

Growth Performance of Khari and Crossbred Boer Goats with Respect to Different Levels of Crude Protein-based Feeding in the Mid-hills of Nepal

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Abstract

Purpose: Goats are one of the important livestock species in Nepal and among available goat, Khari breed is popular for meat purpose. They have long history of disease resistance and have contributed meaningfully to the livelihood support of Nepalese farmers. In spite of these facts, they are relatively small in body size whereas farmers are lately inclined to crossbred of Khari with heavy body weight imported breed such as Boer. Under this context research was done to analyze the effect of Crude Protein (CP) based nutritional plan of feeding on growth performance, especially body weight gain of crossbred Boer and Khari goats under various Crude Protein (CP) feeding regimes.

Methods: Four types of CP based diets were formulated and fed by keeping 50% Boer and Khari crossbred goats for 120 days at 6 months of age and were fed ad libitum fodder trees and available seasonal fodders in a randomized Complete Block Design, by replicating each treatment for three times.

Results: Results clearly revealed that Khari breed and Boer 50% crossbred had different response to varied level of CP content in their diet for growth performance whereas feed intake and body weight gain which was relatively better for Khari with lower level of CP (12%). On the other hand, Boer 50% crossbred responded well to higher (18%) CP, especially during later stage of growth.

Conclusion: Thus, these differences might be crucial to be considered while formulating additional diet through formulated feed whereas in-depth study on availability of major nutrients of common fodder trees and seasonality of variation might be further useful to consider for scientific study. Since preparing strategic feed plan is very important in rearing goats, findings of this research would also have further imperative value in determining the feed preparation plan by considering in body physiology and nutritional requirements.

Keywords: Crossbred Boer, Crude protein, Growth performance, Khari

1 Introduction

Livestock is an integral part in Nepalese agricultural system which contributes about 25.70 percent of total agriculture gross domestic product (AGDP) (MoALD, 2021). Among livestock species, goat is a common one with an emerging and important enterprise which is used mainly for meat purpose. There are 13.99 million goats in Nepal which produce 74,241 t of meat and accounted for 14.48% of the total meat production of the nation (MoALD, 2023). However, this production does not meet increasing demand of goat meat so live castrated bucks and frozen meat are imported, especially from India and China (DLS, 2022). Goat is one of the major components of mixed farming systems of mid hills of Nepal, with its rapidly commercializing potentials. In recent years, Boer goat (*Capra hircus*) is considered as one of the most preferred goat breeds with respect to growth performance and meat production by the farmers in Nepal (Sapkota et. al, 2016). It has gained worldwide recognition for excellent body conformation, fast growing rate and good carcass quality. Its popularity as a meat goat breed soared during the last decade due to its availability in Australia, New Zealand and later in North America and other parts of the world including Nepal. It has been demonstrated that Boer goats can improve productive performance of many indigenous breeds through cross breeding (Bhattarai et. al, 2019; Kadel et al., 2020; NGRP, 2021). It has a strong impact on the meat goat industry globally (Lu, 2002).

In spite of its popular demand for goat meat in Nepal, the supply situation is not enough to meet the required quantity. This has necessitated to work for more meat production and cross breeding of local Khari with heavy weight breed, such as Boer which could be one of the options to improve body weight gain crossbred goat. In this

sense performance evaluation of feeding with different protein levels in terms of daily weight gain and associated parameters are important field of scientific research. This research was designed to understand and analyze the effect of Crude protein (CP) based nutritional plan of feeding on growth performance, especially body weight gain of crossbred Boer and Khari goats under mid-hills context of Nepal.

2 Materials and methods

2.1 Description of study site

This research was done at the National Goat Research Program, (NGRP) during January to March 2020. NGRP is one of the key commodity research program under Nepal Agricultural Research Council (NARC) and is located at Bandipur Rural Municipality, Tanahun district in Gandaki Province. NGRP is the leading research center of goat in Nepal that represents hilly geography. The elevation NGRP ranges 800-1200 masl with the longitude of 84° 38' E and latitude 27° 04' N. The Program receives an average annual rainfall of 2000 mm with an average relative humidity of 85%, and maximum and minimum temperature of 32°C and 8°C, respectively. The station is in the distance of 141 km from Kathmandu, the capital city and 72 km from Pokhara city.

2.2 Experimental design and treatments arrangements

2 x 4 factorial combination of Randomized Complete Block Design (RCBD) was employed in this research. Accordingly, two breeds of goats (Boer 50% and Khari) were combined with four levels of crude protein (CP) based plan of nutrition. They were 12% CP fed @1.5% of body weight: 14% CP fed @ 1.5% of body weight: 16% CP fed @ 1.5% of body weight, and 18% CP fed @ 1.5% of body weight. Thus, a total of 8 treatments were used by keeping, one goat in an experimental pen where urine and feces could be collected separately with the provision of replicating each treatment for three times. All experimental goats were male having average age of six months during the time of research and were provided with allocated experimental diets and adlib fodder, forages and water.

2.3 Feeding

Feed was formulated with different CP level of 12, 14, 16 and 18% also by considering, all other nutrients requirements as of, constant by using the locally available feed ingredients and mineral mixtures. The experimental goats were provided with seasonal forages and fodders ad libitum. The fodders supplied during the experiment were Tanki (*Bauhinia purpurea*), Mohani (*Caryopteris odorata*), Saj (*Terminalia alata* Heyne), Koiralo (*Bauhinia variegata*), and Chiuri (*Diploknema butyracea*). The prepared feed was offered to the experimental animals 1.5% of the body weight for the first seven days during the adjustment period and then recording of actual feed intake was done to the entire experimental duration of 120 days as spelled out in the experimental design and treatments arrangements.

2.4 Data collection

Body weight of crossbred Boer and Khari was taken in monthly interval, likewise daily feeding records were done by including feed and fodder offered as well as feed and fodder discarded. The total feed intake, feeding efficiency, feed conversion ratio was calculated based on intake and body weight gain. A special format was developed for data collection of feeding trial of the experimental bucks.

2.5 Methods and technique of data analysis

After the collection of data, they were cleaned, coded and entered into the computer using MS Excel. Growth performance of crossbred Boer and Khari was analyzed by using SPSS (Version 26) computer software and means were compared for significance differences by using DMRT.

3 Results

3.1 Growth performance (body weight gain)

The effect of crude protein-based diet to the body weight of crossbreed Boer and Khari breed has been presented in Table 1. Accordingly, the effect of breeds was such that the growth of Boer 50% was statistically significant $p < 0.05$ to Khari breed only at 90 and 120 days. In that perspective, body weight of Boer 50% was 24 to 30% higher at 90 and 120 days. On the other hand, if we ignore the breed and consider only the effect of CP% in diet, we found similar growth performance among the treatments $p > 0.05$ for all diets at 30 to 120 days, whether we fed 12% or 18% CP based diet (Table 1). The same scenario was truly reflected in the treatment combinations

of breed and different level of CP% to the growth performance of Boer 50% and Khari. This means treatment effect was statistically non-significant $p > 0.05$ with respect to the varied levels of CP in the diet at all stages of growth 30, 60, 80, 120 days (Table 1). However, at 120 days of feeding, Boer 50% with 18% CP had better performance.

Table 1: Effect of CP based nutritional plan of feeding on body weight of crossbreed Boer and Khari goats in NGRP, Bandipur, Nepal, 2020.

Treatments effects	Body weight (Mean±S.E.) kg				
	Initial	At 30 days	At 60 days	At 90 days	At 120 days
Overall	17.67±0.89	20.31±1.02	22.08±1.13	24.93±1.29	26.77±1.23
Effect of Breeds					
Boer 50%	19.04±1.26	22.00±1.44	23.85±1.59	27.63±1.83	30.31±1.74
Khari	16.29±1.26	18.62±1.44	20.30±1.59	22.24±1.82	23.21±1.74
P value	0.144	0.116	0.136	0.053	0.011
LSD	2.75	3.377	3.545	5.385	7.075
CV%	22.41	22.54	22.76	24.33	23.46
Effect of nutrition					
12% CP with 1.5% of B. Wt.	17.62±1.79	20.02±2.03	21.72±2.26	24.57±2.58	26.72±2.45
14% CP with 1.5% of B. Wt.	17.68±1.79	19.89±2.03	21.41±2.26	24.40±2.58	26.26±2.45
16% CP with 1.5% of B. Wt.	17.52±1.79	19.95±2.03	21.92±2.26	24.32±2.58	26.01±2.45
18% CP with 1.5% of B. Wt.	17.85±1.79	21.38±2.03	23.27±2.26	26.45±2.58	28.05±2.45
P value	0.999	0.944	0.94	0.925	0.938
LSD	0.067	0.067	0.2	0.08	0.21
CV%	22.41	22.54	22.76	24.33	23.46
Treatment combination					
Boer 50% with 12% CP	18.63±2.53	21.83±2.87	23.67±3.20	27.63±3.65	30.63±3.47
Boer 50% with 14% CP	19.50±2.53	21.67±2.87	23.27±3.20	26.73±3.65	29.53±3.47
Boer 50% with 16% CP	18.17±2.53	20.73±2.87	23.03±3.20	25.93±3.65	28.52±3.47
Boer 50% with 18% CP	19.87±2.53	23.77±2.87	25.43±3.20	30.20±3.65	32.53±3.47
Khari with 12% CP	16.60±2.53	16.60±2.53	19.76±3.20	21.50±3.65	22.80±3.47
Khari with 14% CP	15.87±2.53	18.13±2.87	19.55±3.20	22.06±3.65	22.98±3.47
Khari with 16% CP	16.87±2.53	19.17±2.87	20.80±3.20	22.70±3.65	23.57±3.47
Khari with 18% CP	15.83±2.53	19.00±2.87	21.10±3.20	22.70±3.65	23.57±3.47
P value	0.94	0.955	0.989	0.942	0.945
LSD	0.0667	0.667	0.2	0.64	0.183
CV%	22.41	22.54	22.76	24.33	23.46

3.2 Body weight gain

The effect of CP based diet to the daily body weight gain of crossbreed Boer and Khari breed has been presented in Table 2. Accordingly, the mean daily weight gain of Boer 50% was significantly higher $p < 0.01$ with Khari breed only at 90 and 120 days. At those days, the body weight of Boer 50% was 24 to 30% higher than Khari. If we look at the effect of variation of CP in diet, daily body weight gain was such that there was no effect $p > 0.05$ of difference of CP content to the mean daily weight gain at all stages of growth.

Effect of CP levels among the treatments while combining breeds with CP% was such that it remained statistically similar $p > 0.05$ for mean daily weight gain for all stages of growth (Table 2). Here again, highest mean daily weight gain was obtained from the treatment with 12%CP content in diet for Boer 50% Khari breed had all the way lowest mean daily weight gain irrespective of CP content but it was comparatively higher for the treatment with 12% CP (Table 2)

But; the effect of CP% diet was found similar in growth rate for all diets at 30 to 120 days. The same result was obtained in the treatment combinations of breed and different level of CP% to the weight gain of Boer 50%. However, at 90 and 120 days of feeding, Boer 50% with 18% CP at diet had higher body weight gain with 12% CP had the lowest growth rate (Table2).

Table 2: Effect of CP based nutritional plan of feeding on body weight gain of crossbreed Boer and Khari goats in NGRP, Bandipur, Nepal, 2020.

Factors	Body weight gain (Mean±S.E.)			
	At 0-30 days	At 31-60 days	At 61-90 days	At 91-120 days
Overall	88.17±6.97	58.86±6.87	95.17±6.24	61.14±5.02
Effect of Breeds				
Boer 50%	98.61±9.85	61.67±9.71	125.83±8.83	89.31±7.10
Khari	77.72±9.85	56.06±9.71	64.50±8.83	32.97±7.10
P value	0.153	0.688	0.000	0.000
LSD	20.89	5.611	61.33	56.333
Effect of nutrition				
12% CP with 1.5% of B. Wt.	80.00±13.93	56.67±13.73	95.00±12.48	71.67±10.04
14% CP with 1.5% of B. Wt.	73.78±13.93	50.44±13.73	99.55±12.48	61.94±10.04
16% CP with 1.5% of B. Wt.	81.11±13.93	65.56±13.73	80.00±12.48	57.61±10.04
18% CP with 1.5% of B. Wt.	117.78±13.93	62.78±13.73	106.11±12.48	53.33±10.04
P value	0.146	0.867	0.517	0.617
LSD	1.11	2.783	4.553	4.28
Treatment combination				
Boer 50% with 12% CP	106.67±19.70	61.11±19.42	132.22±17.65	100.00±14.20
Boer 50% with 14% CP	72.22±19.70	53.33±19.42	115.55±17.65	93.11±14.20
Boer 50% with 16% CP	85.55±19.70	76.67±19.42	96.67±17.65	86.34±14.20
Boer 50% with 18% CP	130.00±19.70	55.56±19.42	158.89±17.65	77.78±14.20
Khari with 12% CP	53.33±19.70	52.22±19.42	57.78±17.65	43.33±14.20
Khari with 14% CP	75.33±19.70	47.55±19.42	83.55±17.65	30.78±14.20
Khari with 16% CP	76.67±19.70	54.45±19.42	63.33±17.65	28.89±14.20
Khari with 18% CP	105.56±19.70	70.00±19.42	53.33±17.65	28.89±14.20
P value	0.529	0.822	0.152	0.972
LSD	1.11	4.67	4.444	1.889
CV%	41.73	50.28	46.68	59.04

3.3 Feed consumption

The status of feed consumption of crossbreed Boer and Khari as specified in the treatments has been presented in Table 3. Accordingly, the feed consumption of Boer 50% was significantly $p < 0.05$ higher to Khari breed at 120 days but the feed consumption was found similar with different CP% in diet at 30 to 90 days (Table 3). The effect of plan of nutrition mainly with respect to the variation of CP% in diet was also statistically similar $p > 0.05$ among the treatments. However slightly higher consumption was recorded with the treatment of 12% CP (Table 3).

Similar status of feed consumption was found while combining treatments with respect to breed and levels of CP content. Accordingly, at all stage of growth the effect was significantly similar $p > 0.05$. Here again, higher intake was found with the goat fed 12% CP diet for Boer breed. The lowest intake was recorded for the fed with 18% CP diet (Table 3).

3.4 Fodder consumption

The effect of crude protein-based diet to the fodder consumption of crossbreed Boer and Khari has been presented in Table 4. Accordingly, the overall fodder consumption increased while days progresses, whereas Boer 50% and Khari had significantly different consumption at 120 days $p < 0.06$. On the other hand, effect of CP remained non-significant $p > 0.05$ at all days of growing and similar situation was resulted for treatment combination of Boer crossbred and Khari with respect to the varied CP content (Table 4).

Table 3: Effect of CP based nutritional plan of feeding on feed consumption of crossbreed Boer and Khari goats in NGRP, Bandipur, Nepal, 2020.

Factors	Feed consumption (Mean±S.E.) in kg at			
	0-30 days	31-60 days	61-90 days	91-120 days
Overall	8.05±0.41	8.69±0.43	10.03±0.52	10.63±0.57
Effect of Breeds				
Boer 50%	8.64±0.57	9.35±0.61	11.03±0.73	11.95±0.81
Khari	7.46±0.57	8.03±0.61	9.03±0.73	9.31±0.81
P value	0.165	0.147	0.072	0.036
LSD	1.177	1.32	1.99	2.634
Effect of nutrition				
12% CP with 1.5% of B. Wt.	8.06±0.81	8.59±0.87	10.21±1.03	11.04±1.15
14% CP with 1.5% of B. Wt.	8.23±0.81	8.75±0.87	9.64±1.03	10.36±1.15
16% CP with 1.5% of B. Wt.	7.84±0.81	8.46±0.87	9.87±1.03	10.52±1.15
18% CP with 1.5% of B. Wt.	8.06±0.81	8.95±0.87	10.40±1.03	10.60±1.15
P value	0.99	0.98	0.954	0.978
LSD	0.002	1.224	0.192	0.078
Treatment combination				
Boer 50% with 12% CP	8.64±1.15	9.30±1.22	11.21±1.46	12.73±1.63
Boer 50% with 14% CP	8.98±1.15	9.50±1.22	10.77±1.46	11.53±1.63
Boer 50% with 16% CP	8.06±1.15	8.72±1.22	10.58±1.46	11.28±1.63
Boer 50% with 18% CP	8.86±1.15	9.87±1.22	11.54±1.46	12.40±1.63
Khari with 12% CP	7.49±1.14	7.89±1.22	9.20±1.46	9.56±1.62
Khari with 14% CP	7.47±1.14	8.00±1.22	8.51±1.46	9.14±1.62
Khari with 16% CP	7.62±1.14	8.19±1.22	9.15±1.46	9.76±1.62
Khari with 18% CP	7.26±1.14	8.03±1.22	9.26±1.46	8.79±1.62
P value	0.954	0.957	0.99	0.929
LSD	0.02	0.1367	0.051	0.197
CV%	22.13	22.07	23.66	25.84

4 Discussion

The experiment evaluated graded levels of CP in goat diets on feeding and growth performance. Elevating the protein level merely in their diets does not improve the rate of gain in Boer and Spanish cross goats. Feeding diets containing 18 and 24% crude protein did not improve weight gain and feed efficiency. The result implied that over nutrition might not increase economic return for Boer crosses (Prieto et al., 2000; Lu, 2002)

Effects of feed, especially plane of major nutrients are widely researched, also in Asian context whereas often it is contradictory whether crude protein or basic energy and mineral requirements are more crucial for better body weight gain and productive performance of goats. Native breed such as Khari in Nepalese context are considered hardy, stunt and capable of surviving even during harsh weather and poor feeding resources. They are largely reared based on forest/bush grazing, even at the rocky mountain and steep terrain. Probably for their hardy survivability in nature, they are acclimatized to survive by adjusting small body size whereas improved breeds such as those from Indian origin and African such as Boer are not adapted to such condition. Their physiology and growth size are comparatively larger than that of Khari but growth performance being based on poor plane of nutrition is often questionable to those breeds. Khari is one of the outstanding indigenous genetic resources of goat in Nepal with higher prolificacy, multiple kidding ability and carcass quality (Neopane,1997; Kunwar, 2000).

Crossbreeding provides opportunities to evaluate best combination of native breeds such as Khari to those of Boer at different blood level whereas 50% F1 crossbred are widely accepted in terms of appropriate growth performance and also for meat quality. However, it is always tricky whether certain level of CP content in their diet is crucial to consider for a better growing. In our study, we did not find significant contribution to the body weight and growth performance of 50% crossbred of Boer and Khari when CP% was quite high (18%) or low (12%). This might be due to the fact that these breeds basically received minimum required level of crude protein even from forest grazing or when they are reared based on feeding twigs and branches of domesticated fodder trees that are quite good in CP content. This finding thus needs further detailed investigation by considering CP content of the fodder trees as feeds are supplied to the goats only as of supplementation. It was concluded that CP level of 15.40% in the complete pellet diet of Black Bengal goats was beneficial for commercial goat farming under stall feeding system in Bangladesh (Jafur et al.,2015). It can be concluded that increasing levels of CP content in TMR not only improved CP intake but also enhanced CP digestibility and promoted growth performance of Thai indigenous goats (Chobtang et al.,2009).

Table 4: Effect of CP based nutritional plan of feeding on fodder consumption of crossbred Boer and Khari goats in NGRP, Bandipur, Nepal, 2020.

Factors	Feed consumption (Mean±S.E.) in kg at			
	0-30 days	31-60 days	61-90 days	91-120 days
Overall	57.98±3.70	69.22±4.48	80.14±5.58	86.27±6.25
Effect of Breeds				
Boer 50%	61.42±5.24	74.45±6.34	86.78±7.89	98.50±8.84
Khari	54.53±5.24	63.99±6.34	73.53±7.89	74.03±8.84
P value	0.637	0.26	0.253	0.068
LSD	6.887	10.463	13.23	24.472
Effect of nutrition				
12% CP with 1.5% of B. Wt.	55.25±7.41	67.56±8.97	81.20±11.16	86.30±12.51
14% CP with 1.5% of B. Wt.	61.17±7.41	66.80±8.97	77.75±11.16	79.24±12.51
16% CP with 1.5% of B. Wt.	56.74±7.41	67.98±8.97	78.77±11.16	88.03±12.51
18% CP with 1.5% of B. Wt.	58.72±7.41	74.53±8.97	82.86±11.16	91.43±12.51
P value	0.948	0.922	0.988	0.915
LSD	1.453	0.415	1.017	1.727
Treatment combination				
Boer 50% with 12% CP	57.04±10.48	71.15±12.68	89.59±15.78	100.77±17.69
Boer 50% with 14% CP	61.78±10.48	70.66±12.68	85.93±15.78	89.48±17.69
Boer 50% with 16% CP	57.43±10.48	71.34±12.68	78.88±15.78	91.95±17.69
Boer 50% with 18% CP	69.43±10.48	84.67±12.68	92.65±15.78	111.81±17.69
Khari with 12% CP	53.53±10.48	63.97±12.67	72.82±15.78	71.83±17.69
Khari with 14% CP	60.55±10.48	62.94±12.67	69.57±15.78	69.00±17.69
Khari with 16% CP	56.04±10.48	64.64±12.67	78.67±15.78	84.11±17.69
Khari with 18% CP	48.01±10.48	64.39±12.67	73.07±15.78	71.18±17.69
P value	0.733	0.939	0.925	0.821
LSD	0.396	1.697	0.25	0.65
CV%	28.09	28.25	30.17	34.14

Pattern of body weight gain as we found in this experiment are pretty similar to that of growth performance for crossbred and also to the breed. Obviously, breeds of Boer are superior in daily body weight gain compared to the Khari and their crossbred at 50% level but when they become older around 120 days of feeding, effect of higher crude protein was significant to the crossbred whereas such result was not visible in the case of Khari which had better performance even at low level of CP content (Tiwari et al., 2012). This sort of variation in response of CP level could be due to several reasons, one of them could be their small body size as physiological demand of nutrient for tissue tear and wear could be minimum for small size Khari compared to the crossbred Boer that are heavy, larger and their growing period to arrive at the finisher stage is longer than that of Khari (KC, 2016; Trivedi and Paudel, 2019). This necessitates to consider growth pattern along with physiological needs of major nutrients while researching about the effect of certain levels of CP in diet.

Dry matter intake increased as metabolizable energy density of diet increased from 2650 to 2850 Kcal/kg DM but it is not affected by increasing protein level from 16 to 18%. The average daily gains were not improved $p > 0.05$ as the crude protein level and metabolizable energy density of diet increased (Ginting et al., 2017). Boer and Spanish crosses were reported to have higher dry matter intake and average daily gain than Spanish goats (Cameron et al., 2001).

This sort of findings indicated that there could be straight variation in consumption/intake by different breed such as Khari, Boer and their crossbred. When Khari breeds are constantly showing better response at 12% CP and when such responses are not found in the case of Boer and their crossbred (Kawas et. al., 2012), those variations are crucial to consider while formulating their diet as they may not be similar to suit to their body weight gain and growth performance. Average daily gain (ADG) significantly $p < 0.05$ increased as dietary CP levels increased but the highest ADG was found on the 18% CP treatment (Hwangbo et. al, 2009)

The results of this experiment well indicated that fodder consumption and its resultants effects are similar to that of growth performance and body weight gain which is truly reflected in terms of intake as well. Several factors might have played their role in having such scenario of feeding intake and variation, but as discussed earlier, body physiology and nutrient requirements of Boer and Khari should have reflected their different kinds of response and performances (Panday, 2008) that needs to be considered while formulating feed plan (Ghimire et al., 2022). DM intake by breeds of goats and species of fodder trees were highly significant $p < 0.001$. The ADG of Boer cross, Jamunapari cross, Khari and Barbari cross were 70.94, 59.34, 53.34 and 45.37, respectively and highly significant $p < 0.01$ inferring that the genetic makeup of the breed require diversity in their dietary needs and therefore warrants crucial feeding strategy (Ghimire et al., 2022).

5 Conclusion

Findings of this research clearly revealed that Khari breed and Boer 50% crossbred had different response to varied level of CP content in their diet for growth performance, feed intake and body weight gain which was relatively better for Khari with lower level of CP (12%) whereas Boer 50% crossbred responded well to higher (18%) CP, especially during later stage of growth. Thus, this differences in variation might be crucial to consider while formulating additional diet through formulated feed whereas in-depth study on availability of major nutrients of common fodder trees and seasonality of variation might be further useful to consider for scientific study.

Acknowledgement

The authors would like to acknowledge Nepal Agricultural Research Council (NARC), Singhadarbar Plaza, Kathmandu, Nepal for making fund availability for the research. Likewise, authors acknowledge to all staffs of National Goat Research Program, Bandipur, Tanahun and Agriculture and Forestry University, Rampur, Chitwan, Nepal.

Authors' Contribution

RK is responsible for overall drafting of the articles. MPS mainly contributed for overall formatting and primary guidelines to analyze the data. NB and NKG authors helped in data analysis. NRD provided overall contribution for data analysis, methodological set up and editing of the whole manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Correct citation: Kadel, R., Sharma, M. P., Bhattarai, N., Gurung, N. K., & Devkota, N. R. (2024). Growth Performance of Khari and Crossbred Boer Goats with Respect to Different Levels of Crude Protein-based Feeding in the Mid-hills of Nepal. *Jagriti-An Official Journal of Gandaki University*, 1(1), 93-100.