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Research Article

Effect of Concentrate Feed Supplementation on Performance of Indigenous Grazing Sheep

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Abstract

Sheep may not receive enough nutrition by grazing poor pastures, particularly during the dry season. Supplementing concentrated feed may be a useful approach to maximize rumen microbial activity by providing a balanced amount of energy and protein. An experiment was carried out to optimize the supplementation of concentrate feed for native coastal sheep in southwest Bangladesh. Five treatment groups consisting of twenty female sheep each were randomly assigned to receive five different degrees of concentrate feed. A randomized complete block design (RCBD) was the basis for the experimental setup. The five treatment groups were assigned a concentrate mix of 0, 100, 150, 200, and 250 g sheep-1 day-1, respectively. The energy and crude protein content of the concentrate mixture were 12.00 MJ and 219.0g kg DM^{-1}. Every day, from 8 a.m. to 6 p.m., all groups of sheep were permitted to graze for ten hours. Before allowing them to concentrate feeding and grazing, empty body weight measurements were recorded every two weeks. Body weight of sheep fed different levels of concentrate was similar ($p>0.05$). The growth rate varied significantly among different concentrate supplemented group only at week 10 ($p=0.029$) and at week 14 ($p=0.013$) however, at other cases the growth rate was statistically similar ($p>0.05$). This implies that the nutrient intake from grazing was likely sufficient for maintaining similar growth across groups outside the weights at week 10 and 14. In summary, the absence of a significant variation in weight gain despite higher concentrate feed supplementation likely reflects the complex interplay of biological, genetic, and environmental factors that regulate weight gain.

Keywords: Body weight, Coastal sheep, Pasture, Growth rate, Lambing interval, Reproductive traits

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Introduction

Livestock is one of the most significant agricultural subsectors in Bangladesh and is crucial to the growth of the national economy of the nation (Sharma et al., 2014). Sheep farming is becoming more and more popular in our nation among all small ruminants. Because of their adaptability to hard agro-climatic conditions, inadequate management, and poor feeding methods, sheep are a useful animal that are easy to maintain in rural areas. Sheep farming can help alleviate part of Bangladesh's animal product scarcity to some extent. The country as a whole have about 3.401 million sheep heads (DLS, 2017). While some hybrid sheep are retained, the majority of sheep are native breeds (Bhuiyan, 2006). Professional sheep farming is being practiced by landless and marginal farmers because sheep don't require a lot of area. Sheep don't need a lot of food, and more significantly, they don't have a set feeding schedule. They are able to consume grass and leaves straight from the pasture. Sheep are raised on roadsides, in canals, and on fallow land, depending on the type of feed that is typically used (Sultana et al., 2010). Because of this, they don't need a lot of labor to maintain. Taking care of a sheep farm doesn't need much skill, even for illiterate men, women, and kids.

Sheep are primarily raised in Bangladesh under extensive grazing conditions without concentrate feed additives by poor farmers and women. Sheep may not receive enough nourishment from inadequate pastures, particularly during the dry season (Sultana et al., 2011). According to Chaturvedi et al. (2003), the majority of sheep flocks in semi-arid areas do not supplement concentrate diet to their pregnant and lactating sheep. Concentrate supplementation can be a useful strategy for improving rumen microbial activity in sheep grazing unsatisfactory pastures by providing a balanced amount of fermentable carbohydrates and nitrogen. Concentrate supplementation decreases N loss, particularly urine N excretion (Hoekstra et al., 2007; Zhao et al., 2015), and CH_4 emissions (Yan et al., 2010). The main constraint to sheep production in Bangladesh is the lack of and poor quality of feed resources. Previous studies suggest that concentrate supplementation to indigenous sheep fed green grass can improve their productivity (Reddy et al., 2017; Salim et al., 2003). Feeding systems for the productive and reproductive performance of native sheep in Bangladesh have not been investigated (Sultana et al., 2011). Therefore, the present study was undertaken to optimize concentrate supplementation for indigenous grazing sheep in the southwestern coastal region of Bangladesh.

Materials And Methods

Design of experiment

There were twenty native female sheep split up into five treatment groups. Based on their initial live weight, the experimental animals were weighed individually, divided into five groups, and randomly allocated to five distinct concentrate mixes containing 0, 100, 150, 200, and 250 g sheep^{-1} day^{-1}. Randomized Complete Block Design

(RCBD) was the basis for the experimentation and data analysis. Ensuring that all factors (surroundings and amenities), except for the concentrate mixture supplementation, are kept constant across all groups. By maintaining uniformity in the surroundings and amenities for all the sheep, the study ensures that any observed differences in outcomes such as growth rate or weight can be attributed solely to the different levels of concentrate supplementation.

Housing and management of sheep

Sheep were housed in individual pens with slate floors (made of bamboo). The sheep shed was equipped with adequate ventilation systems. Waterers, feeders, and sheds were consistently cleaned. To avoid infection, the proper biosecurity precautions were implemented. An anthelmintics injection (A-mectin plus) was used to deworm all sheep, and the procedure was repeated three months later. All sheep received vaccinations against infectious diseases. Sheep were grazed on the Khulna University campus's playground, roadside, and field laboratory. Sheep were grazed daily 8 AM to 6 PM. All the sheep have free access to clean drinking water at all times.

Type and quality of pasture

The pasture was a natural grassland composed primarily of native grasses and sheep were allowed under rotational grazing management to maintain health and productivity of pasture. At the time of the study, the pasture was moderately grazed, with sheep rotating between paddocks to allow for pasture recovery. The pasture had a mix of different grasses like Arail (*Leersia hexandra*), German lata (*Mikania cordata*), Durba (*Cynodon dactylon*), Gitlaghash (*Paspalum distichum*), Chanchi (*Alternanthera sessilis*) and Kakpaya ghash (*Dactyloctenium aegyptium*) providing adequate forage biomass. However, forage availability varied seasonally, with reduced quality observed in late summer. The composition of the available forages is detailed in a separate article authored by the researcher, which was part of an independent experiment (Rumpa et al., 2022). Pasture quality, measured by crude protein and fiber content, was highest in spring and early summer, with a decline in quality during late summer and fall due to reduced rainfall and heat stress.

Vaccination schedule for experimental sheep

The experimental sheep were vaccinated at various intervals with multiple vaccines, including A-mectin plus, FMD, Hemorrhagic septicemia, Anthrax, Sheep pox, and PPR vaccines. The vaccinations were administered subcutaneously in varying doses, with A-mectin plus given as a regular treatment at intervals throughout the study period, while the other vaccines were provided according to the required schedule.

Concentrate supplementation

Concentrate mixture at the rate of 0, 100, 150, 200, and 250 g sheep^{-1} day^{-1} were allocated to the sheep under the five treatment groups, respectively. The allocated concentrate mixture was divided into two equal portions and given to them in the morning and evening every day. The concentrate mixture contains 12.00MJ ME and

219.0g crude protein kg^{-1} DM. The chemical composition and ingredient composition of the concentrate mixture are shown in Table 1 and Table 2, respectively.

Table 1. Chemical compositions (Mean ± SE) of concentrate feed ingredients.

Feed ingredients	Dry matter (DM)	ME (MJ/kg)	Crude protein (%)	Ether extract (%)	Crude fiber (%)	Ash (%)
Cracked maize (*Zea mays*)	91.11±3.70	13.30	8.27±0.07	2.88±0.33	1.82±0.33	0.50±0.00
Wheat (*Triticum vulgare*) bran	91.50±3.26	11.82	17.08±0.64	2.69±0.65	5.30±0.60	2.50±0.29
Rice (*Oryza sativa*) polish	90.65±1.02	9.93	18.12±0.93	21.12±1.87	6.97±0.72	7.53±0.91
Mustard (*Brassica spp.*) oil cake	94.77±1.81	12.49	41.57±0.19	12.55±2.89	11.08±1.04	8.81±1.02
Soybean (*Glycine max*) meal	92.53±3.20	12.30	50.75±0.75	9.26±1.03	8.33±1.18	6.40±0.22

Table 2. Ingredient composition of the concentrate mixture.

Sl. No.	Ingredients	Quantity (kg/100kg)
1	Cracked maize (*Zea mays*)	40
2	Wheat (*Triticum vulgare*) bran	15
3	Rice (*Oryza sativa*) polish	12
4	Mustard (*Brassica spp.*) oil cake	15
5	Soybean (*Glycine max*) meal	15
6	Dicalcium phosphate (DCP)	2
7	Common salt	0.75
8	Vitamin mineral premix	0.25
	Total	**100**
	Nutrient composition (kg^{-1} DM)	
	Metabolizable energy (MJ)	12.00

Crude protein (g)	219.0

Data collection and analyses

The body weight, the date of conception, the commencement of estrus, vaccinations, deworming, and medicines were monitored and recorded regularly and entered into a computer. Before they could graze, empty body weight measurements were recorded every two weeks. The data were analyzed using the General Linear Model (GLM) approach in SAS version 9.1.3 (SAS, 2009). Analysis of variance was use to investigate the effects of concentrated supplementation, and Duncan's Multiple Range Test (DMRT) was employed to compare treatment means, with a significance level of $p < 0.05$.

Results and Discussion

Body weight

Concentrate supplementation showed no significant variation ($p>0.05$) in the body weight of sheep in all weight categories under study (Figure 1). However, body weight increased numerically ($p>0.05$) with the increasing level of concentrate supplementation. The graph (Figure 1) illustrates the trend of body weight gain in indigenous coastal sheep over 26 weeks, supplemented with different levels of concentrate feed (0 g, 100 g, 150 g, 200 g, and 250 g). All supplementation levels showed an increase in body weight over the study period, with the highest gains in the 250 g group and the least in the 0 g group. Sheep fed with 250 g concentrate consistently gained weight at the fastest rate, starting from an initial weight of 12.8 kg to 19.6 kg at week 26 ($p>0.05$). Groups with intermediate supplementation levels (100-200 g) showed moderate weight gain trends. This aligns with the physiological need for increased energy and nutrients to support growth in sheep. The trend suggests diminishing returns at lower supplementation levels, with the 100 g and 150 g groups showing similar weight trajectories. This indicates that moderate supplementation might only marginally benefit weight gain, and higher supplementation levels are required for optimal growth. The findings highlight the importance of adequate concentrate supplementation in promoting growth in sheep, particularly in coastal breeds that may have specific dietary requirements due to environmental conditions. However, further studies should explore cost-effectiveness, feed conversion efficiency, and the potential effects on overall health and productivity.

Significance level considered at $p < 0.05$

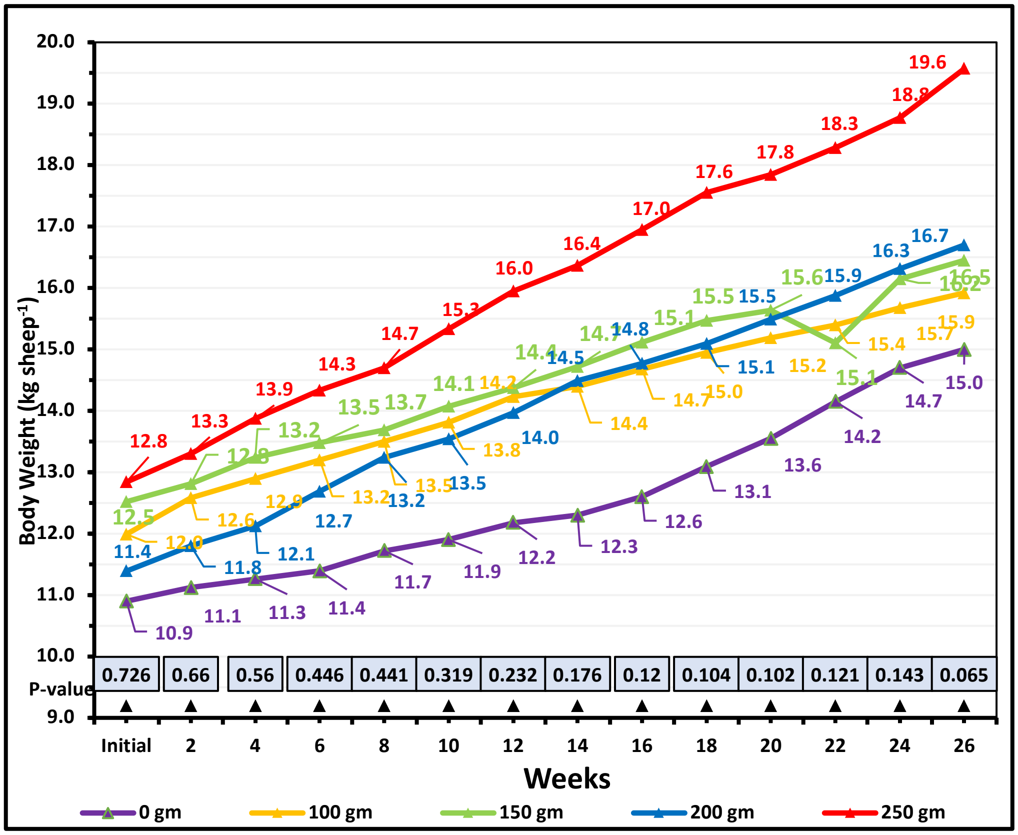

Fig. 1. Trends of body weight gain (kg sheep^{-1}) at two week interval of indigenous coastal sheep supplemented with different levels of concentrate feed.

Growth rate

Table (3) presents the average growth rate of indigenous sheep fed different amounts of concentrated mixture at two-week intervals. According to data from the Table 3, the average growth rate of grazing sheep differed significantly at week 10 ($p=0.029$) and week 14 ($p=0.013$) of the feeding trial across the sheep groups fed varying amounts of concentrate mix. In the remaining weight cases, there was no significant mean differences observed ($p>0.05$). The growth rate (g d^{-1}) at week 10 varied from 12.33±4.02 in the group that did not receive concentrate to 42.00±5.88 in the group that received concentrate at a rate of 250g sheep^{-1}d^{-1}. There were significant variations ($p<0.05$) in the growth rate of sheep at week 14 as well; the growth rate of sheep fed 200g of concentrate sheep^{-1} d^{-1} was highest (34.67±9.55), while the growth rate of sheep fed no concentrate (8.18±0.95) was lowest. Similar findings about the effect of dietary concentrate on Tibetan sheep were observed in a study (Liu et al., 2019), wherein growth performance was improved by increasing the concentrate content in the diet. Concentrate supplementation changed the rumen fermentation from acetate to propionate, which improved the energy utilization efficiency of Tibetan sheep. The group with 60% concentrate and 40% roughage exhibited the best growth performance, with an average daily gain of 134.38 ± 22.41g (Liu et al., 2019). Concentrate increases dry matter intake (DMI), organic matter intake (OMI), and nutritional digestibility when fed to Thalli lambs at 20% and 40% of their meal (Chishti et al., 2022). According to Sultana et al. (2011), the pre-weaning growth rate of native sheep in Bangladesh under semi-intensive settings was observed to be 65.0g d^{-1}. According to Zohara et al. (2014), the native ewes in Bangladesh gained weight on a daily basis at a rate of 21.19 and 40.95 g d^{-1}, respectively, for the grazing and concentrate supplemented groups. The growth rate of native coastal sheep was measured by Pervage et al. (2009) and was 51.21g d^{-1}. According to Ahmed et al. (2018), coastal sheep in Bangladesh grow at a rate of 91.29g d^{-1} when raised in intensive conditions. Lambs from coastal regions had the greatest daily gain, followed by lambs from the Barind and Jamuna River basins (Ahmed et al., 2018). Different authors have reported varying values for the daily growth rate of Bengal lambs in the 4–9 months age range (Sultana et al., 2011; Ahmed et al., 2015; Sultana et al., 2017). Sultana et al. (2017) discovered greater values for daily growth (118.17-134.33 g d^{-1}) among them, but other studies showed significantly lower values, which may have been caused by variations in feed, the age of the lambs, or the quality of the trials.

In contrast to numerous studies that show positive effects of concentrate supplementation, this study did not observe significant improvements in weight gain or reproductive performance, likely due to the high-quality pasture available during the study period. Pasture composition, could have provided adequate nutrition, thus reducing the need for additional concentrate supplementation. While studies such as those by Smith et al. (2020) and Jones et al. (2018) report significant increases in body weight gain with concentrate supplementation under more controlled or limited grazing systems.

Table 3. Growth rate (g d^{-1}; Mean ± SE) of indigenous coastal sheep fed different levels of concentrate feed at fortnight interval.

Week of weigh	Concentrate supplementation (g $sheep^{-1}$ d^{-1})					P-value
	0	100	150	200	250	
Week 2	15.33±5.21	38.83±10.25	18.83±11.39	28.50±4.80	30.33±5.77	0.284
Week 4	9.17±4.40	20.83±7.40	28.83±8.37	21.00±3.54	37.50±10.54	0.136
Week 6	7.75±2.37	21.17±7.43	15.67±4.33	37.67±9.74	31.50±15.12	0.184
Week 8	22.67±8.20	20.00±7.33	13.83±2.10	36.83±19.32	24.50±6.50	0.630
Week 10	12.33±4.02	20.10±6.20	25.33±7.30	20.00±4.95	42.00±5.88	0.029
Week 12	18.25±7.32	28.00±9.24	19.83±8.60	28.50±8.78	41.50±12.20	0.452
Week 14	8.18±0.95	10.67±4.88	24.17±3.78	34.67±9.55	27.00±2.50	0.013
Week 16	19.75±8.25	18.50±7.37	26.83±5.85	18.50±6.20	39.67±11.10	0.316
Week 18	32.74±10.39	18.91±3.11	22.50±10.89	21.09±2.75	39.67±12.70	0.453
Week 20	30.83±6.00	15.41±6.60	11.67±5.53	26.91±11.90	19.67±4.37	0.367
Week 22	40.50±9.95	13.67±6.12	23.83±6.71	26.09±13.14	28.59±8.13	0.390
Week 24	36.33±11.10	18.50±11.15	10.17±3.91	29.41±8.05	32.83±6.67	0.231
Week 26	20.33±5.88	17.17±5.14	20.00±5.24	24.83±10.02	53.41±20.01	0.164

Significance level was at $p < 0.05$

Weight at maturity

Data in the Table 4 showed that the average maturity weight (kg $sheep^{-1}$) was highest in sheep group fed concentrate feed at 250g day^{-1} (11.99±1.00) and lowest in the 150g supplemented group (10.50±1.80). Mean differences among different levels of concentrate feed-supplemented groups were not significant.

Weight of ewes

There were no significant effects of concentrate feed supplementation on the weight of ewes (kg $sheep^{-1}$) at first lambing (Table 4). Numerically highest ($p>0.05$) weight at maturity was observed in the 250 g supplemented group (13.49±1.13) followed by 200 g (12.27±0.36), 100 g (11.97±1.26), no concentrate group (11.78±0.45) and 150 g (11.33±0.75) supplemented group. Data in the Table 5 showed that the weight of ewes at second lambing (kg $sheep^{-1}$) was highest in the sheep group fed concentrate feed at the rate of 100g $sheep^{-1}day^{-1}$ (13.79±1.26) followed by 150 g (13.50), no concentrate (13.43±0.45), 250 g (13.30) and 200 g group (12.85±0.75). The effects of concentrate feed supplementation on the weight of ewes at second lambing were not significant ($p>0.05$).

Table 4. Production and reproductive performance of ewes at first lambing fed different levels of concentrates

Parameters		Concentrate supplementation (g sheep^{-1} d^{-1})					P-value
		0	100	150	200	250	
Weight at maturity (kg)		11.20±1.09	10.77±0.93	10.50±1.80	11.68±0.31	11.99±1.00	0.847
Weight of ewes at first lambing (kg)		11.78±0.45	11.97±1.26	11.33±0.75	12.27±0.36	13.49±1.13	0.590
Litter size (number)		1.33±0.33	1.25±0.25	1.00±0.00	1.00±00	1.33±0.33	0.698
Sex of lambs (%)	Male	33.33	50	33.33	100	66.67	
	Female	66.67	50	66.67	0	33.33	
Birth weight of lamb (kg)		1.10±0.25	1.64±0.21	1.42±0.26	1.53±0.11	1.57±0.30	0.505
Weaning age (days)		155.00	148.75±2.50	141.67±1.20	147.33±5.49	154.50±5.50	0.268
Weaning weight (kg)		7.43	9.92±1.61	9.87±1.56	9.23±0.74	6.94±2.84	0.729
Post-partum heat (days)		73.00±17	74.67±19.62	33.00	53.00±8.08	56.00	0.623
Lambing interval (days)		234.00±11	220.33±16.84	211.00	214.67±6.36	213.00	0.836

significance level considered at $p < 0.05$

Litter size

There were no significant effects of concentrate supplementation on the litter size of sheep being highest in 250 g and no concentrate supplemented group (1.33±0.33) and lowest in 150 g and 200 g supplemented group (Table 4). Litter size at 2nd lambing was found highest (2.00) in the sheep group fed no concentrate feed followed by 100 g (1.67±0.33), 200 g (1.33±0.33), 150 g (1.00), and 250 g group (1.00) (Table 5). The effects of concentrate feed supplementation on litter size at second lambing were not significant ($p>0.05$).

Sex of lambs

Sheep groups fed concentrate feed at the rate of 200 g and 250 g sheep^{-1}day^{-1}, gave birth to more male lambs than other groups (Table 4). On the other hand, groups of sheep fed 150 g concentrate mix gave birth to more female lambs.

Birth weight of lambs

Birth weights (kg sheep^{-1}) of lambs at first lambing were found highest (1.64±0.21) in the sheep group fed 100g concentrate mix sheep^{-1}day^{-1} followed by 250g (1.57±0.30), 200g (1.53±0.11), 150g (1.42±0.26) and no concentrate feed group (1.10±0.25) (Table 4). The effects of concentrate feed supplementation on the birth weight of lambs at first lambing were not significant (p>0.05). Birth weights of lambs at second lambing were found highest in the sheep group fed 150g concentrate feed $sheep^{-1}day^{-1}$ (2.50) followed by 250g (2.40), 200g (1.77±0.37), 100g (1.77±0.38), and no concentrate feed group (1.72±0.08), respectively (Table 5). The effects of concentrate feed supplementation on the birth weight of lambs at second lambing were not significant (p>0.05).

Weaning age and weight

Data in the Table 4 showed that the weaning age (days) of lambs at first lambing was highest (155.00) in the sheep group fed no concentrate feed followed by 250 g (154.50±5.50), 100 g (148.75±2.50), 200 g (147.33±5.49) and 150 g group (141.67±1.20). The effects of concentrate feed supplementation on the weaning age of lambs at first lambing were not significant (p>0.05). Weaning weights of lambs (kg) at first lambing were found highest (9.92±1.61) in the sheep group fed 100g concentrate feed per sheep per day followed by 150g (9.87±1.56), 200g (9.23±0.74), no concentrate feed (7.43) and 250g group (6.94±2.84) (Table 4). The effects of concentrate feed supplementation on the weaning weight of lambs at first lambing were not significant (p>0.05). According to another study that body weight, daily weight growth, and the behavior of newborn lambs until they are weaned were all positively impacted by higher concentrate levels in the diet (Omar et al., 2019).

Post-partum heat

There were no significant effects of concentrate supplementation on post-partum heat of ewes (days) (Table 4). Numerically highest (p>0.05) post-partum heat of ewes (days) was observed in sheep group fed concentrate feed at the rate of 100g $sheep^{-1}day^{-1}$ (74.67±19.62), followed by no concentrate (73.00±17.00), 250 g (56.00), 200 g (53.00±8.08), and 150 g group (33.00), respectively.

Lambing interval

Lambing intervals (days) were found highest (234.00±11.00) in the sheep group fed no concentrate feed, followed by 100 g (220.33±16.84), 200 g (214.67±6.36), 250 g (213.00), and 150g (211.00) concentrate feed group, respectively (Table 4). The effects of concentrate feed supplementation on lambing interval were not significant (p>0.05).

Table 5. Production and reproductive performance of ewes at second lambing fed different levels of concentrates

Parameters	Concentrate supplementation (g $sheep^{-1}d^{-1}$)					P-value
	0	100	150	200	250	
Weight of ewes at 2nd lambing (kg)	13.43±0.45	13.79±1.26	13.50	12.85±0.75	13.30	0.965
Litter size (number) in 2nd lambing	2.00±0.00	1.67±0.33	1.00	1.33±0.33	1.00	0.450
Birth weight of lamb (kg) in 2nd lambing	1.72±0.08	1.77±0.38	2.50	1.77±0.37	2.40	0.693

significance level considered at $p < 0.05$

Mortality

Effects of concentrate supplementation were not significant on the mortality of lambs ($p>0.05$). The highest lamb mortality (50.00±28.87) was observed in the sheep group fed no concentrate feed followed by 200 g (37.50±23.94), 250 g (16.67±16.67) and 100 g supplemented group (12.50±12.50). (Table 6). The lack of lamb mortality in the group fed 150 g concentrate supplementation per sheep per day could be attributed to the optimal balance of nutrients provided, which supported healthy growth without overloading the animals' physiological capacity. Higher levels of concentrate feed may have exceeded the animals' ability to process and utilize the nutrients effectively, leading to stress or metabolic imbalances that contributed to higher mortality rates. Additionally, environmental factors and health conditions may have played a role in the different outcomes observed across supplementation levels.

Table 6. Mortality and dystocia problems of sheep fed different levels of concentrates

Parameters	Concentrate supplementation (g $sheep^{-1}d^{-1}$)					P-value
	0	100	150	200	250	
Lamb mortality (%)	50.00±28.87	12.50±12.50	00	37.50±23.94	16.67±16.67	0.442
Incidence of dystocia (%)	100	75.00	66.67	50.00	100	-

significance level considered at $p < 0.05$

Incidence of Dystocia

In cent percent of cases, dystocia was observed in sheep groups fed 250 g concentrate feed $sheep^{-1}$ day^{-1} whereas the lowest percentage of dystocia was observed in 200 g concentrate feed group (Table 6).

Conclusion

The productive and reproductive characteristics of native grazing sheep were not significantly affected by concentrate feed supplementation ($p>0.05$). The results of this study indicate that the native sheep were able to meet their nutritional requirements through ten hours of daily grazing, with minimal supplementation needed. This suggests that grazing alone can provide adequate nutrition for the sheep under the conditions tested, highlighting the importance of grazing time in meeting their dietary needs. Further research may be necessary to evaluate the effects of different grazing durations and supplementation levels on health and productivity of indigenous sheep.

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