

Effect of Concentrate Feeding Levels and Frequency on Performance of Crossbred Dairy Cows

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Abstract

Forty-eight crossbred Holstein cows were grouped into three treatments in 3x2 factorial experiments to determine the effect of concentrate feeding levels and frequency on feed intake and efficiency, body weight change, milk yield and quality. Cows in each treatment were randomly assigned to mixed concentrate at 2%, 2.5% and 3% of their initial average body weights. Moreover; cows in each treatment were randomly subdivided into two groups (n=8); and one group fed mixed concentrate two times while the other group fed three times in daily in two and three equal portions. All data were analyzed with SAS and a difference was detected by Duncan's multiple range test. All treatment groups showed an increased trend in weight gain even though cows in T1 gained more weight. Cows fed concentrate three times per day gained 21.75 kg more weight in comparison to that of two times feeding. Animals provided with different levels of concentrate at the same frequency had less significant effect on average daily body weight gain (p<0.05), concentrate intake and production cost (p<0.05). Animals provided with the same level of concentrate at different feeding frequency had significant effect on average daily body weight gain, milk protein and total solid. Response in milk output to the level of concentrate input is slightly significant whereas there was no significant difference in milk response to concentrate feeding frequency. The economic analysis rate on concentrate return indicated that each additional unit of 1 Ethiopian Birr per cow cost increment resulted in 1.6 and 1.5 ETB benefit for two and three times feeding frequency whereas 0.98, 1.96 and 1.86 ETB benefit for cows fed at 3%, 2.5% and 2% of their body weight, respectively.

Keywords: Body weight; Concentrate levels; Feeding frequency; Milk quality; Milk yield

Introduction

The transition period has been considered the stage of highest interest in the life of dairy cows [1]. Over this period, animals undergo several anatomical, physiological, hormonal, and metabolic changes. Because of these, this is the period of most concern in terms of nutrition and occurrence of metabolic and infectious [2]. Roche [3] stated that high-producing cows have a greater negative energy balance (NEB) and its magnitude is directly related to reproductive failure. Considering the calving interval should be 13-14 months ideally, cows should be pregnant up to 45-90 days after calving, and those that do not meet this target are at higher chance of being culled [4].

Concentrates are energy rich feed that contribute to minimize the NEB and which had a major effect on the subsequent lactation performance. Accordingly, a large amount of concentrate is usually fed to cows in early lactation to increase milk production, maintain body condition and thereby improve the profitability of dairy farm [5]. For this reason, dairy cows in early lactation are usually fed diets with a high proportion of concentrates to increase the nutrient density of the diet. However, high-concentrate diets when consumed within short periods might result in ruminal acidosis [6] and other metabolic disturbances.

Twice-daily feeding of concentrates is a common practice on many commercial operations [6]. It has been argued, however, that this may not be the best feeding strategy for optimizing milk production efficiency. Increasing daily feeding frequency has resulted in higher average rumen fluid pH, reductions in pH fluctuations, improvements in the acetate and propionate ratio, and higher milk-fat tests [6]. Moreover, Gibb et al. [7] and Robinson [8] offered concentrate at 8 kg /cow/day and reported that it can perturb the rumen environment, decrease dry matter intake (DMI) and reduce the efficiency of nutrient utilization but more frequent concentrate feeding may reduce the detrimental effects. Increasing concentrate feeding frequency affects the dry matter digestibility, milk yield, weight gains [9] and it also reduces risk of acidosis [10].

Therefore, feeding dairy cows in early lactation with a high density proportion of concentrates at optimum level that entail frequent feeding of concentrates in small allotments at regular intervals reduce the detrimental effects of NEB on production and reproduction performance. Therefore, reallocation of the available concentrate to coincide with the milk production requirements during the period of most concern appears to be a sustainable option. Therefore, the purpose of this study was to investigate effect of concentrate feeding levels and frequency on milk yield and milk composition, feed intake, body weight change and dairy efficiency over the first 45 days in milk (DIM).

Materials and Methods

Study area

The study was carried out at Haramaya University dairy farm situated in Haramaya district. Geographically, the study area is located at 9°26'N and 42°3'E and altitude of 1980 meters above sea levels. The area receives 780 mm mean annual rainfall. The mean annual minimum and maximum temperatures are 8.5 and 24.4°C, respectively.

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Experimental animals and research design

Following calving (at seven days postpartum) forty-eight Holstein Friesian crossbred milking cows were selected on the basis of nearly the same parity and age. They were housed as a single unit in free stalls with concrete flooring cubicles (2.20 m long and 1.20 m wide) that are bedded with rubber mats. The floors of cubicles were scraped three times daily. Lights left on in the buildings during night times. Cows were randomly assigned to the treatments (n=16 cows per treatment) and also animals in each treatment were randomly subdivided into two groups (n=8); and one of the groups fed mixed concentrate two times (2x) while the other group fed three times (3x) daily in two and three equal portions of the total concentrate mix for forty five days. Animals provided the concentrate at twelve and eight hours interval for 2x and 3x feeding, respectively. The mixed concentrate was offered to experimental animals at 2%, 2.5% and 3% of their average initial body weights and fed individually in a feeding trough made of rubber cuts. Required quantity of concentrate weighed for each animal on sensitive weighing balance and offered to the animals. Adaptation period of seven days was given until the cows completely shifted onto experimental rations. An animal in each treatment received equal amount of corn silage twice a day and had free access to water at all times. The experimental feed ingredients used in concentrate formulation are given in Table 1. The ingredient of the mixed diet, composite diet and the corn silage were analyzed for chemical composition.

Feed intake and analysis

Feed used in experiment was analyzed at Haramaya University Animal Nutrition laboratory. The samples were analysed for DM, CP, neutral detergent fibre (NDF), acid detergent fibre (ADF), and ash. DM and nitrogen (N) were analysed according to the standard methods of AOAC [11], whereas NDF, ADF and ADL were determined by the methods of Van Soest et al. [12]. Feed offered and refused were recorded on daily basis and feed intake was calculated as feed offered minus feed refused.

Body weight

Cows in each treatment were weighed early in the morning after milking and prior to feeding at the start and end of the study using weighting balance (1000 kg scale). Body weight change was determined as the difference between the initial and final weight.

Milk yield and quality analysis

Milking was done by milking machine twice a day at equal milking interval with cows walking about 40 meter to the milking parlour.

Milking operation was performed following standard procedures. Morning and evening milk yield for each cow was separately weighed by using sensitive balance and recorded on daily basis. A 200 ml milk sample was taken three times from each cow on two consecutive days every thirteen days interval and average result was taken. Separate analysis was done for the morning and afternoon for fat, protein, lactose, ash and SNF, Total solid, Milk urea nitrogen by using milk analyzer (Milko-scan) machine at Haramaya University Dairy Technology laboratory.

Partial budget analysis

The economic benefit was calculated for each treatment assuming all production cost was the same except concentrate feed. The costs of feed ingredient used were registered at purchase and the feed consumed by cows were multiplied by the cost of the ingredient. The milk produced from each treatment throughout the experimental period was calculated based on the present sale price of milk per litter and then the costs of each treatment were calculated.

Statistical design and analysis

3*2 factorial experiment in complete randomized design was used to analyze data for the effect of concentrate feeding levels and frequency. All data were analyzed using SAS 9.1.3 and a statistical difference was detected by Duncan's multiple range tests.

Results and Discussion

Concentrate feeding levels and frequency had significant effect on live weight change of milking cows (Table 2). Average initial live weight of the animals in T1, T2 and T3 fed concentrate at 3%, 2.5% and 2% were 431.0, 370.25 and 463.6 kg, whereas the final body weight recorded were 462.2, 389.5 and 486.4 kg, respectively. All treatment groups showed an increased trend in weight gain even though cows fed concentrate at 3% (T1) of their initial body weight gained 13.5 and 6.37 kg more weight than those fed at 2.5% (T2) and 2% (T3), respectively. The higher body weight gain in T1 was due to the higher concentrate feed intake which was 2.9 and 2.67 kg/day more than T2 and T3, in that order. Increasing live weight gain in milking cows with higher concentrate supplementation was also reported by Aston et al. [13]. Furthermore, cows fed concentrate three times per day gained totally 21.75 kg more weight in comparison to cows that fed two times that is body weight was affected by concentrate feeding frequency. This might be due to small frequent feed offered at regular interval that avoid rumen overload and improves the efficiency of rumen digestive capacity and quicker nutrient absorption to the cell. Similarly, Schingoethe et al. [9] reported as increasing concentrate feeding frequency will affect

Ingredients	0/	Average Nutritional Value (%)								
	%	DM	СР	NDF	ADF	ADL	EE	Ash		
Ground corn	56.1	89	7.1	27.9	3.9	0.6	5.3	2.3		
Wheat bran	20.6	93.1	15.3	43.1	9.5	4.2	4.8	3.9		
Soybean meal	5.2	93.2	38.5	-	-	-	8.9	8.0		
Peanut meal	14.9	94.7	37.3	34.7	13.8	6.3	9.6	6.2		
Corn Silage	-	94.9	7.7	75.0	41.0	-	2.3	7.6		
Salt	0.7	-	-	-	-	-	-	-		
Limestone	1.0	-	-	-	-	-	-	-		
Ruminant premix	1.5	-	-	-	-	-	-	-		
Mixed concentrate	-	90.1	12.5	46.1	26.2	3.6	6.7	3.7		
DM: Drv Matter: CP	2: Crude Protein: E	E: Ether Extract: N	IDF: Neutral Deter	aent Fiber: ADF: A	cid Detergent Fiber	: ADL: Acid Deterge	ent Lianin: - : Not e	valuated		

Table 1: Proportion of ingredients used in the experimental ration.

the weight gain. Nevertheless, Gibson [14] found no evidence that body-weight changes were affected by feeding frequency. Concentrate feeding frequency did not affect concentrate intake (Table 2) which is consistent to Macleod et al. [6] and Macmillan et al. [15] that reported reducing feed intake when increasing the frequency of feeding which might encourage distribution of eating throughout the day. The lack of effect of increasing concentrate feeding frequency on concentrate intake observed in this study is in agreement with the results of Gill et al. and Nocek et al. [16,17]. Contrarily, DeVries et al. and Mantysaari et al. [18,19] reported as cows fed more frequently consume more feed. Animals provided different levels of concentrate feed at the same feeding interval or frequency had less significant effect on average daily body weight gain, concentrate intake and cost of concentrate feed (Tables 3-7).

Devenetere	Feeding Frequency (FF)		Concentrate levels (CL)			P-value		
Parameters	2X	3X	T1	T2	Т3	CL	FF	CL*FF
Total body weight gain (Kg/cow)	15.25 ^b	37.00a	32.75	19.25	26.38	0.055	0.0008	0.0349
Average daily body weight gain (Kg/cow/day)	0.34 ^b	0.82ª	0.73ª	0.43 ^b	0.59 ^{ab}	0.054	0.0008	0.0349
Concentrate feed efficiency (on BW basis)	1.02ª	0.29 ^b	0.39	0.74	0.84	0.385	0.0301	0.276
Average daily concentrate mix intake (kg/cow/day)	10.11	10.06	11.94ª	9.04 ^b	9.27 ^b	0.0003	0.88	0.869
Average daily milk yield (Kg/cow/day)	21.67	21.10	19.69	22.33	22.12	0.442	0.752	0.312
Concentrate feed efficiency (on Milk yield basis)	0.49	0.48	0.61ª	0.41 ^b	0.42 ^b	0.012	0.913	0.292
Protein (%)	3.50	3.67	3.79	3.41	3.10	0.187	0.633	0.454
Fat (%)	3.79	3.56	3.61	3.88	3.53	0.880	0.720	0.964
Solid Not Fat (%)	8.64	8.52	8.60	8.80	8.33	0.450	0.704	0.868
Total Solid (%)	12.53	12.17	12.32	12.79	11.95	0.686	0.658	0.910
Lactose (%)	4.37	4.7	4.12	4.66	4.48	0.393	0.746	0.636
Casein (%)	2.55	2.47	2.73	2.54	2.26	0.138	0.666	0.520
Milk Urea Nitrogen (mg/dl)	36.02	35.79	36.72	36.12	34.88	0.831	0.927	0.368

T1: Fed concentrate at 3% of body weight (BW), T2: Fed concentrate at 2.5% of body weight, T3: Fed concentrate at 2% of body weight, FE: Feed efficiency, X-times, SL: Significance level at P<0.05, NS: Non-significant, ^{abc} Means within the same row carrying different superscripts differ significantly (P<0.05).

Table 2: Effect of concentrate feeding levels and frequency on the performance of cows.

Dananakan	Concentrate	Feeding	Frequency	Durahus		
Parameters	levels	2 times	3 times	P-value	5L	
	T1	0.59	0.87	0.19	NS	
Average daily body weight gain (Kg/cow/day)	T2	0.28	0.58	0.24	NS	
	T3	0.15⁵	1.02ª	0.003	**	
	T1	11.88	12.00	0.89	NS	
Average daily concentrate mix intake (kg/cow/day)	T2	9.17	8.92	0.53	NS	
	T3	9.28	9.27	0.88	NS	
	T1	19.17	20.21	0.62	NS	
Average daily milk yield (Kg/cow/day)	T2	21.35	23.30	0.68	NS	
	T3	24.48	19.76	0.24	NS	
	T1	3.87	3.71	0.84	NS	
Protein (%)	T2	3.67	3.13	0.31	NS	
	Т3	2.95⁵	3.26ª	0.02	*	
	T1	3.84	3.92	0.81	NS	
Fat (%)	T2	3.96	3.81	0.76	NS	
	Т3	3.57	3.49	0.90	NS	
	T1	8.77	8.44	0.57	NS	
Solid Not Fat (%)	T2	8.82	8.78	0.91	NS	
	Т3	8.32	8.35	0.97	NS	
	T1	12.71	11.93	0.74	NS	
Total Solid (%)	T2	12.95ª	12.62 ^b	0.046	*	
	Т3	11.93	11.97	0.97	NS	
	T1	4.14	4.10	0.96	NS	
Lactose (%)	T2	4.40	4.92	0.08	NS	
	Т3	4.56	4.39	0.73	NS	
	T1	2.78	2.67	0.82	NS	
Casein (%)	T2	2.70	2.40	0.32	NS	
	T3	2.17	2.35	0.10	NS	
	T1	38.48	34.96	0.53	NS	
Milk Urea Nitrogen (mg/dl)	T2	33.56	38.68	0.30	NS	
	Т3	36.03	33.72	0.66	NS	

T1: Feed concentrate 3% of body weight (BW), T2: Feed concentrate 2.5% of body weight, T3: Feed concentrate 2% of body weight, FE: Feed efficiency, SL: Significance level at P<0.05, NS: Non-significant, ^{abc} Means within the same row carrying different superscripts differ significantly (P<0.05)

 Table 3: Effect of concentrate feeding frequency on the performance of dairy cows.

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Demonsterre	Feeding	C	concentrate level	_ .	SL	
Parameters	Frequency	T1 T2		Т3		P-value
	2 times/day	0.59	0.28	0.15	0.12	NS
Average daily body weight gain (Kg/cow/day)	3 times/day	0.87a⁵	0.58 ^b	1.02ª	0.05	*
	2 times/day	11.88ª	9.17 ^₅	9.28 ^b	0.01	*
Average daily concentrate mix intake (kg/cow/day)	3 times/day	12.0ª	8.92 ^b	9.27 ^b	0.03	*
Average deily mill(vield (Kg/eeu/dev)	2 times/day	19.17	21.35	24.48	0.35	NS
Average daily milk yield (Kg/cow/day)	3 times/day	20.21	23.30	19.76	0.52	NS
	2 times/day	3.87	3.69	2.95	0.35	NS
Protein (%)	3 times/day	3.71	3.13	3.26	0.33	NS
	2 times/day	3.84	3.96	3.57	0.95	NS
Fat (%)	3 times/day	3.39	3.81	3.49	0.84	NS
	2 times/day	8.77	8.82	8.32	0.17	NS
Solid Not Fat (%)	3 times/day	8.44	8.78	8.35	0.80	NS
Total Calid (9/)	2 times/day	12.71	12.95	11.93	0.78	NS
	3 times/day	11.93	12.62	11.97	0.82	NS
	2 times/day	4.14	4.40	4.56	0.58	NS
Lactose (%)	3 times/day	4.10	4.92	4.39	0.52	NS
$C_{constitution}(0/1)$	2 times/day	2.78	2.69	2.17	0.31	NS
Casein (%)	3 times/day	2.67	2.40	2.35	0.32	NS
Milk Lirop Nitrogon (mg/dl)	2 times/day	38.48	33.56	36.03	0.41	NS
wilk orea will ogen (mg/di)	3 times/day	34.96	38.68	33.72	0.65	NS

T1: Feed concentrate 3% of body weight (BW), T2: Feed concentrate 2.5% of body weight, T3: Feed concentrate 2% of body weight, FE: Feed efficiency, SL: Signey level at P<0.05, NS: Non-significant, abc Means within the same row carrying different superscripts differ significantly (P<0.05).

Table 4: Effect of concentrate feeding levels on the performance of dairy cows.

	Feeding Frequency(FF)		Concentrate levels (CL)			P-value		
Parameters								
	2X	3X	T1	T2	Т3	CL	FF	CL*FF
Number of Animals (N)	24	24	16	16	16	-	-	-
Total concentrate mix intake (Kg/cow)	454.95	452.7	537.13ª	406.91 ^b	417.26 ^b	0.0003	0.880	0.869
Total cost of concentrate mix (ETB/cow)	4548.0	4527.4	5371.3ª	4069.1 ^b	4172.6 ^b	0.0003	0.880	0.869
Total Milk produced (Kg/Cow)	975.0	949.0	885.94	1004.63	995.40	0.442	0.752	0.312
Total selling price of raw milk (ETB/cow)	11700.0	11387.7	10631.0	12056.0	11945.0	0.442	0.752	0.312
Total return (ETB/Cow)	7152.0	6860.3	5260.0	7986.0	7772.0	0.096	0.764	0.293

T1: Feed concentrate 3% of body weight (BW), T2: Feed concentrate 2.5% of body weight, T3: Feed concentrate 2% of body weight, SL: Significance level at P<0.05, ETB: Ethiopian birr/currency. Selling price of raw milk (ETB/Kg) : 12, Cost of concentrate mix (ETB/Kg) : 10, ^{abc} Means within the same row carrying different superscripts differ significantly (P<0.05).

Table 5: Effect of concentrate feeding levels and frequency on economic returns.

Variables	Concentrate feeding	Feeding I	Frequency	Dyrahua		
variables	levels (CL)	2 times	3 times	P-value	51	
	T1	534.38	539.89	0.89	NS	
Total concentrate mix intake (Kg/cow)	T2	412.65	401.18	0.53	NS	
	Т3	417.38	417.15	0.88	NS	
Total cost of concentrate mix (ETB/cow)	T1	5343.8	5398.9	0.89	NS	
	T2	4126.5	4011.8	0.53	NS	
	Т3	4173.75	4171.50	0.88	NS	
	T1	862.65	909.23	0.62	NS	
Total Milk produced (Kg/Cow)	T2	960.8	1048.5	0.68	NS	
	Т3	1101.6	889.2	0.24	NS	
	T1	10351.8	10910.7	0.62	NS	
Total selling price of raw milk (ETB/cow)	T2	11529.0	12582.0	0.68	NS	
	Т3	13219.0	10670.0	0.24	NS	
	T1	5008.0	5511.8	0.61	NS	
Total return (ETB/Cow)	T2	7403.0	8570.0	0.64	NS	
	Т3	9045.0	6499.0	0.24	NS	

level at P<0.05, NS: Non-significant, ETB: Ethiopian birr/currency. ^{abc} Means within the same row carrying different superscripts differ significantly (P<0.05).

Table 6: Effect of concentrate feeding frequency on economic returns.

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Verichles	Feeding	Conce	entrate feeding leve	Durahua	ei.		
variables	Frequency	T1 T2		Т3	P-value	3L	
Total concentrate mix intelse (Kalesus)	2 times/day	534.38ª	412.65 ^b	417.38 ^b	0.01	**	
Total concentrate mix intake (Kg/cow)	3 times/day	539.89ª	401.18 ^b	417.15 [⊳]	0.03	*	
	2 times/day	5343.8ª	4126.5 ^b	4173.8 ^b	0.01	**	
Total cost of concentrate mix (ETB/cow)	3 times/day	5398.9ª	4011.8 ^b	4171.5 [⊳]	0.03	*	
Total Mills produced (Ka/Cow)	2 times/day	862.7	960.8	1101.6	0.35	NS	
Total Milk produced (Kg/Cow)	3 times/day	909.2	1048.5	889.2	0.52	NS	
	2 times/day	10352	11529	13219	0.35	NS	
Total selling price of raw milk (ETB/cow)	3 times/day	10911	12582	10670	0.52	NS	
Total rature (ETD/Cau)	2 times/day	5008	7403	9045	0.21	NS	
Total return (ETB/Cow)	3 times/day	5512	8570	6499	0.25	NS	

T1: Feed concentrate 3% of body weight (BW), T2: Feed concentrate 2.5% of body weight, T3: Feed concentrate 2% of body weight, FE: Feed efficiency, SL: Significance level at P<0.05, NS: Non-significant, ETB: Ethiopian Birr, abc Means within the same row carrying different superscripts differ significantly (P<0.05).

Table 7: Effect of concentrate feeding levels on economic returns.

The effect of concentrate feeding levels and frequency on daily milk yield and milk composition during early lactation stage was found nonsignificant except protein and total solids (Table 2). Similar study result was reported by Macleod et al. [6] as concentrate feeding frequency had no significant effect on milk composition. Moreover, Hongerholt et al. [20] reported inconsistent study result that increased concentrate input increased milk yield and decreased milk fat content. In contrary to this finding, higher level of milk is reported with higher input of concentrate but milk fat content has been observed to follow reverse trend [21]. Ferris [22] also determined that increasing concentrate feeding level increased the milk protein. Johnson and Martz et al. [23,24] reported no difference in milk yield between cows fed three times per day in comparison to that of two times feeding. Moreover, Hardie [25] reported increased milk production in high-yielding dairy cows with increased frequency of grain feeding. An increase in the frequency of grain feeding from 2 to 4 times daily at 6 hour intervals for cows did not improve production [20]. Dalley [26] demonstrated increases in milk production of up to 2.01% per day with 8 kg concentrate a day when grain was fed in four rather than two meals per day to cows. Thus, the results from previous study in dairy cows in which feeding frequency has been increased in an attempt to elevate level of milk production and composition are inconsistent. Milk-fat concentration and to a lesser extent milk yield could be increased but no evidence that milkprotein concentration, lactose concentration or body-weight changes were affected by increasing the frequency of feeding [14]. Feeding frequency of concentrates (two and five times daily) had no significant effect on milk production in either high- or low yielding cows [23]. The non-significant difference in milk yield and compositions between two and three times feeding frequency of concentrates in this study was probably due to the similar daily concentrate mix intake (Table 2). Animals provided the same level of concentrate at different feeding frequency had no significant effect on all parameters evaluated in this study except on average daily body weight gain and milk protein in T3 and total solid in T2 (Tables 3-6).

Response in milk output to the level of concentrate input is slightly significant whereas there was no significant difference in milk response to concentrate feeding frequency as a result of the same average daily concentrate mix intake (Table 2). Concentrate for cows in T1 supplied at the ratio of 0.61 kg per each kg of milk and this higher concentrate intake might be due to their higher body weight gain than T2 and T3. In this study the intake of concentrate ranges between 0.41 to 0.61 kg DM per kg milk and this response is better than 1 kg of concentrate per 0.6 kg milk that reported by King [27]. Bines [28] also reported intake of concentrate ranges between 0.16 to 0.36 kg DM per kg milk.

A simple economic analysis was performed, considering only the cost of concentrate inputs and selling price of milk (Table 7). Although concentrate feeding levels and frequency had no significant effect on economic return, animals fed concentrate twice per day earned 291.7 more Ethiopian Birr (ETB) than those feeding three times. Likewise, animals fed concentrate at 2.5% of their body weight (T2) earned 272 and 214 more ETB than animal in T1 and T3, respectively. The economic analysis rate on concentrate return indicated that each additional unit of 1 ETB per cow concentrate cost increment resulted in 1.6 and 1.5 ETB benefit for two and three times feeding frequency per day whereas 0.98, 1.96 and 1.86 ETB benefit for cows fed concentrate at 3%, 2.5% and 2% of their body weight in T1, T2 and T3, respectively.

Conclusion

Animals provided with the same level of concentrate at different feeding frequency had significant effect on average daily body weight gain, milk protein and total solid. Animals provided with different levels of concentrate at the same feeding frequency had less significant effect on average daily body weight gain, concentrate intake and concentrate cost. Response in milk output to the level of concentrate input is slightly significant. No significant difference in milk response to concentrate feeding frequency. Cows fed concentrate twice per day earned more income than those feeding three times and cows fed concentrate at 2.5% of their body weight earned more return. Therefore; concentrate feeding twice in daily at 2.5% of body weight or 0.41 kg per litter of milk is economically more efficient in dairy cows during the early lactation.

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