$ ± 0.20 | 59.70$^{c}$ ± 14.69 | 54.49$^{c}$ ± 2.27 | 57.09$^{c}$ ± 2.63 | 71.69$^{b}$ ± 5.20 | 65.074 $^{b}$± 4.23 |
| **Plasma Alkaline phosphatase (ALP KA units)** | EXT | 2.85 ± 0.40 | 1.83 ± 0.65 | 2.11$^{a}$ ± 1.80 | 1.70$^{b}$ ± 1.13 | 2.32$^{a}$ ± 1.27 | 2.06 ± 0.51 | 2.22$^{a}$ ± 0.79 | 1.34$^{b}$ ± 0.59 | 1.68$^{b}$ ± 0.57 | 1.18$^{b}$ ± 0.38 | 1.18 ± 0.68 | 1.709 ± 0.38 |
| | SINT | 2.65 ± 0.36 | 1.67 ± 0.38 | 1.34$^{b}$ ± 0.59 | 2.32$^{a}$ ± 0.73 | 1.89$^{b}$ ± 0.39 | 2.54 ± 0.51 | 1.47$^{b}$ ± 0.51 | 2.03$^{a}$ ± 1.29 | 2.11$^{a}$ ± 0.88 | 2.65$^{a}$ ± 2.02 | 1.98 ± 0.69 | 1.861 ± 0.40 |
| | INT | 2.57 ± 0.36 | 1.57 ± 0.38 | 1.34$^{b}$ ± 0.59 | 1.43$^{b}$ ± 0.66 | 2.47$^{a}$ ± 1.29 | 2.03 ± 1.12 | 2.19$^{a}$ ± 0.64 | 2.37$^{a}$ ± 1.36 | 1.83$^{b}$ ± 0.56 | 1.11$^{b}$ ± 0.42 | 1.70 ± 0.39 | 1.784 ± 0.53 |

**Note:** Values within a row with different uppercase letters (a, b, c) differ significantly between groups i.e. Extensive, Semi-intensive and Intensive. EXT: Extensive; SINT: Semi-Intensive; INT: Intensive; A/G: Albumin/Globulin; PCV: Packed Cell Volume; Hb: Haemoglobin; M: Month.

**Table 3:** Reproductive and productive traits of Black Bengal goats under different management systems.

| System vs Traits | Management System (Mean ± SEM) | | |
|---|---|---|---|
| | Extensive | Semi-intensive | Intensive |
| Mean (±SEM) of age (days) at puberty | 197.60 ± 0.93$^{b}$ | 206.40 ± 1.72$^{a}$ | 210.40 ± 1.21$^{a}$ |
| Mean (±SEM) of body weight (kg) at puberty | 8.30 ± 0.30 | 7.9 ± 0.33 | 7.6 ± 0.29 |
| Total no. of kids born | 24 | 17 | 19 |
| Prolificacy rate (%) | 218.18$^{a}$ | 170.00$^{b}$ | 211.11$^{a}$ |
| Mean (±SEM) of litter size | 1.50 ± 0.14 | 1.54 ± 0.16 | 1.58 ± 0.15 |
| Mean (±SEM) of body wt. (kg) of male kids at birth | 1.05 ± 0.06 (n = 10) | 1.24 ± 0.19 (n = 6) | 1.13 ± 0.15 (n = 7) |
| Mean (±SEM) of body wt. (kg) of female kids at birth | 0.94 ± 0.03 (n = 14) | 1.05 ± 0.04 (n = 11) | 0.99 ± 0.03 (n = 12) |
| Male to female sex ratio | 01:01.4 | 01:01.8 | 01:01.7 |
| No. of kidding (%) | 16 (80%) | 11 (55%) | 12 (60%) |
| Single births (%) | 8 (50%) | 5 (45.45%) | 5 (41.67%) |
| Twin births (%) | 8 (50%) | 6 (54.54%) | 7 (58.33%) |
| Mean (± SEM) of kidding interval (days) | 187.5 ± 1.79 | 190 ± 3.23 | 197.5 ± 3.19 |

**Note:** Values within a row with different uppercase letters (a, b, c) differ significantly between groups i.e. Extensive, Semi-intensive and Intensive.

**Table 4:** Incidence of parasitic infestations in Black Bengal goats under different management systems.

| Systems/seasons v's Parasites | Different Management System | | |
|---|---|---|---|
| | Extensive | Semi-intensive | Intensive |
| No. of faecal samples examined | 84 | 77 | 78 |
| Positive % | 46.6 | 37.39 | 40.11 |
| Strongyles % | 20.83 | 14.53 | 42.85 |
| Strongyloides % | 0 | 4.76 | 4.76 |
| Trichuris % | 0 | 0 | 4.76 |
| Moniezia % | 0 | 4.76 | 0 |
| Coocidiosis % | 46.6 | 34.05 | 33.75 |

**Table 5:** Incidence of diseases and mortality pattern in goats under different management systems.

| Type of Disease | | Management Systems | | |
|---|---|---|---|---|
| | | Extensive | Semi-intensive | Intensive |
| Infectious | Contagious ecthyma | 50% | 50% | 50% |
| | Diarrhoea | 12.50% | 0 | 0 |
| | Foot rot | 0 | 0 | 15% |
| | Mastitis | 15% | 0 | 0 |
| Non-infectious | Corneal opacity of eyes | 0 | 19.04% | 0 |
| | Alopecia | 0 | 0 | 25% |
| | Bloat | 0 | 4.54% | 0 |
| Mortality | Kids | 9 | 7 | 5 |
| | Adults | 2 | 3 | 3 |

**Table 6:** Economic analysis of goat farming for one year.

| Sl. No. | Particulars | Management system | | |
|---|---|---|---|---|
| | | Extensive | Semi-intensive | Intensive |
| 1 | Cost of goats, at the locally prevailing market rate (Rs.) while initiation of the investigation | 20 nos goat x 1200 = Rs. 24, 000 | 20 nos goat x 1200 = Rs. 24, 000 | 20 nos goat x 1200 = Rs. 24, 000 |
| 2 | One labour was engaged @ Rs. 150.00 per day | Rs. 27, 375.00 | Rs. 27, 375.00 | Rs. 27, 375.00 |
| 3 | Concentrated feed offered and consumed (kg) | - | 18.3 kg | 18.3 kg |
| 4 | Cost of Concentrated feed including transport per kg (Rs.) | - | Rs. 25 | Rs. 25 |
| 5 | Total cost of ration (Rs.) | - | Rs. 7932.50 | Rs.7932.50 |
| 6 | Cost of medicines and vaccines etc. (Rs.) | Rs. 700.00 | Rs. 700.00 | Rs. 700.00 |
| 7 | Miscellaneous expenditure (Rs.) | Rs. 90.00 | Rs. 90.00 | Rs. 90.00 |
| 8 | Total expenditure (Rs.) | Rs. 52, 165.00 | Rs. 60, 097.50 | Rs. 60, 097.50 |
| 9 | Total no. of kids born | 24 | 17 | 19 |
| 10 | Total no. of goats mortality (including kids and adults) | Adult = 2<br>Kids = 10 | Adult = 3<br>Kids = 5 | Adult = 3<br>Kids = 5 |
| 11 | Estimated selling rate of kids, at the locally prevailing market rate (Rs.) | Rs. 1500.00 | Rs. 1500.00 | Rs. 1500.00 |
| 12 | Estimated selling rate of adult goats, at the locally prevailing market rate (Rs.) | Rs. 3000.00 | Rs. 3000.00 | Rs. 3000.00 |
| 13 | Gross income from kids (Rs.) | Rs. 21, 000.00 | Rs. 18, 000.00 | Rs. 21, 000.00 |
| 14 | Gross income from adult goats (Rs.) | Rs. 54, 000.00 | Rs. 51, 000.00 | Rs. 51, 000.00 |
| 15 | Gross total income (Rs.) | Rs. 75, 000.00 | Rs.69, 000.00 | Rs. 72, 000.00 |
| 16 | Net income (Rs.) | Rs. 22, 835.00 | Rs. 8902.50 | Rs. 11, 902.50 |
| 17 | Marginal rate of return (Rs.) | Rs. 43.77 | Rs. 14.81 | Rs. 19.80 |

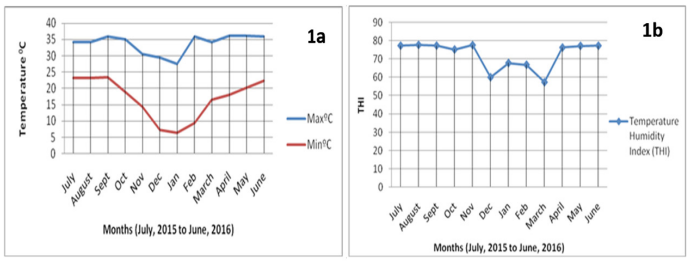


**Figure 1 a,b:** Changes in monthly meteorological observations and THI during the experimental period.

## Discussion

Wide variety of farming as well as production systems are found to be suitable for goat farming because of their capability (natural) to feed upon variety of vegetation's their high capacity of adaptation and so also because of fitness level. A farming system (inclusive of the household of the farm; livestock and cropping operations) is a class of farms structured similarly [6,7]. The present investigation outlines the different farming systems approach and a general framework of the various findings involved like body growth and measurement, reproductive and hemato-biochemical parameters in goat performance among the management systems. In addition, the study also focuses on the incidence of various parasite infestation, occurrence of diseases in black Bengal goat in various seasons during the experimental period and lastly the budget analysis for profitability was also estimated for various farming systems.

The findings from our study reported that there has been a consistent increase in the body weight of goats from the extensive group throughout the growing period over the goats of semi-intensive and intensive systems. Previous findings reported that from 4$^{th}$ to 9$^{th}$ months of age (under semi-intensive set up) goats have reduced body weight due to stress related to either management or nutrition [8,9]. However, Wijethunga et al., [4] in their study revealed that in comparison to extensive system under the intensive system there are greater ($p<0.05$) weight at birth and slaughter along with higher rate of growth. In a separate study the weight at birth of kids of Blanca Serrana Andaluza breed when compared under extensive and intensive systems were found to be statistically insignificant [10]. Faster average daily gain had been observed under semi-intensive and extensive systems in comparison to intensive system in case of Murciano-Granadina kids. Under extensive system the greater gain in body weight may be due to availability of feeds and fodders ad libitum as per choice.

Measuring certain linear measurements (directly proportional to body weight) and their interpretation are easy [11]. As per the breed; gender; type of yield as well as age there are differences in body measurements as revealed by research of Pesmen et al., [12]. The long leg length of kids was found to be greatest under extensive system with no major differences under intensive and semi-intensive systems [3]. The long leg length is shorter in those animals raised in small pens [13]. In the present study it has been found that height at withers as well as heart girth increase with animals' age and body weight and this finding is in agreement with the findings of Muhammad et al., [14] and Tsegaye et al., [15]. Daily grazing is possible for goats reared under extensive system and obviously their body measurement lengths are also higher as compared to the intensive and semi-intensive systems. Thus under extensive system the overall level of performance is found to be better in comparison to the two other management systems.

In order to evaluate physiological status (normal) of the animal the haematological as well as biochemical values need to be looked upon with importance. In domestic animals there is well documentation of the significance to determine biochemical and haematological indices and between different goat breeds such parameters vary greatly [16]. The mean Hb level (gm/dl) in goats among the farming system in our experiment did not differ significantly and remained within the normal range as reported previously [17]. The goats under extensive and semi-intensive system showed a lower level of PCV % than the intensive system and similar findings were reported by Imasuen and Otoikhian [18]. Without any manifestation of anaemia clinically certain goat breeds (indigenous) show PCV value of 16.5 per cent (minimum). Breed, age and sex of the animal; status of health (including physiological status); ambient temperature; variations seasonally and management influence PCV [19-21]. Diarrhoea induced dehydration may be responsible for higher PCV values.

The values of plasma glucose found in the present study was in close agreement with Ramprabhu et al., [22] but Perez et al., [23] reported concentration of blood glucose in wild goat to be in the higher side (126.1 ± 66.0 mg/dl) than the values recorded in the present study. There may be appreciable utilization of blood glucose for activities related to browsing as well as physical activities by the goats reared under extensive system. The differences in intake of feed and nutritional differences might be responsible for the variation in level of protein under different management systems. Individual animal's nutritional level and metabolic activity might be responsible for the differences in several hemato-biochemical analysis related parameters. Reproduction is affected positively by cholesterol. The cell membranes become weaker and vitamins may be utilised insufficiently due to low level of cholesterol leading to lower quality of meat [24,25]. Thus, it has been found that the extensive system is additionally beneficial when compared to intensive system because of the greater (significant) cholesterol level in goats under extensive system of rearing.

Enterprises in the small ruminant sector primarily depend on efficient production of offspring for profit. In this regard reproduction is a salient point in order to pilot the system of livestock production. Goats in the tropical region come to their first estrous when 60-70 per cent of live weight (adult) is attained and in such animals it is a general consideration to relate puberty less to age than growth [26]. In this study, goats attained puberty earlier under extensive management which is correlated with mean increase in body weight growth mentioned above. The present study revealed that there was no significant ($p>0.05$) difference in litter size amongst the different system of management and the birth weights of male kids are more than the female kids in all the system of management. The weight at birth of kids is affected by the diet of females that are pregnant and feed stuffs are easily available to the dams reared under intensive and semi-intensive systems [27]. In extensive system the number of kidding is highest and least in semi-intensive system. Seasons and system of rearing may be responsible for the variation of results.

In the present study, the higher rate of parasitic infection in goats of extensive system in the months of rainy season could possibly be due to animals being exposed constantly to the larval (infective) stage of parasites on the grounds for grazing and similar findings were also reported in sheep by Rahman et al. [28]. Mixed infection by Strongyles; Strongyloides; Trichuris; and Moniezia was common which is in agreement with the findings of the Ntonifor et al. 2013. The parasites grow and propagate well when rainfall and humidity are high as observed in our study. However the faecal count of parasitic eggs was either less or decreased steadily with the advent of winter and autumn due to the low mean temperatures not suitable for growth of larvae. Nevertheless during the rainy season the load of parasitic infection was high predominantly due to increase in relative humidity per cent (but not temperature) gradually.

In the present study 50 percent of the goats from all the farming system were affected by contagious ecthyma and similar observations were also recorded by Noman et al., [29]. During the rainy season, the diseases might be caused by high humidity. Too much access to tender and green leaves and load of parasites (lowering the immunity power) might be responsible for diarrhea in the animals. Managemental issues involved in goat rearing under intensive system might be responsible for occurrence of foot rot (15 per cent). Goats reared under semi intensive system might be suffering from deficiency of vitamin A which gave rise to opacity of cornea. Rearing of kids at indoors and access of field to the dams for grazing purpose might lead to incidence of mastitis in goats (lactating) under extensive system. Accumulation of milk in the teat canal of dams whose kids are not allowed to suckle for prolonged period attracts the micro-organisms thereby resulting in infection ultimately causing mastitis. In the present study, 25% of goats from the intensive group were only affected from alopecia during the rainy season.

Important constituents of gross income are returns generated and amounts received by selling kids and adult goats and this forms the basis of success on any system of production. The net profit by rearing goats was found to be higher in extensive system compared to intensive and semi intensive systems (as per analysis of budget partially). The margin of profit is higher in un-supplemented goats when compared to feed supplemented goats. This condition might have resulted due to greater price of variable costs (total) especially the supplemented feed price (5 per cent). From the results of the current study, to make the profit margin higher, however, it is imperative to consider price of the kids, feeds, labour cost and strategic time of fattening. From this finding we can conclude that, even though supplementation favour better growth rate and improved body condition during the lean seasons in the semi-intensive and intensive systems but it was not economically better than extensive systems. The present findings were in close agreement with the findings of Dixit and Singh [30]. However as per the study conducted by Patil et al. [31] the profit by rearing Osmanabadi goats (10 numbers) for three months was found to be higher in groups that are stall fed in comparison to the groups that are allowed to graze.

## Conclusion

The present study has meticulously highlighted the feasibility and profitability of rearing goats under various management system of farming. The changes of mean body weight, body measurements and reproductive characters of black Bengal goats has clearly indicated that extensive system represents a realistic possibility for production of meat type goat. The semi-intensive and intensive systems showed minimal difference in production and reproduction traits in our present investigation. Although the occurrence of parasitic and seasonal diseases were more prevalent in goats managed under extensive system. However, the partial budget analysis showed that the goats reared under extensive system gave a maximum return

in comparison to the rest of the management systems. It was also observed that animals should be provided with extra feed supplements during the lean periods (December - May) for better growth rate. Overall, the present study indicated that the extensive system of management could be the best option for sustainable and profitable goat farming.

## Declarations

**Funding:** We thank Joint Director, ICAR- Tripura centre and Dean, WBUAFS, Kolkata, WB for providing necessary financial assistance for conducting the research work.

**Ethics approval:** All animal experimental procedures were approved by the institutes Animal Ethics Committee.

**Consent to participate:** All the authors have given their consent to participate hence contributing to this research activity.

**Consent for publication:** All the authors have given their consent for publishing this research paper.

**Availability of data and material:** All the data and materials are provided.

**Authors' contribution:** All the authors have contributed in this research article.

## References

1. Banerjee GC. A Text Book of Animal Husbandry. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. 8th edition. 2004: 933 - 961.
2. Kumar S. Commercial Goat Farming in India: An Emerging Agri-Business Opportunity. Agricultural Economics Research Review. 2007; 20: 503 - 520.
3. Herrera PZ, Bermejo JVD, Henríquez AA, Vallejo M EC, Costa RG. Effects of extensive system versus semi-intensive and intensive systems on growth and carcass quality of dairy kids. Revista Brasileira de Zootecnia. 2011; 40: 2613-2620.
4. Wijethunga RAUK, Premaratne S, Peiris BL. Goat management systems in Bulathkohupitiya veterinary range. Tropical Agricultural Research. 2015; 26: 441-447.
5. Soulsby EJL. Helminth, Arthropods and Protozoa of domesticated animals, 7th Ed. The English Language Book Society and Bailliere Tindall, London. 1982: 763 - 773.
6. Silanikove N. The physiological basis of adaptation in goats to harsh environments. Small Rumin. Res. 2000; 35: 181-193.
7. Alexandre G, González-García E, Lallo CHO, Ortega-Jimenez E, Pariacote F, et al. Goat management and systems of production: Global framework and study cases in the Caribbean. Small Ruminant Research. 2010; 89; 193-206.
8. Santra A, Karim SA and Chaturvedi AH. Effect of concentrate supplementation on nutrient intake and performance of lambs of two genotypes grazing on semiarid rangeland. Small Ruminant Research. 2002; 44: 37 - 45.
9. Karim SA, Porwal K, Kumar S and Sing VK. Carcass traits of Kheri lambs maintained on different system of feeding management. Meat Science. 2007; 76: 395 - 401.
10. Camacho ME, Costa RG, Vallecillo AF, et al. Short note: An experimental approach to the standardized weight and daily gain of the Blanca Andaluza kids. Tropical and Subtropical Agroecosystems. 2009; 11: 101-104.
11. Adeyinka IA and Mohammed ID. Relationship of live weight and linear body measurement in two breeds of northern Nigeria. Journal of Animal and Veterinary Advances. 2006; 5: 891 - 893.
12. Pesmen G and Yardimci M. Estimating the live weight using somebody measurements in Saanen goats. Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Animal Husbandry, Archiva Zootechnica. 2008; 11: 30 - 40.
13. Borghese A, Terzano GM, Bartocci S. La produzione del capretto negli allevamenti intensiva. 6. Caratteristiche della carcassa e della carne in soggetti Saanen e Camosciata delle Alpi di 35 e 50 giorni di eta. Zootecnia e Nutrizione Animale. 1990; 16: 167-178.
14. Muhammad F, Khan H, Pervez A, Zubair M, Nawaz G, et al. Relationship of body weight with linear body measurements in goats. Journal of Animal and Veterinary Advance. 2006; 5: 452 - 455.
15. Tsegaye D, Belay B and Haile A. Linear Body Measurements as Predictor of Body Weight in Hararghe Highland Goats under Farmers Environment: Ethiopia, Global Veterinaria. 2013; 11: 649 - 656.
16. Waziri MA, Ribadu AY and Sivachelvan N. Changes in the serum proteins, hematological and some serum biochemical profiles in the gestation period in the Sahel goats. Vet. Arhiv. 2010; 80: 215-224.
17. Kaneko SJ. Clinical Biochemistry of Domestic Animals. 9th edn. Academic Press, California. 1989.
18. Imasuen JA and Otoikhian CSO. Growth and physiological performance of WAD goats reared under two different management environments: Proceedings of the 9th Annual Conference of Animal Science Association of Nigeria, held at Ebonyi State University, Abakaliki. 2004: 146 - 148.
19. Kaneko JJ. Serum proteins and the dysproteinemias. In: JJ Kaneko JW, Harvey and ML Bruss, (Eds), Clinical Biochemistry of Domestic Animals (5th ed.), Academic Press, San Diego, CA. 1997; 117 - 138.
20. Tibbo M, Jibril Y, Woldemeskel M, Dawo F, Aragaw K, Rege JEO. Hematological profiles in three Ethiopian indigenous goat breeds. International Journal of Applied Research of Veterinary Medicine. 2004; 2: 297 - 308.
21. Grunwaldt EG, Guevara JC, Estevez OR, Vicente A, Rousselle H, et al. Biochemical and haematological measurements in beef cattle in Mendoza plain rangelands (Argentina). Tropical Animal Health and Production. 2005; 37: 527 - 540.
22. Ramprabhu R, Chellapandian M, Balachandran S and Jonhson J. Influence of age and sex on blood parameters of kanni goats in Tamil Nadu. Indian Journal of Small Ruminants. 2010; 16: 249 - 251.
23. Pérez JM, González FJ, Granados JE, Pérez MC, Fandos P, et al. Hematologic and biochemical reference intervals for Spanish ibex. Journal of Wildlife Diseases. 2003; 39: 209-215.
24. Okonkwo JC, Omeje IS, Okonkwo IF and Umeghalu ICE. Effects of breed, sex and source within breed on theblood bilirubin, cholesterol and glucose concentrations of Nigerian goats. Pakistan Journal of Nutrition. 2010; 9: 120-124.
25. Saez F, Ouvrier A and Drevet JR. Epididymis cholesterol homeostasis and sperm fertilizing ability. Asian J. Androl. 2011; 13: 11-17.
26. Devendra C and Burns M. Goat production in the Tropics. Second Edition. Commonwealth Agricultural Bureau. Farnham Royal, Slough SL 3BN, UK. 1983: 183.
27. Tag-Eldin MI. Studies on some productive and reproductive parameters of Nubian goats and their Saanen crossbreds under local environmental conditions. Thesis (PhD in Animal and Poultry Production) - Khartoum University, Khartoum. 2000.

28. Rahman H, Pal Papri, Bandyopadhyay S and Chatlod LR. Epidemiology of gastrointestinal parasitism in goats in Sikkim. Indian Journal of Animal Sciences. 2012; 82 355 - 358.

29. Noman MA, Shaikat A, Nath B, Shil S and Hossain M. Incidence and modulating effects of environmental factors on infectious diseases of Black Bengal goat in Cox's Bazar district of Bangladesh. YYU Veterinary Fakultesi Dergisi. 2011; 22: 163 - 167.

30. Dixit AK and Singh MK. Economic analysis of goat rearinig under field conditions of Bundelkhand region. Indian Journal of Small Ruminants. 2014; 20: 165 - 168.

31. Patil M, Kumar P, Teggelli RG and Ubhale P. A Study on Comparison of Stall Feeding System of Goat Rearing with Grazing System. APCBEE Procedia. 2014; 8: 242-247.