



Research article

## Effect of Concentrate Feed Supplementation on the Growth Performance of Crossbred Sheep

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### ABSTRACT

Poor-quality pastures can limit the nutritional intake of sheep, particularly during dry seasons, leading to suboptimal growth. To address this, a study was conducted at the field laboratory of Agrotechnology Discipline, Khulna University, Khulna, Bangladesh to optimize the concentrate feed supplementation for crossbred sheep. This experiment involved 20 female sheep divided into five treatment groups, with each group receiving a different level of concentrate supplementation (0, 100, 150, 200, or 250 g sheep<sup>-1</sup> day<sup>-1</sup>). The sheep grazed for 10 hours daily. Every 14-day interval body weight measurements were taken in the morning before the animals were allowed to graze and concentrate feed. Statistical analysis using SAS software indicated that body weight generally increased with higher levels of concentrate supplementation, although, the differences were not statistically significant ( $p > 0.05$ ). For the weigh at day 70, the sheep given 250 g of concentrate had the highest average body weight ( $18.11 \pm 1.53$ kg), while the group without supplementation had the lowest ( $13.28 \pm 2.37$ kg) body weight. Growth rates (g day<sup>-1</sup>) also tended to increase with greater amount of concentrate supplementation. At 56-day of weigh, 250g concentrate supplemented group had the highest average daily weight gain ( $80.44 \pm 5.39$  g day<sup>-1</sup>), and group with no concentrate supplementation had the lowest weight gain ( $22.22 \pm 5.55$  g day<sup>-1</sup>) ( $p < 0.05$ ). Concentrate feed tends to increase weight gain in sheep, with a pattern suggesting that higher levels of supplementation lead to faster growth rates. However, all day of weigh did not show statistically significant differences, indicating that factors other than concentrate feed intake might be impacting the growth rate of crossbred sheep.

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### Introduction

In Bangladesh, the agriculture sector comprises crop cultivation, fisheries, and livestock (Rahman & Biswas, 2020). Bangladesh relies on its agriculture and livestock sectors for food security (Ali et al., 2020). Livestock sector of Bangladesh is comprised of 24.86 million cattle, 1.52 million buffalo, 3.83 million sheep, 26.95 million goats, 319.69 million chickens, and 66.02 million ducks where the number of sheep has increased by 19.37% over the previous nine years (DLS, 2023). Small ruminants like sheep and goats play a significant and diverse role in livestock sector of Bangladesh (Begum et al., 2007). Sheep production is well-regarded due to their early maturity, high prolificacy, remarkable disease resistance capacity, excellent skin quality, and capacity to adapt to a variety of harsh agro-climatic conditions (Sultana et al., 2011). Farm households benefit from the abundance of resources that

sheep give, including cash income, meat, fiber, and manure. Sheep have short production cycles with fast growth rate, grow more quickly, require low initial capital investment, and are easier to maintain than larger ruminants like cattle (Gizaw et al., 2013; Tadesse et al., 2015).

Most shepherds don't provide supplemental concentrates to their sheep, even during crucial physiological stages such as pregnancy and lactation (Chaturvedi et al., 2002). This led to suboptimal production and reproduction rates in sheep. Even a modest addition of supplementation of concentrates, alongside grazing on rangeland, can enhance lamb growth, nutrient digestibility, and the overall productivity of sheep (Chaturvedi et al., 2006).

Feedlot conditions play a significant role in lamb production and it impacts on carcass traits and meat

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quality. Several factors contribute to production outcomes which include the breed and age of the lamb, the type of feed provided, and the length of time the animals are fed (Rashid et al., 2013). Supplementing adult sheep with concentrate feed has also been shown to enhance marbling and improved tenderness of mutton (Nishimura, 2010). When lambs get concentrate feed in addition to their grazing diet, they accumulate more intramuscular fat (Valvo et al., 2005). As animals consume more dietary concentrates, there is also a corresponding increase in live weight gain (Santra et al., 2002). Addition of small amounts of concentrate feed to diets with medium to low

## Methodology

### Design of experiment

Twenty crossbred female sheep was divided into 5 treatment groups. After being individually weighed, the experimental animals were divided into five groups based on their initial live weight. Each group was then randomly assigned into five dietary treatment groups with different amounts of concentrate feed—100, 150, 200, or 250 g sheep<sup>-1</sup> day<sup>-1</sup>. The experiment was designed under the Randomized Complete Block Design (RCBD).

### Housing and management of sheep

The sheep were housed in individual pens with slate flooring. There were adequate ventilation systems in the

quality forages generally reduces methane (CH<sub>4</sub>) emissions in ruminant animals (Hristov et al., 2013). It was also noticed that increasing the concentrate level in the fattening diet of Awassi lambs to as much as 85% led to improvements in growth performance, feed efficiency, and carcass weight (Haddad & Husein, 2004). Crossbred sheep are essential component of livestock farming especially in areas with inconsistent forage quality. However, this study examines how concentrate supplements affect growth, with the aim to find optimal feeding methods to promote efficient and sustainable sheep farming.

sheep shed. Regular cleanings were done for the waterer, feeder, and shed. To stop illnesses, appropriate biosecurity measures were maintained. Sheep were dewormed using an anthelmintic injection (A-mectin plus vet), and the procedure was repeated after three months. Every sheep received vaccinations against the infectious diseases which are listed in Table 1. Sheep were permitted to graze on the Khulna University campus's playground, roadsides, and field of laboratory. Sheep grazing began each day at 8:00 am and finished at 6:00 pm. Every sheep had unlimited access to clean drinking water. With the exception of the difference in the amount of concentrate feed combination, every sheep had the identical surroundings and amenities.

Table 1: Vaccination and medication schedule for crossbred experimental sheep

Vaccine/medicine	Dose	Route	First Dose	Interval
A-mectin plus vet (Deworming)	1.0 ml 50kg <sup>-1</sup> body weight	Sub-cutaneous	8 weeks of age follow up booster dose at 3 months	3-months
Peste des petits ruminants (PPR)	1.0 ml sheep <sup>-1</sup>	Sub-cutaneous	4 months of age	6-months

### Concentrate feed supplementation

Concentrate feed mixture was allocated for sheep under five treatment groups of 0, 100, 150, 200 and 250g sheep<sup>-1</sup> day<sup>-1</sup>, respectively. Allocated concentrate mixture was divided into two equal portion and supplied in the morning and evening every day. Chemical compositions of individual supplied concentrate feed ingredients are shown in Table 2, and compositions of concentrate feed mixture are shown in Table 3.

### Data collection and analysis

Every pertinent piece of information, including body weight, deworming, vaccination, and medicine, was consistently documented. Before they were let to graze and concentrate feed, their body weight was recorded every two weeks. The growth rate (g day<sup>-1</sup>) was computed by dividing the weight by the number of days after deducting the initial weight from the current weight. SAS version 9.1.3's GLM algorithm was used to analyze the data (SAS, 2009). Analysis of variance was utilized to examine the effects of concentrate supplementation, and DMRT was employed to compare the treatment means, with a significance level of p<0.05.

## Results

### Body weight (kg sheep<sup>-1</sup>)

The effect of concentrate supplementation on body weight of sheep was not significant in any of the weight categories under the study (Table 4). The data showed a pattern of increasing weight with higher supplementation of concentrate level of feed which indicated a positive correlation between concentrate levels and weight gain. At the beginning, the average initial body weight for sheep across supplementation groups ranged from 11.00±2.71 (no supplementation) to 12.13±1.47 kg sheep<sup>-1</sup> (250g concentrate supplementation). Weigh at day 14, weights ranged from 11.59±2.48 to 13.32±1.42 kg sheep<sup>-1</sup>, indicating increasing trend (p>0.05) of weights with the increasing of concentrate supplementation. As the study proceeded, weight at 28<sup>th</sup> day of the experiment, it was showed a similar pattern with weights between 11.92±2.44 and 14.56±1.43 kg sheep<sup>-1</sup> (p>0.05). At the fourth interval (42 days), the average weight varied from 12.43±2.43 to 15.73±1.46 kg sheep<sup>-1</sup> (p>0.05). At the fifth interval (56 days of experiment), the weights ranged from 12.95±2.45 to 16.91±1.5 kg sheep<sup>-1</sup> (p>0.05), by the sixth interval (70 days of experiment), the weights varied from 13.28±2.37 to 18.11±1.53 kg sheep<sup>-1</sup> (p>0.05).

Table 2: Chemical compositions (Mean  $\pm$  SE) of individual concentrate feed ingredients

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

Table 3: Composition of concentrate feed mixture

Sl. No.	Ingredients	Quantity (%)
1	Cracked maize ( <i>Zea mays</i> )	40
2	Wheat bran ( <i>Triticum vulgare</i> )	15
3	Rice polish ( <i>Oryza sativa</i> )	12
4	Mustard oilcake ( <i>Brassica spp.</i> )	15
5	Soybean meal ( <i>Glycine max</i> )	15
6	Dicalcium phosphate (DCP)	2
7	Common salt	0.75
8	Vitamin mineral premix	0.25
<b>Total</b>		<b>100</b>
<b>Nutrient composition (per kg DM)</b>		
Metabolizable energy (MJ)		12.00
Crude protein (g)		219.0

Table 4: Body weight (kg sheep<sup>-1</sup>; Mean  $\pm$  SE) of crossbred sheep fed different levels of concentrate feed at 14-day interval

Day of weigh	Concentrate supplementation (g sheep <sup>-1</sup> d <sup>-1</sup> )					P-value
	0	100	150	200	250	
Initial BW	11.25 $\pm$ 2.58	11.00 $\pm$ 2.71	11.84 $\pm$ 3.96	11.03 $\pm$ 1.67	12.13 $\pm$ 1.47	0.997
Day 14	11.59 $\pm$ 2.48	11.91 $\pm$ 2.42	12.78 $\pm$ 4.23	12.01 $\pm$ 1.65	13.32 $\pm$ 1.42	0.989
Day 28	11.92 $\pm$ 2.44	12.78 $\pm$ 2.55	13.7 $\pm$ 4.38	12.96 $\pm$ 1.62	14.56 $\pm$ 1.43	0.965
Day 42	12.43 $\pm$ 2.43	13.63 $\pm$ 2.83	14.62 $\pm$ 4.23	14.04 $\pm$ 1.63	15.73 $\pm$ 1.46	0.931
Day 56	12.95 $\pm$ 2.45	14.60 $\pm$ 2.77	15.63 $\pm$ 4.33	15.19 $\pm$ 1.52	16.91 $\pm$ 1.5	0.881
Day 70	13.28 $\pm$ 2.37	15.52 $\pm$ 2.68	16.55 $\pm$ 4.33	16.34 $\pm$ 1.76	18.11 $\pm$ 1.53	0.79

**Growth rate (g day<sup>-1</sup>)**

Table 5 shows sheep's growth rates at various intervals, with different levels of concentrate supplementation from 0 to 250 g sheep<sup>-1</sup> day<sup>-1</sup>. Groups with higher concentrate supplementation had greater growth rates. At 14 days after starting of the experiment, weight gain ranged from 23.00 $\pm$ 7.54 to 79.44 $\pm$ 10.82 g day<sup>-1</sup> (p>0.05). Growth rate at 28 days was ranged from 21.78 $\pm$ 2.84 to 82.89 $\pm$ 6.56 g

day<sup>-1</sup> (p=0.01). At 42 days, growth rate was recorded and it ranged from 34.44 $\pm$ 1.11 to 78.22 $\pm$ 7.6 g day<sup>-1</sup> (p>0.05). At 56 days, growth rates were ranged from 34.45 $\pm$ 7.78 to 78.22 $\pm$ 4.81 g day<sup>-1</sup> (p=0.05). The final growth rate measured at 70 days, ranged from 22.22 $\pm$ 5.55 to 80.44 $\pm$ 5.39 g day<sup>-1</sup> (p<0.05). Mean growth rates at the 28-day, 56-day, and 70-day of experiment were differed significantly.

Table 5: Growth rates (g sheep<sup>-1</sup> d<sup>-1</sup>; Mean ± SE) of crossbred sheep fed different levels of concentrate feed at 14-day interval

Day of weigh	Concentrate supplementation (g sheep <sup>-1</sup> d <sup>-1</sup> )					P-value
	0	100	150	200	250	
Day 14	23.00±7.54	60.45±21.53	62.67±23.86	65.11±4.87	79.44±10.82	0.207
Day 28	21.78 <sup>b</sup> ±2.84	58.00 <sup>a</sup> ±9.05	61.44 <sup>a</sup> ±16.18	63.11 <sup>a</sup> ±3.45	82.89 <sup>a</sup> ±6.56	0.01
Day 42	34.44±1.11	56.67±18.26	61.55±12.89	72.45±1.35	78.22±7.6	0.103
Day 56	34.45 <sup>b</sup> ±7.78	64.89 <sup>a</sup> ±3.64	67.22 <sup>a</sup> ±15.14	76.67 <sup>a</sup> ±11.79	78.22 <sup>a</sup> ±4.81	0.05
Day 70	22.22 <sup>b</sup> ±5.55	61.11 <sup>a</sup> ±6.49	61.56 <sup>a</sup> ±13.75	76.67 <sup>a</sup> ±17.21	80.44 <sup>a</sup> ±5.39	0.024

abc, Mean with uncommon superscripts in a row differed significantly

### Discussion

Sheep weight appeared to increase with greater supplementation of concentrate feed with the p-values across all intervals were statistically insignificant (Table 4). Higher concentrate supplementation had higher growth rate where weight measurement at day 28, 56 and 70 were statistically significant (Table 5). Present study is in agreement with other studies where one study noticed that ruminant animals fed with diets rich in concentrate feed tend to show improved milk production, higher growth rate, and better feed conversion ratio compared to those fed with lower-concentrate rations (Santra & Karim, 2009). Effect of dietary concentrate on Tibetan sheep was also showed similar results, where increasing the concentrate content in the diet enhanced growth performance which is consistent with the current findings. The addition of concentrate to their feed altered rumen fermentation from acetate-dominated to propionate-dominated, resulting in improved energy utilization efficiency for Tibetan sheep where 60% concentrate and 40% roughage showed highest average daily gain of  $134.38 \pm 22.41$  g day<sup>-1</sup> (Liu et al., 2019). Another study found that cattle that were given concentrates along with pasture had much higher daily growth rates than those grazing solely on natural pasture and for both sustainable grazing practices and profitable ruminant production use of locally available concentrates in a strategic manner can provide higher growth rate (Selemani & Eik, 2016). Reported higher growth rates of sheep from their study may be due to different breeds, pasture quality and environmental conditions. Adding concentrate to feed to Thalli lambs at 20% and 40% leads to enhanced growth performance and boosts dry matter intake (DMI), organic matter intake (OMI), and nutrient digestibility (Chishti et al., 2022). Another study is in agreement with the present study and found that increased concentrate levels in the feed positively impacted reproductive outcomes in ewes, as well as body weight, growth rate, and the neonatal behavior of lambs up to weaning (Omar et al., 2019). It was observed that lambs on a high-concentrate diet showed increased dry matter intake and eating rates, while total chewing time was reduced (Sari et al., 2018). Ruminant animals (male

Murrah buffalo calves) also showed that when higher levels of concentrate were provided, the average daily gain and feed conversion efficiency showed a significant increased (Nampoothiri et al., 2018).

Higher levels of concentrate supplementation had been shown to increase body weight and daily growth rates in sheep. According to Zohara et al. (2014), the growth rate of native sheep in Bangladesh was 21.19 g day<sup>-1</sup> for grazing groups and 40.95 g day<sup>-1</sup> for concentrate supplemented groups. According to Ahmed et al. (2018), coastal sheep in Bangladesh grow at a rate of 91.29 g day<sup>-1</sup> when raised in intensive conditions. Despite these findings, more investigation is needed to find out the ideal concentrate supplementation of feed that would be beneficial as well as cost-effective.

### Conclusion

Concentrate feed supplementation appears to increase weight gain and growth rates in crossbred sheep, but the significance of this study effects varies across measurement intervals. This inconsistency indicates potential factors beyond supplementation that could be affecting growth. The group with the highest supplementation showed the most significant weight and growth rate increases, but not all differences were statistically significant. These findings suggest that additional concentrate may lead to better growth, and more research is required to identify the reasons for inconsistent outcomes and the potential influence of other variables.

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### Conflict of Interest

The authors confirm that there is no conflict of interest with the publication of this article.

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