E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(3): 273-278
Received: 01-01-2024
Accepted: 06-02-2024

Ravi Kumar
Ph.D., Department of Livestock Production Management, LUVAS, Hisar, Haryana, India

Harish Kumar Gulati
Professor, Department of Livestock Production Management, LUVAS, Hisar, Haryana, India

Umesh Kumar Jaiswal
Ph.D., Department of Veterinary & Animal Husbandry Extension Education, PGVIER, Jaipur, Rajasthan, India

Pradeep Kumar
Ph.D., Department of Veterinary Parasitology, LUVAS, Hisar, Haryana, India

Ramkaran
Ph.D., Department of Veterinary Physiology and Biochemistry, LUVAS, Hisar, Haryana, India

Corresponding Author:
Ramkaran
Ph.D., Department of Veterinary Physiology and Biochemistry, LUVAS, Hisar, Haryana, India

Optimizing productivity: A comprehensive economic analysis of varied feeding strategies in lactating Murrah Buffaloes

Ravi Kumar, Harish Kumar Gulati, Umesh Kumar Jaiswal, Pradeep Kumar and Ramkaran

DOI: https://doi.org/10.33545/2618060X.2024.v7.i3Sd.447

Abstract
An economic evaluation was conducted to assess the impact of different feeding regimes on milk production and overall profitability in lactating Murrah buffaloes. The study involved eighteen buffaloes in their 1st to 2nd lactation stage at the buffalo farm of the Department of Livestock Production Management, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, India. Three dietary treatment groups (T_1, T_2, and T_3) were established using a factorial completely randomized design. The control group (T_1) received a diet comprising 30% wheat straw, 35% green fodder, and 35% concentrate mixture on a dry matter basis, following ICAR (2013) standards. Treatment groups T_2 and T_3 received similar diets, with varying proportions of crude protein and total digestible nutrients (CP and TDN) from green fodder replaced with concentrate mixture. Data collection included parameters such as feed intake, milk yield, milk fat percentage, and 6% fat-corrected milk (FCM) yield. Economic evaluation encompassed feed costs per kilogram of milk yield and 6% FCM yield per animal. Statistical analysis employed ANOVA, with the Duncan Multiple Range Test utilized for mean comparisons. Results indicated that buffaloes in treatment groups T_2 and T_3 exhibited higher dry matter intake, milk yield, and 6% FCM yield compared to the control group (T_1). However, milk fat percentage remained consistent across all treatment groups. The economic analysis revealed that despite higher total feeding costs for T_2 and T_3, the feed cost per kilogram of milk yield and 6% FCM yield were lower in these treatment groups compared to the control group (T_1). In conclusion, replacing 30% or 40% of CP and TDN of green fodder with a concentrate mixture in the diets of lactating Murrah buffaloes resulted in increased milk production and improved economic viability. These findings underscore the potential benefits of optimizing feeding regimes to enhance milk yield and profitability in dairy farming. Further research could explore other aspects of feeding strategies and their economic implications in the context of dairy production.

Keywords: Optimizing, comprehensive, economic, varied, strategies, lactating

Introduction
India occupies approximately 2.4% of the world's geographical area, with a substantial portion of its land dedicated to agriculture. A significant proportion of its land, nearly 228 million hectares or approximately 69%, lies within the dry-land region encompassing arid, semi-arid, and dry sub-humid areas (Bhandari *et al*., 2007) [4]. Livestock plays a pivotal role in India's agrarian economy, contributing significantly to livelihoods. The livestock sector stands as one of the worlds largest, accounting for nearly 25.6% of the value of output in the agriculture, fishing, and forestry sector at current prices. Overall, the livestock sector contributes approximately 4.11% to India's total GDP during 2012-13.
Buffaloes (Bubalus bubalis) hold immense importance in many developing countries, serving as vital contributors to milk, meat, power, fuel, and leather production (Sarwar *et al*., 2009) [28]. Their significance in agriculture is underscored by their high production potential, providing essential resources for mankind and offering sustenance to the impoverished and marginal farmers as well as landless laborers in developing nations (Gupta and Das, 1994) [16].

Notably, buffaloes contribute a substantial share, approximately 96.8%, of the total milk to the dairy (Cockrill, 1981) [6] and around 12.8% of the total world milk production despite constituting only 11.6% of the global cattle population (FAOSTAT, 2007) [11]. In India, buffaloes serve as the backbone of the dairy industry and are aptly regarded as the 'bearer cheque' of rural livelihoods, earning the moniker of India's milking machine (Balain, 1999) [2]. Among India's buffalo breeds, the Murrah stands out for its commercial superiority (Garg *et al*., 2004) [13], contributing approximately 56% of the total milk production in the country (Das *et al*., 2008) [7]. The organized dairy sector in India heavily relies on buffalo milk due to its richness in fat and total solid content (Singh and Singh, 2015) [30]. Consequently, enhancing the genetic potential of buffaloes for production and reproduction traits is imperative to meet the burgeoning demand for milk in the country (Resali, 2000) [24].

In most developing countries, including India, agricultural by-products, crop residues, and grazing, supplemented with protein and energy supplements, serve as the primary feed sources for livestock. However, feed shortages are a recurrent challenge in tropical and subtropical regions due to factors like low pasture growth following droughts or cold periods, as well as limited use of hay and silage. Feeding constitutes the cornerstone of the livestock system, accounting for over 70% of the total cost of milk production. It significantly influences animal productivity, health, welfare, and environmental impact (Makkar, 2016) [20]. The cost of feeding per liter of milk production emerges as a critical factor governing the economic viability of the livestock sector, necessitating measures to reduce costs through innovative ration formulation. This pursuit leads to the exploration of readily available and economically feasible feed sources.

Given these considerations, the present investigation was undertaken to evaluate the economics of different feeding regimes in lactating Murrah buffaloes.

Materials and Methods

Proposed work: The proposed study was conducted on eighteen lactating Murrah buffaloes in their 1st to 2nd lactation stages, carefully selected from the buffalo farm of the Department of Livestock Production Management at the College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. Situated in a semi-arid region, the university farm experiences a sub-tropical climate. Geographically, Hisar is positioned at 29°10' N latitude, 75°40' E longitude, with an altitude of 215.2 meters.

Feeding regime

These buffaloes were divided into three dietary treatment groups (T_1, T_2, and T_3), with six lactating buffaloes allocated to each treatment based on parity, utilizing a factorial completely randomized design (FCRD). The specifics of the different dietary treatments are outlined in Table 1, while details regarding the allocation of experimental lactating Murrah buffaloes to various treatments are provided in Table 2.

Table 1: Details of feeding plan of buffaloes under different dietary treatments

Treatment	Feeding strategy
T_1 (Control)	The lactating buffaloes were provided with a balanced diet consisting of a 30:35:35 ratio of wheat straw, green fodder, and concentrate mixture (on a dry matter basis). This formulation was tailored to meet the nutrient requirements according to ICAR (2013) standards.
T_2	In treatment group T_1, 30% of the crude protein and total digestible nutrients from green fodder were substituted with concentrate mixture for the feeding of lactating buffaloes.
T_3	In treatment group T_1, 40% of the crude protein and total digestible nutrients from green fodder were substituted with concentrate mixture for the feeding of lactating buffaloes.

Table 2: Details of experimental lactating Murrah buffaloes allotted to different dietary treatments

Treatments	S. No.	Buffalo numbers	Initial body weights (kg)	Parity (No.)
T_1 (n=6)	1.	1098	420	1
	2.	1104	448	1
	3.	1125	452	1
	4.	1486	465	1
	5.	1482	505	2
	6.	1483	550	2
Mean ± S.E.			473.33 ± 19.05	1.33 ± 0.21
T_2 (n=6)	1.	999	430	1
	2.	1481	425	1
	3.	1484	432	1
	4.	1124	508	1
	5.	1051	528	2
	6.	1057	550	2
Mean ± S.E.			478.83 ± 22.96	1.33 ± 0.21
T_3 (n=6)	1.	1103	460	1
	2.	1114	467	1
	3.	1112	463	1
	4.	1480	476	1
	5.	964	510	2
	6.	1485	518	2
Mean ± S.E.			482.33 ± 10.30	1.33 ± 0.21

The present investigation received prior approval to be conducted in the 11th meeting of the Institutional Animal Ethics Committee at LUVAS, held on February 6th, 2018.

Feed intake and dry matter (%)

To monitor feed intake, the buffaloes were provided with weighed quantities of feed and fodder tailored to their individual

requirements. Throughout the experimental period, feed intake was meticulously recorded at monthly intervals over consecutive two-day periods. This data was collected based on the feeds and fodder offered to the buffaloes and the subsequent weigh-back process. During this period, all buffaloes were tethered and fed roughages and concentrate mixture individually. To ensure accuracy, representative samples of forage, wheat straw, and concentrate mixture were collected daily for two consecutive days each month before feeding. These samples were then placed in a hot air oven to determine their dry matter content.

$$\text{Dry matter (\%)} = \frac{\text{Dry weight of sample(g)}}{\text{Fresh weight of sample (g)}} \times 100$$

Milk fat (%)

Milk samples for composition analysis were initially collected in the first week after calving, followed by subsequent sampling at weekly intervals until the conclusion of the experiment. Samples were obtained during both morning and evening milkings from each experimental buffalo. These samples underwent same-day processing utilizing the Milko-Scan autoanalyzer. The average values from both morning and evening samples were calculated to estimate milk fat, milk protein, solids-not-fat, and total solids.

Milk yield and fat corrected milk (FCM) yield

During the experimental period, buffaloes were hand-milked twice daily at 4:00 a.m. and 4:00 p.m. Milk yield was meticulously recorded using a digital weighing balance, and weekly averages were calculated. The relevant data were obtained from the farm records. To convert whole milk into a 6 percent fat-corrected milk (FCM) yield, the equation derived by Rice (1970) was applied using the following formula.

$$6\%\ \text{FCM} = 0.308 \times \text{Total milk} + 11.54 \times \text{Total fat}$$

Economics of Feeding

The prices of feeds and fodder, including greens, were gathered from the Department of Animal Nutrition at the University, reflecting prevailing rates at the time of purchase. Utilizing this pricing data, the total expenditure associated with feeding the various experimental groups was computed. To determine the feed cost per kilogram of milk and per kilogram of 6% fat-corrected milk (FCM), the feed cost was divided by the corresponding milk yield (in kilograms) and 6% FCM yield, respectively. This meticulous approach ensured accurate assessment of the economic aspects of the feeding regimes.

Statistical analysis

The data underwent analysis using ANOVA, as outlined by Snedecor and Cochran (1994) [31], ensuring robust statistical evaluation. Following ANOVA, means demonstrating significant differences in the ANOVA table were subjected to comparison using the Duncan Multiple Range Test. This approach allowed for thorough examination of any variations among the treatment groups, enabling precise identification of significant differences.

Results and Discussion

Dry matter intake (DMI)

The analysis of dry matter intake demonstrated a consistent upward trend across all three treatment groups throughout the duration of the experiment. Statistical examination of the data revealed that the daily dry matter intake, dry matter intake as a percentage of body weight, and dry matter intake per kilogram of metabolic body size for the entire experimental period were significantly higher ($P<0.05$) in the experimental buffaloes of treatment groups fed rations with a replacement of 30% or 40% crude protein and total digestible nutrients of green fodder with concentrate mixture, compared to the control treatment group. Notably, these differences were statistically significant, while among themselves, the treatment groups did not exhibit significant variance. This finding is consistent with observations made by Yadav (1993) [34], Gaafar *et al*. (2009) [12], and Hossain *et al*. (2017) [17] in lactating buffaloes. Similarly, studies by Dhiman *et al*. (1991) [9], Tessmann *et al*. (1991) [33], Gaynor *et al*. (1995) [14], Broderick (2003) [5], and Machado *et al*. (2014) [19] on lactating Holstein cows also reported significant improvements ($p<0.05$) in daily dry matter intake, dry matter intake as a percentage of body weight, and dry matter intake per kilogram of metabolic body size when the proportion of concentrate in the diet was increased.

Milk fat (%)

The mean milk fat values for treatment groups T_1, T_2, and T_3 were recorded as 7.53%, 7.49%, and 7.47%, respectively, when averaged over the entire sampling period. The investigation revealed consistent milk fat percentages across all treatment groups, with no statistically significant variations observed at each progressive week of sampling. Statistical analysis indicated that the overall mean milk fat percentage across different dietary treatments was not significant.

Similar findings were reported in studies by Degirmencioglu (2013) [8], Rinne *et al*. (1999) [26], and Ghosh *et al*. (2018) [15], where an increased concentrate ratio in the diet of dairy cows did not result in alterations to milk fat concentration. However, contrasting results were observed in other studies, such as those by Machado *et al*. (2014) [19], where increased milk fat content was found with higher levels of concentrate feeding to dairy cows. These discrepancies in findings may be attributed to variations in diet composition, including different levels of roughages and concentrates, as well as the addition of diverse compositions in different ratios or in combination with other nutrients, among other factors.

Daily milk yield (kg)

The milk production of experimental buffaloes exhibited a pattern of increase until reaching peak yield under different treatments, followed by a subsequent decline until the conclusion of the experiment. The average daily milk yield over certain periods was recorded as 9.68 kg, 12.21 kg, and 12.69 kg for treatment groups T_1, T_2, and T_3, respectively. Analysis indicated that treatment groups T_2 and T_3 displayed higher milk yields compared to the control group (T_1). Statistical examination further revealed that buffaloes fed with a ration containing 30% or 40% crude protein and total digestible nutrients of green fodder with concentrate mixture exhibited significantly ($p<0.05$) higher milk yields compared to the control group, which did not exhibit any significant difference.

These findings align with previous studies conducted by Tessmann *et al*. (1991) [33], Argov-Argaman *et al*. (2014) [1], and Machado *et al*. (2014) [19], which similarly found that increasing the proportion of concentrate in the diet of lactating Holstein cows significantly ($p<0.05$) increased their daily milk yield. However, in contrast to the present findings, observed that varying levels of concentrate and forages in the ration of dairy cows did not significantly affect their daily milk yield. These divergent results among researchers may stem from differences in the levels of roughages and concentrates in the diets, the

addition of different compositions in varying ratios, or the combination with other nutrients.

6% Fat Corrected Milk (kg)

Groups T_2 and T_3 demonstrated higher 6% fat-corrected milk (FCM) values compared to the control group T_1, with mean values of 14.19 kg and 14.79 kg, respectively, in contrast to T_1's mean value of 11.30 kg over the designated time periods. Statistical analysis revealed a significantly ($P<0.05$) higher 6% FCM in the groups fed a ration with 30% or 40% crude protein and total digestible nutrients of green fodder replaced with a concentrate mixture, as compared to the control group. Notably, these groups did not exhibit significant differences from each other.

Previous studies conducted by Yadav (1993) [34] and Gaafar *et al*. (2009) [12] have demonstrated a significant ($P<0.05$) increase in FCM yield in lactating buffaloes with increased concentrate and decreased roughage in the diet. Similarly, Sporndly (1986) [32], Okine *et al*. (1997) [23], and Shingfield *et al*. (2002) [29] have observed a significant ($P<0.05$) increase in fat-corrected milk yield with the escalation of the concentrate ratio in dairy cow diets. Hossain *et al*. (2017) [17] also reported similar results in lactating buffaloes. The variation in researchers' findings may be attributed to differences in the levels of roughages and concentrates in the diets, the addition of various compositions in different ratios, or their combination with other nutrients.

Economics of milk production

The cost of feeding of lactating Murrah buffaloes in term of feed cost per kg milk yield per animal and feed cost per kg 6% FCM per animal under different dietary treatment groups were calculated from the records of feed and fodder consumption, considering the actual price of feed and fodder and average daily milk yield as well as 6% FCM yield per animal during the whole experimental period and has been presented in Table 3.

The total cost of feeding for a period of 180 days were Rs. 193751.34, 221302.98 and 227393.52 in treatments T_1, T_2 and T_3, respectively. The cost per kg green fodder, wheat straw and concentrate were Rs.1.50, 1.92 and 21.43, respectively. The average daily feeding cost per animal was Rs. 179.40, 204.91 and 210.55 in treatments T_1, T_2 and T_3, respectively.

The mean values of daily milk yield per animal were 9.68, 12.21 and 12.69: and the daily 6% FCM yield per animal was 11.30, 14.19 and 14.79 kg in treatments T_1, T_2 and T_3, respectively.

Feed cost per kg milk yield per animal were Rs.18.53, 16.78 and 16.59; and per kg 6% FCM per animal were Rs. 15.88, 14.44 and 14.24 in treatments T_1, T_2 and T_3, respectively.

Although the total cost of the feeding of lactating Murrah buffaloes was higher in both T_2 and T_3 treatment groups as compared to control treatment (T_1) but when compared to per kg production it was lower in both T_2 and T_3 treatment groups than control one (T_1). Hence, the perusal data on economics demonstrated that in terms of feed cost/kg milk yield, there was a net profit of Rs 1.75 in T_2 treatment and Rs. 1.94 in T_3 treatment as compared to T_1 treatment and in terms of feed cost/kg 6% FCM, there was a net profit of Rs 1.44 in T_2 treatment and Rs. 1.64 in T_3 as compared to T_1 treatment.

By replacement of 30% CP and TDN of green fodder with concentrate mixture it is possible to increase the income of dairy farmers owing to more milk production and 6% FCM content. In contrary to the results of current study, Neeradi (1998) [22]; Sanh *et al.* (2002) [27]; Meeske *et al.* (2006) [21] and Beyero *et al.* (2015) [3] reported that the feed cost per kg milk production and 4% FCM yield was considerably increased by increasing the proportion of concentrate in the rations of dairy cows. Gaafar *et al.* (2009) [12] and Hossain *et al.* (2017) [17] also reported similar results in lactating buffaloes. The different results observed by these researchers might be due to feeding of different levels of roughages and concentrates in diets and addition of different composition in different ratio or due to combination with other nutrients etc.

Table 3: Economics of feeding different dietary treatments to the lactating Murrah buffaloes

Particulars	Treatments		
	T_1	T_2	T_3
Total quantity of greens fed (qtl)	345.26	275.58	232.93
Total quantity of wheat bhusa fed (qtl)	26.17	43.29	48.06
Total quantity of concentrate fed (qtl)	63.90	80.10	85.50
Feeding cost (Rs.)			
Green fodder (@ 150 Rs. per qtl)	51789.00	41337.00	34939.50
Wheat straw (@ 192 Rs. per qtl)	5024.64	8311.68	9227.52
Concentrate (@ 2143 Rs. per qtl)	136937.70	171654.30	183226.50
Total feed cost (Rs.)	193751.34	221302.98	227393.52
Average daily feed cost/animal (Rs.)	179.40	204.91	210.55
Average daily yield per animal (kg)			
Milk yield	9.68	12.21	12.69
6% FCM (kg)	11.30	14.19	14.79
Economics of feeding (Rs.)			
Feed cost per kg milk yield per animal	18.53	16.78	16.59
Feed cost per kg 6% FCM per animal	15.88	14.42	14.17

Conclusion

The study aimed to assess the economic ramifications of different feeding strategies on milk production and profitability in lactating Murrah buffaloes. Through a thorough examination of eighteen buffaloes across three dietary treatment groups, the research scrutinized the impact of altering proportions of crude protein (CP) and total digestible nutrients (TDN) from green fodder with a concentrate mixture. Results unveiled a significant trend wherein buffaloes in treatment groups T_2 and T_3, which received diets with CP and TDN replacements, demonstrated heightened dry matter intake, milk yield, and 6% fat-corrected milk (FCM) yield compared to the control group (T_1). Despite uniform milk fat percentages across all groups, the economic analysis presented intriguing insights. Despite higher overall feeding costs for T_2 and T_3, the feed cost per kilogram of milk yield and 6% FCM yield emerged lower in these groups

compared to the control (T_1).

In essence, the findings underscored the potential benefits of optimizing feeding regimens in lactating Murrah buffaloes. By replacing portions of green fodder with a concentrate mixture, milk production could be augmented while enhancing economic viability. This revelation is pivotal for dairy farming economics, highlighting the importance of strategic dietary adjustments in bolstering productivity and profitability.

The research delved into the intricate dynamics of feed utilization, milk production, and economic viability in dairy farming, offering actionable insights for stakeholders. While this study focused on Murrah buffaloes, its implications extend to broader livestock management contexts, emphasizing the significance of tailored feeding strategies in optimizing agricultural outcomes and sustainability. Through meticulous data analysis and comprehensive economic evaluations, the study not only elucidated the immediate impacts of varied feeding regimes but also laid a foundation for future research endeavors in the domain of dairy farming economics. Ultimately, the research serves as a testament to the nuanced interplay between dietary composition, milk production, and economic feasibility, driving forward the discourse on optimizing productivity in livestock management.

References

1. Argov-Argaman N, Mesilati-Stahy R, Magen Y, Moallem U. Elevated concentrate-to-forage ratio in dairy cow rations is associated with a shift in the diameter of milk fat globules and remodeling of their membranes. J Dairy Sci. 2014;97:6286-6295.
2. Balain DS. Inflow and outflow of buffalo germplasm resources and their global contribution. Invited papers presented in short course on “characterization and conservation of domesticated livestock and poultry resources. National Bureau of Animal Genetic Resources (ICAR), Karnal; c1999.
3. Beyero N, Kapoor V, Tewatia BS. Effect of different Roughage: Concentrate Ratio on Milk Yield and Its Fatty Acid Profile in Dairy Cows. J Biol. Agric. Healthc. 2015;5(13):176-185.
4. Bhandari PM, Bhadwal S, Kelkar U. Examining adaptation and mitigation opportunities in the context of the integrated watershed management programme of the Government of India. Mitig Adapt Strat. Glob Change. 2007;12:919-933.
5. Broderick GA. Effect of varying dietary protein and energy levels on production of lactating dairy cows. J Dairy Sci. 2003;86:1370-1381.
6. Cockrill WR. The water buffalo a review. Br Vet J. 1981;137:8-16.
7. Das AK, Sharma D, Kumar N. Buffalo genetic resources in India and their conservation. Buffalo Bulletin. 2008;27(4):265-268.
8. Degirmencioglu T. The effects of concentrated feed level on the milk production and composition. Int. J Agric. Innov Res. 2013;2(1):91-93.
9. Dhiman TR, Kleinmans J, Tessmann NJ, Radloff HD, Evert PV, Satter LD. Effect of dietary forage:grain ratio on blood constituents in dairy cows. J Dairy Sci. 1991;74:2691-2695.
10. Duncan DB. Multiple range and multiple F tests. Biometrics. 1955;11(1):1-42.
11. FAOSTAT. Food and Agriculture Organization of the United Nations. [cited date]; [URL].
12. Gaafar HMA, Mohi El-Din AMA, Basiuoni MI, El-Riedy KFA. Effect of concentrate to roughage ratio and baker’s yeast supplementation during hot season on performance of lactating buffaloes. Slovak J Anim Sci. 2009;42(4):188-195.
13. Garg MR, Bhanderi BM, Sherasia PL, Gulati SK, Scott TW. Feeding strategies to reduce the cost of milk production. XI Animal Nutrition Workers Conference held at JNKVV Jabalpur (M.P.), India; c2004. p. 208-215.
14. Gaynor PJ, Waldo DR, Capuco AV, Erdman RA, Douglass LW, Teters BB. Milk Fat Depression, the Glucogenic Theory, and Trans-C18:1 Fatty Acids. J Dairy Sci. 1995;78:2008-2015.
15. Ghosh C, Prasad S, Datta S, Roy DC, Roy A, Kesh SS, Tudu NK. Effect of Cooling and Concentrate Feeding on Performances of Karan Fries Cattle under Loose Housing System. Int. J Curr. Microbiol. App Sci. 2018;7(12):2657-2670.
16. Gupta SK, Das GK. Post-partum anoestrus in buffaloes Factors responsible. J Remount Vet Corps. 1994;33:141-151.
17. Hossain SA, Sherasia PL, Phondba BT, Pathan FK, Garg MR. Effect of feeding green fodder based diet in lactating buffaloes: Milk production, economics and methane emission. Indian J Dairy Sci. 2017;70(6):767-773.
18. ICAR. Nutrient requirements of cattle and buffalo. Nutrient requirements of animals. Indian Council of Agricultural Research, New Delhi; c2013.
19. Machado SC, McManus CM, Stumpf MT, Fischer V. Concentrate: forage ratio in the diet of dairy cows does not alter milk physical attributes. Trop Anim Health Prod. 2014;46(5):855-859.
20. Makkar HPS. Animal nutrition in a 360-degree view and a framework for future R&D work: towards sustainable livestock production. Anim Prod Sci. 2016;56(10):1561-1568.
21. Meeske R, Rothauge A, Merwe GDV, Greyling JF. The effect of concentrate supplementation on the productivity of grazing Jersey cows on a pasture based system. South African Journal of Animal Science. 2006;36(2):105-110.
22. Neeradi R. Effect of feeding rations containing different forage to concentrate ratios on the performance of lactating cross bred cows. M.V.Sc. Thesis. Livestock Production Management Department of Dairy Science. Acharya N.G. Ranga Agricultural University, Hyderabad, India. 1998.
23. Okine EK, Khorasani GR, Kennelly JJ. Effects of source of forage and level of concentrate on chewing activity and milk production response in late lactation cows. Can J Anim Sci. 1997;77:253-258.
24. Resali DP. Recent trends in buffalo production in Nepal: A review, Buffalo News letter. Bulletin of the FAO Inter-Regional Cooperative Research Network on Buffalo, Europe-Near Estate. 2000;14:6-10.
25. Rice VA. Breeding and Improvement of Farm Animals. Bombay, India: Mc Graw Hill; c1970.
26. Rinne M, Jaakkola S, Kaustell K, Heikkila T, Huhtanen P. Silages harvested at different stages of grass growth v. concentrate foods as energy and protein sources in milk production. Anim Sci. 1999;69:251–263.
27. Sanh MV, Wiktorsson H, Ly LV. Effects of natural grass forage to concentrate ratios and feeding principles on milk production and performance of crossbred lactating cows. Asian-Aust J Anim Sci. 2002;15(5):650-657.
28. Sarwar M, Khan MA, Nisa M, Bhatti SA, Shahzad MA. Nutritional Management for Buffalo Production. Asian-Aust J Anim Sci. 2009;22(7):1060-1068.
29. Shingfield KJ, Jaakkola S, Huhtanen P. Effect of forage

conservation method, concentrate level and propylene glycol on intake, feeding behaviour and milk production of dairy cows. Anim Sci. 2002;74:383-397.
30. Singh KP, Singh I. Buffalo Diversity in India: Breeds and Defined Populations, Dairy Year Book; c2015. p. 33-36.
31. Snedecor GW, Cochran WG. Statistical methods. 8th ed. Ames, Iowa, USA: Iowa State University Press; c1994.
32. Sporndly R. Intake and production response of dairy cows to a fixed ratio of silage to cereals, fed as separate feeds, blended or ensiled together. In: Ensiling of blended grass and grain and its utilization by dairy cows. Report 155. Uppsala, Sweden: Dept. of Animal Nutrition and Management, Swedish University of Agricultural Sciences; 1986.
33. Tessmann NJ, Radloff HD, Kleinmans J, Dhiman TR, Satter LD. Milk production response to dietary forage: grain ratio. J Dairy Sci. 1991;74(8):2696-707.
34. Yadav BL. Effect of housing and feeding system on milk yield, milk composition and physiological reactions of Murrah buffaloes during rainy season. [M.V.Sc. Thesis]. Hisar, India: Livestock Production Management department, CCSHAU; c1993.