Journal of Veterinary Science & Technology
ISSN: 2157-7579

Research Article Open Access

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

Ewonetu Kebede Senbeta* and Gemechu Taffa

School of Animal and Range Science, Haramaya University, Dire Dawa, Ethiopia

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.

***Corresponding author:** Ewonetu Kebede Senbeta, School of Animal and Range Science, Haramaya University, Dire Dawa, Ethiopia, Tel: +251912927403, E-mail: ewonetu2011@gmail.com

Received May 02, 2019; **Accepted** July 24, 2019; **Published** July 31, 2019

Citation: Senbeta K, Taffa G (2019) Effect of Concentrate Feeding Levels and Frequency on Performance of Crossbred Dairy Cows. J Vet Sci Technol 10: 582.

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	%	Average Nutritional Value (%)						
		DM	CP	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: Dry Matter; CP: Crude Protein; EE: Ether Extract; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; ADL: Acid Detergent Lignin; - : Not evaluated

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).

Parameters	Feeding Frequency (FF)		Concentrate levels (CL)			P-value		
	2X	3X	T1	T2	T3	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}	0.82^{a}	0.73^{a}	0.43^{b}	0.59^{ab}	0.054	0.0008	0.0349
Concentrate feed efficiency (on BW basis)	1.02^{a}	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	11.94^{a}	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	0.61^{a}	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.

Parameters	Concentrate levels	Feeding Frequency		P-value	SL
		2 times	3 times		
Average daily body weight gain (Kg/cow/day)	T1	0.59	0.87	0.19	NS
	T2	0.28	0.58	0.24	NS
	T3	0.15^{b}	1.02^{a}	0.003	**
Average daily concentrate mix intake (kg/cow/day)	T1	11.88	12.00	0.89	NS
	T2	9.17	8.92	0.53	NS
	T3	9.28	9.27	0.88	NS
Average daily milk yield (Kg/cow/day)	T1	19.17	20.21	0.62	NS
	T2	21.35	23.30	0.68	NS
	T3	24.48	19.76	0.24	NS
Protein (%)	T1	3.87	3.71	0.84	NS
	T2	3.67	3.13	0.31	NS
	T3	2.95^{b}	3.26^{a}	0.02	*
Fat (%)	T1	3.84	3.92	0.81	NS
	T2	3.96	3.81	0.76	NS
	T3	3.57	3.49	0.90	NS
Solid Not Fat (%)	T1	8.77	8.44	0.57	NS
	T2	8.82	8.78	0.91	NS
	T3	8.32	8.35	0.97	NS
Total Solid (%)	T1	12.71	11.93	0.74	NS
	T2	12.95^{a}	12.62^{b}	0.046	*
	T3	11.93	11.97	0.97	NS
Lactose (%)	T1	4.14	4.10	0.96	NS
	T2	4.40	4.92	0.08	NS
	T3	4.56	4.39	0.73	NS
Casein (%)	T1	2.78	2.67	0.82	NS
	T2	2.70	2.40	0.32	NS
	T3	2.17	2.35	0.10	NS
Milk Urea Nitrogen (mg/dl)	T1	38.48	34.96	0.53	NS
	T2	33.56	38.68	0.30	NS
	T3	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.

Parameters	Feeding Frequency	Concentrate levels			P-value	SL
		T1	T2	T3		
Average daily body weight gain (Kg/cow/day)	2 times/day	0.59	0.28	0.15	0.12	NS
	3 times/day	0.87a[b]	0.58[b]	1.02[a]	0.05	*
Average daily concentrate mix intake (kg/cow/day)	2 times/day	11.88[a]	9.17[b]	9.28[b]	0.01	*
	3 times/day	12.0[a]	8.92[b]	9.27[b]	0.03	*
Average daily milk yield (Kg/cow/day)	2 times/day	19.17	21.35	24.48	0.35	NS
	3 times/day	20.21	23.30	19.76	0.52	NS
Protein (%)	2 times/day	3.87	3.69	2.95	0.35	NS
	3 times/day	3.71	3.13	3.26	0.33	NS
Fat (%)	2 times/day	3.84	3.96	3.57	0.95	NS
	3 times/day	3.39	3.81	3.49	0.84	NS
Solid Not Fat (%)	2 times/day	8.77	8.82	8.32	0.17	NS
	3 times/day	8.44	8.78	8.35	0.80	NS
Total Solid (%)	2 times/day	12.71	12.95	11.93	0.78	NS
	3 times/day	11.93	12.62	11.97	0.82	NS
Lactose (%)	2 times/day	4.14	4.40	4.56	0.58	NS
	3 times/day	4.10	4.92	4.39	0.52	NS
Casein (%)	2 times/day	2.78	2.69	2.17	0.31	NS
	3 times/day	2.67	2.40	2.35	0.32	NS
Milk Urea Nitrogen (mg/dl)	2 times/day	38.48	33.56	36.03	0.41	NS
	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: Significance 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.

Parameters	Feeding Frequency(FF)		Concentrate levels (CL)			P-value		
	2X	3X	T1	T2	T3	CL	FF	CL*FF
Number of Animals (N)	24	24	16	16	16	-	-	-
Total concentrate mix intake (Kg/cow)	454.95	452.7	537.13[a]	406.91[b]	417.26[b]	0.0003	0.880	0.869
Total cost of concentrate mix (ETB/cow)	4548.0	4527.4	5371.3[a]	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 levels (CL)	Feeding Frequency		P-value	SL
		2 times	3 times		
Total concentrate mix intake (Kg/cow)	T1	534.38	539.89	0.89	NS
	T2	412.65	401.18	0.53	NS
	T3	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
	T3	4173.75	4171.50	0.88	NS
Total Milk produced (Kg/Cow)	T1	862.65	909.23	0.62	NS
	T2	960.8	1048.5	0.68	NS
	T3	1101.6	889.2	0.24	NS
Total selling price of raw milk (ETB/cow)	T1	10351.8	10910.7	0.62	NS
	T2	11529.0	12582.0	0.68	NS
	T3	13219.0	10670.0	0.24	NS
Total return (ETB/Cow)	T1	5008.0	5511.8	0.61	NS
	T2	7403.0	8570.0	0.64	NS
	T3	9045.0	6499.0	0.24	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/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.

Variables	Feeding Frequency	Concentrate feeding levels (CL)			P-value	SL
		T1	T2	T3		
Total concentrate mix intake (Kg/cow)	2 times/day	534.38[a]	412.65[b]	417.38[b]	0.01	**
	3 times/day	539.89[a]	401.18[b]	417.15[b]	0.03	*
Total cost of concentrate mix (ETB/cow)	2 times/day	5343.8[a]	4126.5[b]	4173.8[b]	0.01	**
	3 times/day	5398.9[a]	4011.8[b]	4171.5[b]	0.03	*
Total Milk produced (Kg/Cow)	2 times/day	862.7	960.8	1101.6	0.35	NS
	3 times/day	909.2	1048.5	889.2	0.52	NS
Total selling price of raw milk (ETB/cow)	2 times/day	10352	11529	13219	0.35	NS
	3 times/day	10911	12582	10670	0.52	NS
Total return (ETB/Cow)	2 times/day	5008	7403	9045	0.21	NS
	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 non-significant 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 milk-protein 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.

Acknowledgment

The authors thank Haramaya University for funding the research and all personnel working in the University's dairy farm for the assistance they provided during the research work.

References

1. Drackley JK (1999) Biology of dairy cows during the transition period: The final frontier. Journal of Dairy Science 82: 2259-2273.
2. Dubuc J, Duffield TF, Leslie KE, Walton JS, LeBlanc SJ (2010) Risk factors for postpartum uterine diseases in dairy cows. Journal of Dairy Science 93: 5764-5771.
3. Roche JR (2006) The effect of nutritional management of the dairy cow on reproductive efficiency. Animal Reproduction Science 96: 282-296.
4. Alawneh JI, Stevenson MA, Williamson NB, LopezVilallobos N, Otley T (2012) The effect of live weight change on reproductive performance in a seasonally calving, pasture fed dairy herd. Livestock Science 145: 131-139.
5. Bargo F, Muller LD, Kolver ES, Delahoy JE (2003) Invited Review: Production and digestion of supplemented dairy cows on pasture. Journal of Dairy Science 86: 1-42.

6. Macleod GK, Coluccil PE, Moore AD, Grieve DG, Lewis N (2004) The effects of feeding frequency of concentrates and feeding sequence of hay on eating behavior, ruminal environment and milk production in dairy cows. Canadian Journal of Animal Science 74: 103-113.

7. Gibb MJ, Huckle CA, Nuthall R (2000) Effect of temporal pattern of supplementation on grazing behaviour and herbage intake by dairy cows. In: Grazing management: The principles and practice of grazing, for profit and environmental gain, within temperate grassland systems. British Grassland Society occasional symposium No. 34., UK, pp: 91-96.

8. Robinson PH (2009) Dynamic aspects of feeding management for dairy cows. Journal of Dairy Science 72: 1197-1209.

9. Schingoethe DJ, Casper DP, Drackley JK, Ludens FC (2006) Increased solids intake and feeding frequency for calves in hutches during cold weather. Journal of Dairy Science 69: 1063-1069.

10. Robles V, Gonzalez LA, Ferret A, Manteca X, Calsamiglia S (2007) Effects of feeding frequency on intake, ruminal fermentation, and feeding behaviour in heifers fed high-concentrate diets. Journal of Animal Science 85: 2538-2547.

11. AOAC (2000) Official Methods of Analysis. Association of Official Analytical Chemists International, Arlington, Texas, USA.

12. Van Soest PJ, Robertson JB, Lewis BA (1991) Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science 74: 3583-3597.

13. Aston K, Sutton J, Fisher W (2005) Milk production from grass silage diets: strategies for concentrate allocation. Animal Science 61: 465-480.

14. Gibson JP (2004) The effects of frequency of feeding on milk production of dairy cattle: An analysis of published results. Animal Production 38: 181-189.

15. Macmillan K, Gao X, Oba M (2017) Increased feeding frequency increased milk fat yield and may reduce the severity of subacute ruminal acidosis in higher-risk cows. Journal of Dairy Science 100: 1045-1054.

16. Gill MS, Castle ME (2003) The effects of the frequency of feeding concentrates on milk production and eating behavior in Ayrshire cows. Animal Production 36: 79-85.

17. Nocek JE, Braund DG (2005) Effect of feeding frequency on diurnal dry matter and water consumption, liquid dilution rate, and milk yield in first lactation. Journal of Dairy Science 68: 2238-2247.

18. DeVries TJ, Von Keyserlingk MAG (2005) Time of feed delivery affects the feeding and lying patterns of dairy cows. Journal of Dairy Science 88: 625-631.

19. Mantysaari P, Khalili H, Sariola J (2006) Effect of feeding frequency of a total mixed ration on the performance of high -yielding dairy cows. Journal of Dairy Science 89: 4312-4320.

20. Hongerholt DD, Muller LD, Buckmaster DR (2007) Evaluation of a mobile computerized grain feeder for lactating cows grazing grass pasture. Journal of Dairy Science 80: 3271-3280.

21. Sawal RK, Kurar CK (2008) Milk Yield and Its Fat Content as Affected by Dietary Factors: A-Review. Asian-Australasian Journal of Animal Sciences 11: 217-233.

22. Ferris CP, Patterson DC, Gordon FJ, Kilpatrick DJ (2003) The effect of concentrate feed level on the response of lactating dairy cows to a constant proportion of fodder beet inclusion in a grass silage-based diet. Grass and Forage Science 58: 17-27.

23. Johnson CL (2009) The effect of level and frequency of concentrate feeding on the performance of dairy cows of different yield potential. Journal of Agricultural Science 92: 143-151.

24. Martz FA, Williams LR. Campbell JR, Sikes JD, Hilderbrand ES (2001) Frequent feeding of a corn silage-urea-concentrate blended ration to lactating dairy cows. Journal of Dairy Science 54: 493-496.

25. Hardie R, Sprecher J, Jorgensen NA, Kohls M (2005) Effects on milk production and feed efficiency by frequent feeding of concentrates. Journal of Dairy Science 6: 161.

26. Dalley D (2008) Synchrony of protein and energy supply during early lactation. Annual Report 1997-1998, Agriculture Victoria, Ellinbenk, Australia, pp: 50-51.

27. King KR, Stockdale CR, Tirgg TE (2009) Influence of high energy supplements containing fatty acidys on the productivity of pasture fed dairy cows. Australian Journal of Experimental Agriculture 30: 11-16.

28. Bines JA (2009) Voluntary food intake. In: Feeding strategy for the high yielding dairy cows, Granada, London, UK, pp: 23-41.