Effects of Low-Moisture Block and Liquid Molasses Supplements on Cattle Grazing Patterns

Final report submitted by:

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Introduction

Protein supplements are used to improve forage digestibility of cows grazing dormant, low-quality forage in the fall and winter. Supplemental protein can be delivered to cows on rangeland in a variety of forms. Rangeland cattle producers often prefer to use self-fed supplements rather than hand-fed supplements such as range cake to reduce labor and travel costs required for placement. Protein supplements can be self-fed using liquid, pressed block, chemical block or low-moisture block delivery systems. Self-fed systems allow cattle to have continuous access to the supplement. Intake of the supplement is controlled by a variety of methods such as chemical agents or the hardness of the product. Low-moisture blocks (LMB) can be used to improve the uniformity of grazing on rugged rangeland (Bailey and Welling 1999, Bailey et al. 2001). Through strategic placement of LMB, cattle can be lured to underutilized areas. Low-moisture blocks can be readily transported to rugged areas using ATV's and trailers because blocks are available in 125 and 250 lb. units. Liquid supplements must be transported to the pasture using a truck and can only be placed in accessible areas (gentle terrain or near roads).

Objective

The objective of this study was to compare the grazing patterns of cows fed low-moisture blocks placed in rugged terrain and liquid supplement placed in accessible terrain.

Methods

Study area. The study was conducted at the Thackeray Ranch, which is part of Northern Agricultural Research Center and is located approximately 17 miles south of Havre, MT. Four pastures (Anderson, Arches, Horse, and Rakes Draw) were used in the study. The Arches pasture is 638 acres of rangeland composed primarily of Kentucky bluegrass, bluebunch wheatgrass and rough fescue. Bullhook Creek flows through the northeast corner of Arches pasture. The Anderson pasture is 815 acres of rangeland composed primarily of Kentucky bluegrass and rough fescue. Bullhook Creek bisects the Anderson pasture. The total standing crop at the beginning of the study was 1471 ± 127 lbs/acre in the Anderson pasture and 1101 ± 87 lbs/acre in the Arches pasture. Standing crop of grass was 1377 ± 136 lbs/acre in the Anderson pasture and 912 ± 107 lbs/acre in the Arches pasture. Standing crop of forbs was 93 ± 29 lbs/acre in the Anderson pasture and 189 ± 32 lbs/acre in the Arches pasture. The Horse (244.6 acres) and Rakes Draw (441.3 acres) pastures are smaller and were used in an earlier supplement study. The Horse and Rakes Draw pastures were fenced with part of the Back Pasture so that there was a perennial stream available for watering in both pastures. The total standing crop at the beginning of the study was 1106 ± 101 lbs/acre in the Horse pasture and 1325 ± 159 lbs/acre in the Rakes Draw pasture. Standing crop of grass was 901 ± 141 lbs/acre in the Horse pasture and 1095 ± 265 lbs/acre in the Rakes Draw pasture. Standing crop of forbs was 205 ± 69 lbs/acre in the Horse pasture and 230 ± 83 lbs/acre in the Rakes Draw pasture. All pastures were grazed from mid October through December 2003. Forty cow-calf pairs grazed the Anderson pasture for 1 week in late May 2003. Forty cow-calf pairs grazed Arches pasture during June 2003. Forage in these pastures was still plentiful and sufficient for the study. Cattle had not grazed the Horse and Rakes Draw pastures in 2003.

Cattle. A total of 144 crossbred cows of Hereford, Tarentaise, Angus, Charolais, Piedmontese and Salers breeding were used in the study. Cows ranged in age from 4 to 10 years. These cows were randomly assigned to either the LMB or liquid supplement treatment and grazed the Anderson and Arches pastures, 72 in each treatment. A total of 84 purebred Hereford cows aged 1 to 10 years were also randomly assigned to either the LMB or liquid supplement treatments and the Horse and Rakes Draw pastures, 42 in each treatment. All cows were exposed to LMB in earlier studies. Cows were weaned on October 1, 2003, and the study did not begin until October 15, 2003. During this interim, cows were allowed to become accustomed to liquid supplement. To our knowledge, cows had not previously been exposed to liquid supplements. Exposure to liquid supplement (training) lasted one week (October 7 to October 14) while the two liquid treatment groups grazed the Hay pasture. During the same time period, LMB treatment groups were also allowed to become accustomed to LMB supplement while grazing the AI pasture.

Cows were weighed and body condition scored (1 emaciated – 9 obese) on October 1, 2003 (at weaning - 2 weeks prior to the study) and on December 18, 2003 (end of the study).

Feed. The LMB block contained 30% CP. Blocks or barrels (250 lbs / barrel) were fed at the rate of 1 barrel for every 20 to 25 cows. Liquid supplement was fed using lick wheel tanks based on the dealer's recommendations. The dealer provided the lick wheel tanks and assisted NARC personnel with tank set up and lick wheel adjustments. NARC personnel consulted the dealer on all aspects of cattle training, maintenance of lick wheel tanks, and control of liquid intake. For the crossbred cattle a lick tank with four wheels was used (2 yards or 2 m diameter). Two smaller barrel shaped tanks placed end-to-end (length = 2 yards or 2 m) were used for the Hereford cows. The liquid supplement was 32% CP (as fed) and was approximately 60% dry matter (DM). For both treatments, supplement availability levels were checked at least 3 times per week to ensure that there were not periods in which supplement was not available. Average intake levels were measured every 2 weeks. White salt blocks (50 lbs) were available for each treatment group.

Feed placement. The LMB was placed in difficult terrain as defined in earlier studies (Bailey and Welling 1999 and Bailey et al. 2001). A placement (3 barrels) remained in the same location for 2 weeks and then changed to a new site within difficult terrain. Barrels were placed in areas that were somewhat protected from the prevailing southwest winds (e.g., coulees, northeastern aspects, near trees and brush).

Liquid supplement was placed in terrain that was accessible for a truck. Accessible terrain includes roads (county and 2-track roads that did not require 4-wheel drive vehicles) and gentle terrain. The goal of the liquid supplement placements was to be located as far from water as possible within accessible terrain. Except for one pasture

(Horse), the liquid supplement was placed along a 2 track road next to a gate leading into the pasture. In the Horse pasture, the only available areas to place liquid supplement were near the working facilities and water. As with LMB, liquid supplement was relocated to another site every 2 weeks. Each movement of supplement was recorded by a handheld GPS receiver (GeoExplorer III) capable of accuracy to within 2 yards (m).

Cattle handling. The study was set up in 4 periods (2 weeks / period). During the first 2 periods, LMB was placed in the Arches pasture and liquid supplement was fed in the Anderson pasture (randomly selected). Cows in the Arches pasture were moved to Anderson after 2 periods (4 weeks) and were still fed LMB. Cows in the Anderson pasture were moved to Arches after 2 periods and were still fed liquid supplement.

Similarly, LMB was fed in the Horse pasture during the first 2 periods and liquid supplement was fed in the Rakes Draw pasture. Cows in the Horse pasture were moved to the Rakes Draw pasture after 2 periods and were still fed LMB. Cows in the Rakes Draw pasture were moved to the Horse pasture after 2 periods and were still fed liquid supplement.

Five to six randomly selected cows from each group of the crossbred herd was tracked using Lotek GPS 2200 collars at 10-minute intervals. Collars remained on selected cows for 2 weeks (1 period). Collars were placed on other randomly selected cows during each period. Three to four randomly selected cows from each group of the purebred Hereford herd were also tracked. During the 8 weeks of the study (4 periods), 56 cows were tracked successfully. Twenty-five percent of the cows used in the study were tracked.

Behavioral measurements obtained from GPS collars. Geographic coordinates obtained from collared cows were differentially corrected so that the accuracy was within 10 m. The elevation, slope, distance to supplement, and minimum distance to water were calculated for each recorded location using an USGS digital elevation model in a geographic information system (ArcView™). Terrain attributes associated with respective locations for each cow were averaged and used in the statistical models. Variables that were calculated were the mean elevation, slope and minimum distance to water. These were further divided into the mean elevation, slope and distance to water during daylight and night hours. The average time spent within 100 m of liquid and LMB were also evaluated. The average distance traveled per day was calculated by summing the distances between successive recorded locations of each cow divided by the number of records obtained per day.

Other behavioral measurements. At least 3 times per period, observers on horseback recorded the locations of cows in each pasture. The purpose was to ensure that the grazing patterns of collared cows were representative of the herds. Throughout each period, timing of observations was coordinated so that locations of cows in the herds were recorded in both the morning and afternoon. Observations were collected during mid morning (10:00 AM) or mid afternoon (1:30 PM).

Vegetative measurements. At the end of two periods (4 weeks), forage utilization measurements were collected in each pasture. Height-weight relationships based on stubble height measurements were used to determine forage utilization. There were 19 and 20 measurements recorded in the Rakes Draw and Horse pastures, respectively. Anderson and Arches had 31 measurements recorded in each pasture. Forage utilization measurements were distributed across the pastures at random locations including sites near water and supplement. The process of randomization was completed by first randomly selecting 100 x 100 m cells within the pasture. Locations of transects within cells were also randomly located.

Statistical analyses. Using collar and horseback observation data, cattle use of rugged topography was evaluated. Use of slopes, distances from water and supplement, and elevations were compared between the LMB and liquid supplement treatments. Dependent variables included average slope use, distance from water, and elevation occupied. Independent variables included pasture and treatment (LMB or liquid). Similar analyses were conducted using forage utilization and stubble height measurements. Grazing time and diurnal grazing patterns were evaluated using the vertical head movement sensor in the collars. The frequency and duration of visits by collared animals to supplement placement sites was evaluated for each treatment. In addition, differences in weight gain and body condition score was compared between treatments. For changes in cow weight and body condition score, the statistical model included age (3, 4, 5 and 6+ years), treatment (LMB and range cake), and cow breed. The residual (variation among cows) was used as the error term.

Economic analyses. Required labor, travel costs, time and other data needed for economic evaluations were recorded and evaluated so that the costs for each treatment could be determined. The objective of this economic analysis was to calculate costs for each treatment (including repairs and simple depreciation for wear and tear on equipment) so that producers can readily compare treatments on an expenditure basis.

Results

Intake. Intakes of supplement and salt were similar ($P>0.10$) in all pastures. Cows consumed more ($P = 0.05$) supplement (LMB and liquid pooled) during the first 2 weeks of the study (period 1 – late October) than during the last 2 weeks of the study (period 4 – mid December). Intake of LMB was lower ($P < 0.001$) than liquid supplement on both an "as fed" and DM basis (Table 1). Intake of salt was similar ($P = 0.39$) for both treatments and averaged 0.91 oz / head /day during the study. Cows consumed more salt ($P = 0.001$) during the last 2 weeks of the study than during the first 2 weeks of the study (Table 1). The treatment by period interaction was not important ($P = 0.10$).

Table 1. Intakes of salt and supplement on both an "as fed" and dry matter (DM) basis.

Variable	Supplement (as fed, lb/head/d)	Supplement (DM, lb/head/d)	Salt (oz/head/d)
Treatment			
LMB	0.64[a]	0.61 [a]	0.95 [a]
Liquid	2.95[b]	1.77 [b]	0.88 [a]
Pooled SE	0.14	0.09	0.06
Period			
1 – October	1.28[x]	0.87 [x]	0.65 [x]
2 – November	1.82[xy]	1.18 [xy]	0.80 [xy]
3 – November	1.80 [xy]	1.18 [xy]	0.82 [xy]
4 - December	2.28[y]	1.55 [y]	1.38 [y]
Pooled SE	0.20	0.13	0.08

Means with different superscript for the same variable differ ($P < 0.05$).

Cow performance. Overall cows lost 23 lbs and 0.86 units of body condition score (BCS) during the study (October 1 to December 18, 2003). Two types of analyses were conducted to determine if there were differences in weight and BCS between treatments. The first approach was much more sensitive for detecting treatment differences. This analysis considers individual animals as the sampling unit. The second approach considered a group of cows as a sampling unit ($n = 4$) and was much more conservative. Using the first approach, cows supplemented with LMB lost less weight ($P < 0.001$) than cows fed liquid supplement (Table 2). Changes in BCS were not affected ($P = 0.89$) by the type of supplement fed (Table 3). Hereford cows (-1 ± 5) lost less weight ($P < 0.001$) than crossbred cows (-36 ± 4). Hereford cows ($- 0.62 \pm 0.07$) also lost less body condition ($P < 0.001$) than crossbred cows (-1.00 ± 0.05). The treatment by breed interaction was not important for changes in weight or BCS ($P > 0.10$).

Using the second approach where the treatment group was considered as a sampling unit ($n = 4$), supplement type did not affect weight change ($P = 0.22$). In addition, weight change was similar ($P = 0.17$) for both Hereford and crossbred cattle.

Table 2. Cow weights, weight changes and average daily gain (ADG) during the study (October 1 to December 18, 2003). All weight values are in pounds and ADG is pounds per head per day. Mean values are presented (± standard errors).

Supplement	Breed	n	Oct wt (lb)	Dec wt	Wt change	ADG
LMB		112	1283 ± 17	1272 ± 17	-12 ± 4	-0.15 ± 0.05
Liquid		112	1290 ± 17	1256 ± 16	-35 ± 4	-0.45 ± 0.05
	Crossbred	142	1392 ±	1356 ± 14	-36 ± 4	-0.47 ± 0.05
	Hereford	82	1104 ±	1103 ± 19	-1 ± 5	-0.01 ± 0.06
LMB	Crossbred	72	1385 ± 20	1357 ± 20	-28 ± 5	-0.36 ± 0.07
LMB	Hereford	40	1100 ± 27	1117 ± 27	18 ± 7	0.22 ± 0.09
Liquid	Crossbred	70	1399 ± 21	1355 ± 20	-45 ± 5	-0.58 ± 0.07
Liquid	Hereford	42	1108 ± 27	1089 ± 26	-18 ± 7	-0.23 ± 0.09

Table 3. Changes in body condition score (BCS) during the study (October 1 to December 18, 2003). All BCS values are based on a 1 (emaciated) to 9 (obese) scale. Mean values are presented (± standard errors).

Supplement	Breed	n	Oct BCS	Dec BCS	BCS change
LMB		112	6.02 ± 0.07	5.15 ± 0.07	-.87 ± 0.06
Liquid		113	6.08 ± 0.07	5.22 ± 0.07	-.85 ± 0.06
	Crossbred	143	6.12 ± 0.06	5.12 ± 0.06	-1.00 ± 0.05
	Hereford	82	5.93 ± 0.08	5.31 ± 0.08	-0.62 ± 0.07
LMB	Crossbred	72	6.11 ± 0.08	5.10 ± 0.09	-1.01 ± 0.07
LMB	Hereford	40	5.86 ± 0.11	5.24 ± 0.12	-0.63 ± 0.10
Liquid	Crossbred	70	6.13 ± 0.08	5.13 ± 0.09	-1.00 ± 0.07
Liquid	Hereford	42	5.99 ± 0.11	5.38 ± 0.12	-0.61 ± 0.10

Visits to supplement. Low-moisture blocks (LMB) were placed in higher elevations in all pastures (Table 4). In three of the four study pastures, LMB was placed on steeper slopes. Liquid supplement was placed on steeper slopes in the Horse pasture. The higher elevations in the Horse pasture had relatively gentle slopes. Liquid supplement was placed in areas further from water than LMB in three of the four study pastures (Anderson, Arches, and Rakes Draw). Low-moisture blocks were placed further from water than liquid supplement in the Horse pasture (Table 4).

Cows supplemented with LMB spent more time ($P = 0.03$) visiting the supplement (within 10 yards of LMB and within 13 yards of the center of liquid tank) than cows fed liquid supplement (Table 5). Much of the difference in time spent visiting supplement appears to be during the night (Figure 1). Crossbred and Hereford cows spent similar amounts of time ($P = 0.29$) visiting supplement placements sites (LMB and liquid pooled). Time spent near supplements did not change during the study. Time visiting supplement was similar (P = 0.36) during the four 2-week periods.

Cows spent similar amounts of time (P = 0.58) within 100 yards of LMB and liquid supplement. Time spent within 100 yards of LMB and liquid supplement was similar during the day and night (P > 0.20). Total and active time spent within 400 and 600 yards of LMB and liquid supplement was also similar (Appendix 1). Crossbred and Hereford cows spent similar amounts of time (P = 0.20) within 100 yards of supplement placement sites (Table 5). The time that cows spent within 100 yards of supplement placement sites changed (P = 0.02) during the study. Cows spent about two times longer during the first two periods (2.7 and 2.8 hours, respectively) than during the next two periods (5.1 and 6.1, respectively).

Table 4. Mean terrain attributes of supplement placement sites during the study. Values are averaged by treatment within pasture.

Pasture	Treatment	Period	Elevation, ft	Distance to water, yards	Slope, degrees
Anderson	Liquid	1, 2	3725	835	5.9
	LMB	3, 4	3896	434	12.3
Arches	LMB	1, 2	4051	1112	10.0
	Liquid	3, 4	3962	1208	6.5
Horse	LMB	1, 2	4239	548	7.7
	Liquid	3, 4	4168	502	13.8
Rakes Draw	Liquid	1, 2	3988	698	7.2
	LMB	3, 4	4086	554	11.0

Table 5. Mean differences in time spent visiting supplement and time spent within 100 yards (m) of supplement placement sites. Analyses are based on the averages of GPS collared cows within a pasture during each 2-week period.

Variable	n	Visits to supplement (within 10 yards[1]), minutes / day	Time within 100 yards of supplement, minutes / day
LMB	8	68[a]	238
Liquid	8	46[b]	262
Pooled SE		6	30
Crossbred	8	52	279
Hereford	8	62	221
Pooled SE		6	30

[a,b] Variables with different superscripts differ (P < 0.05).
[1] Visits to LMB were defined as a GPS collared cow within 10 yards of LMB or within 13 yards of the center of the liquid supplement tank.

All 28 collared cows fed LMB visited supplement sites. The minimum average time spent by a collared cow within 10 yards of LMB was 14 minutes per day. One of the 28 collared cows fed liquid supplement was not observed within 13 yards of the center of the lick tank. Two of the 28 collared cows were only observed once within 13 yards of the center of the lick tank (less than 1 minute per day on average).

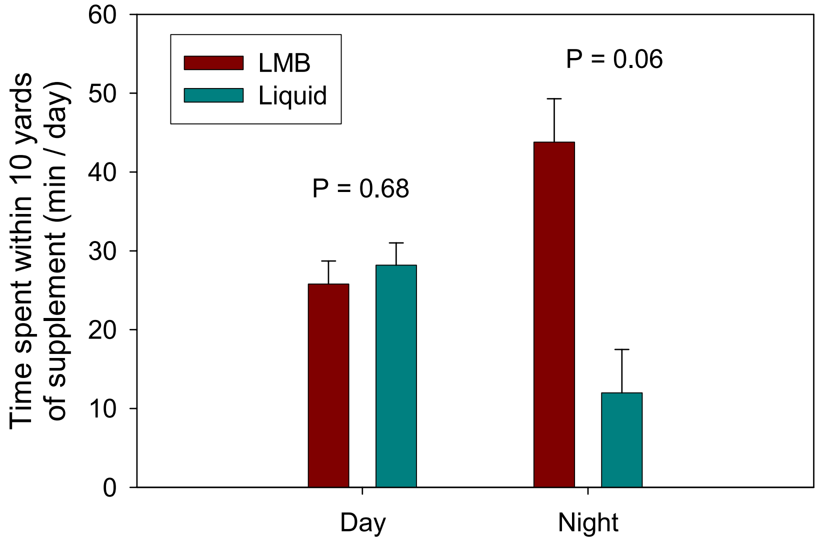

Figure 1. Time spent visiting low moisture block (LMB) and liquid supplement sites during the day and night.

The time spent within 10 yards of supplement was greater (P = 0.005) for cows fed LMB than those fed liquid (Table 6). There were no differences (P > 0.10) between treatments in time spent near water and salt.

Table 6. Time spent near water and attributes of visits (within 10 yards) to supplement and salt.

Variable	LMB	Liquid	Pooled SE	P-value
Time / visit, min	42.3	19.9	4.2	0.005
Visits / day	1.82	2.18	0.20	0.25
Percent of days supplement was visited	56.0	77.1	6.8	0.06
Visits / day if non-visited days are excluded	3.27	2.83	0.14	0.06
Time visiting salt, min/d	13.0	15.8	5.2	0.71
Time spent within 50 yards of water, min/d	76.0	66.2	11.0	0.55
Time spent within 100 yards of water, min/d	108.8	87.5	11.8	0.24

Two of the 28 collared cows fed LMB were not observed within 10 yards of white salt blocks. Similarly 2 of the 28 collared cows fed liquid supplement were not observed within 10 yards of white salt blocks.

Terrain use. The average distance that collared cows were from supplement placement sites was similar (P = 0.22) for the LMB and liquid supplements (Table 6). Hereford cows were closer (P = 0.001) on average to supplement placement sites than the crossbred cows. The distances that collared cows were from supplement placement sites tended to vary between pastures (P = 0.07), but did not change among 2-week periods (P = 0.50).

The minimum distance that collared cows were from water on a 24 hour basis was not affected (P = 0.83) by supplement type (LMB vs. liquid). Hereford cows in the Horse and Rakes Draw pastures were closer to water than the crossbred cows in the Anderson and Arches pastures. The average distance from water varied between pastures (P = 0.003) but not between 2-week periods.

The average elevation that collared cows occupied was similar (P = 0.82) for the LMB and liquid supplement treatments. Cows in the Horse and Rakes Draw pastures used higher elevations than cows in the Anderson and Arches pastures (P < 0.001). The mean elevation of the Horse and Rakes Draw pastures as a whole are 4144 and 3996 feet. The mean elevation of the Anderson and Arches pastures are 3720 and 3990. The mean elevation of collared cows was similar during the four periods of the study (P = 0.33).

Slope use was similar (P = 0.99) for collared cows fed LMB and liquid supplements (Table 7). Hereford and crossbred cows did not vary in their use of slopes (P = 0.14). Slope use was similar among pastures (P = 0.86) and did not vary among periods within the study (P = 0.43).

Collared cows fed LMB and liquid supplement traveled similar (P = 0.29) distances each day. Distances traveled were similar for Hereford and crossbred cows (P = 0.56). Cows traveled an average of 2.8 miles per day during the study. During the first 2-week period (late October) cows traveled further than the other three periods (P = 0.01).

A terrain index that combined slope, vertical distance to water and horizontal distance to water suggested that cows fed LMB used rougher terrain (P = 0.08) than cows fed liquid supplement (Appendix 2). The terrain index value for cows fed LMB was 56.4 while the value for cows fed liquid supplement was 65.4. Lower index values indicate rougher or more difficult terrain.

Table 7. Terrain use by collared cows fed low moisture blocks (LMB) and liquid supplements. Values represent the average distance from water and supplement, elevation, and slope of locations of collared cows (recorded every 10 minutes during 2-week periods). Distance traveled is based on the distance between successive recorded locations of collared cows. Analyses and means are based on the average values of all collared cows in a pasture during a period. There were no important differences between the LMB and liquid supplement treatments (P > 0.10).

Terrain attribute	LMB	Liquid	Pooled SE
Distance to supplement, yards	661	552	57
Distance to water, yards	618	608	31
Elevation, feet	3927	3924	9
Slope, degrees	8.27	8.28	0.42
Travel, miles / day	2.68	2.85	0.11

Terrain use – horseback observations. When cattle locations were recorded by horseback observers, terrain use by cows fed LMB and liquid supplements were similar (Table 8). Cows in the LMB and liquid supplement treatment groups were observed at similar distances from water (0.78). The mean elevation of observed cow locations in the LMB treatment was similar (P = 0.60) to the liquid supplement treatment. Observed slope use was also similar between treatments (P = 0.28).

Table 8. Mean terrain use of cows observed by horseback observers during the morning and afternoon.

Terrain attribute	LMB	Liquid
Distance to water, yards	484 ± 47	516 ± 50
Elevation, feet	3945 ± 17	3909 ± 17
Slope, degrees	8.54 ± 0.88	10.18 ± 0.92

Forage utilization. Forage utilization data collected at the end of periods 2 and 4 did not indicate that there were any differences between supplement treatments (LMB vs. liquid) associated with uniformity of grazing with respect to elevation and slope (Table 9). The treatment by elevation (P = 0.86) and treatment by slope (P = 0.79) interaction components of the analyses were not important. The treatment by horizontal distance from water interaction was important (P = 0.05). The least squares coefficient for the LMB treatment was negative (-0.0184), which suggests that the forage use by cows fed LMB was less uniform than cows fed liquid supplement with respect to distance from water. However, the relationship between forage utilization and distance from water was not important for either the LMB (P = 0.19) or liquid (P = 0.14) supplements when data from each treatment was analyzed separately.

To evaluate if grazing use at higher elevations differed between treatments, changes in forage utilization were compared in the highest 25% of the locations measured within each pasture. Changes in forage utilization in these high locations were similar (P = 0.31) for the LMB (9.9 ± 3.0%) and liquid (4.2 ± 2.9%) supplement treatments.

Table 9. Variables used for analyzing changes in forage utilization. Coefficients and standard errors (SE) from the least-squares analyses are presented for the continuous variables.

Variable	P-value	Coefficient	SE
Treatment (LMB vs liquid)	0.92	--	--
Pasture	0.30	--	--
Treatment x pasture interaction	0.001	--	--
Distance to water	0.11	0.010	0.007
Elevation	0.76	-0.005	0.016
Slope	0.65	-0.120	0.262
Distance to water x treatment interaction	0.05		
LMB		-0.0184	0.009
Liquid		0.0	
Elevation x treatment interaction	0.86		
LMB		0.004	0.022
Liquid		0.0	
Slope x treatment interaction	0.79		
LMB		-0.096	0.370
Liquid		0.0	

Activity. Scan samples of cattle activity obtained by horseback observers found that activities differed (P < 0.001) between supplement type treatments for both the crossbred and Hereford cows (Figure 2). During the periods of observation (late morning and early afternoon), more of the cows fed LMB were grazing than would be expected and fewer cows fed liquid supplement were grazing than would be expected. Fewer cows fed LMB were observed at water than cows fed liquid supplement.

Activity of collared cows were similar between treatments (P = 0.73) on a 24-hour basis. Collared cows fed LMB were active 51.6 ± 1.7% of the time, while cows fed liquid supplement were active 50.5 ± 1.7% of the time.

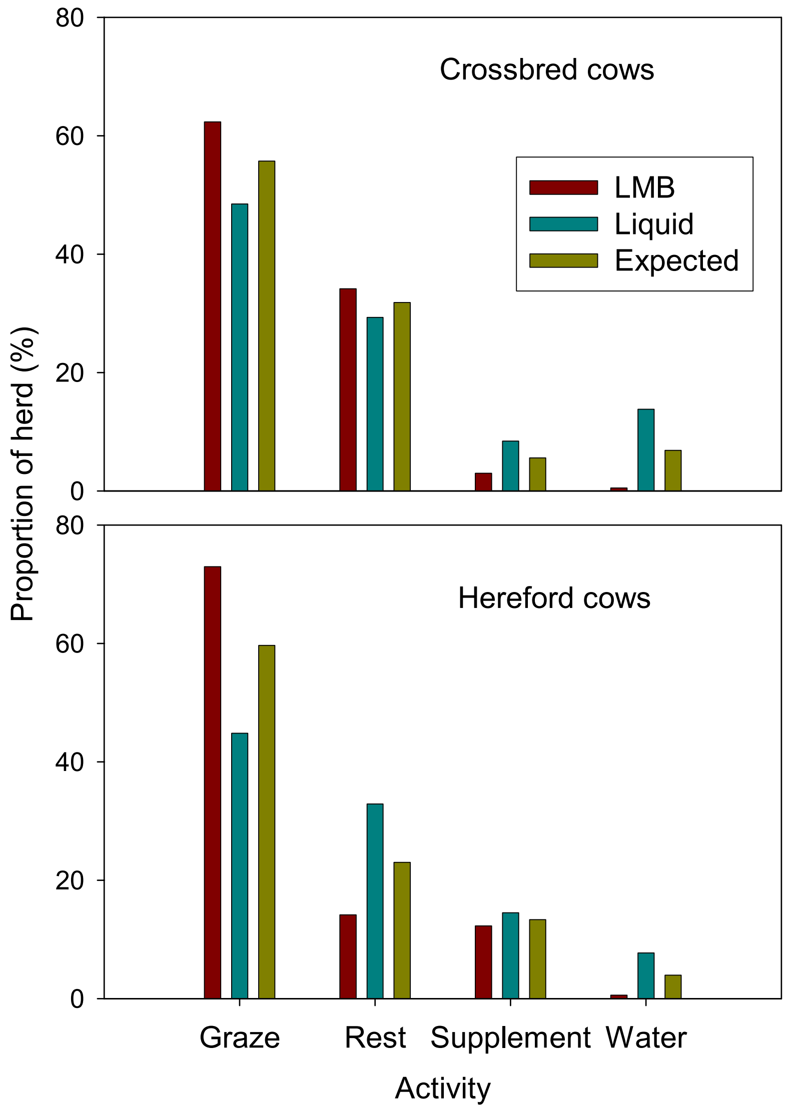

Figure 2. Proportion of cows observed grazing, resting, near supplement, and near water. Proportions are presented for the low-moisture block and liquid supplement treatments. Separate graphs are presented for the crossbred and Hereford cows. Expected values were calculated from the chi-square analyses of the count data. Observations differed from expected values ($P < 0.001$) for both the crossbred and Hereford cows (replications).

Economic analyses. The cost to feed LMB was \$0.28 per head per day (Appendix 3). The cost to feed the liquid supplement was \$0.55 per head per day. The total cost for supplement (excluding travel, labor and lick tank rental) was \$1,189.40 for LMB and \$2,806.92 for liquid supplement during the 56-day study period. Additional costs for travel and labor were only slightly higher for the liquid supplement.

Discussion

Intake and performance. Intake of low-moisture blocks (0.64 lbs / head / day) was similar to that observed in previous studies conducted from 1997 to 2002 at Northern Agriculture Research Center. Cows fed liquid supplement consumed more than cows fed low-moisture blocks (LMB) on both an as fed and dry matter basis. Liquid supplement contains approximately 40% moisture, while LMB contains 2 to 5% moisture. The manufacturer of the liquid supplement recommends that cows consume 1 lb per head per day. The dealer expected an intake of 2 lbs / head / day of liquid supplement using lick tanks. Cows in this study consumed almost 3 lbs of liquid supplement per day.

Cows fed LMB performed at least as well, if not better, than cows fed liquid supplement even though intake of LMB was one third of the intake of the liquid supplement on a dry matter basis. If individual animals are considered as the sampling unit, the performance of cows supplemented with LMB lost less weight than cows supplemented with the liquid product. However, performance could have been affected by pasture conditions, which could confound the analyses. We attempted to control for this variability by switching pastures midway through the study. If a more conservative test is used that compares the average weight loss within a pasture (n = 4), treatment differences in weight changes are not statistically significant. In any case, cows supplemented with LMB performed as well, if not better, than cows supplemented with a liquid product that cost about two times as much on a per head basis.

Visits to supplement. Cows fed LMB spent more time near barrels (within 10 yards) than cows fed liquid supplement (within 13 yards of the center of the lick tank). Most of the additional time spent near supplement by cows fed LMB occurred at night. This may be important because most grazing occurs during daylight hours. The additional time spent near LMB should not have affected grazing time.

In contrast to previous studies, all collared cows (28 of 28) fed LMB visited supplement sites. In earlier studies, 10 to 15% of the collared cows did not visit LMB. The time spent near LMB by the collared cows (at least 14 minutes per day) indicates that all collared cows consumed supplement. In contrast, three of the 28 collared cows spent virtually no time near the lick tanks. Two of these three cows were only observed once (1 out of over 1500 locations) near the lick tanks and the other cows were never observed near the tank.

Cows spent about 4 hours per day within 100 yards of LMB and liquid supplement placement sites, which is similar to the values observed for LMB in the fall 2002 study (Bailey et al. 2004). There were no differences among treatments. The similarity in time spent within 100, 400 and 600 yards of LMB and liquid supplement suggests that these two types of molasses-based, self-fed supplements were equally attractive to cattle.

Terrain use. Low-moisture blocks were easier to transport to high and steep terrain than the liquid supplement. Low-moisture blocks could be transported with an

ATV (4-wheeler) and a trailer. A ¾ or 1-ton truck was required to move the lick wheel tanks and fill them with supplement. Low-moisture blocks were placed in some of the highest elevations in the pasture that typically received little use. Several of these locations were relatively close to water locations. In contrast, liquid supplement was placed in areas far from water that were relatively easy to travel to because they were near existing roads. We expected that differences between treatments in terrain use would have been most apparent for elevation. Placement sites for LMB were at least 70 feet higher in elevation than liquid supplement placement sites on average. Placement sites for LMB were closer to water than for the liquid supplement.

Detection of differences in terrain use between treatments was difficult. Observations by horseback observers were not sufficiently detailed to detect differences in terrain use between treatments. In addition, differences in terrain attributes between LMB and liquid supplement placement sites apparently was not sufficient to result in differences in use by collared cows based on individual indicators of topographical and spatial constraints (i.e., slope, elevation, and distance to water). Collared cows in both treatments used areas that were similar distances from water even though LMB was placed closer to water. Cows used areas that were similar in elevation even though LMB was placed at higher elevations. On a 24-hour basis averaged over the entire study, cows in both treatments were 607 yards from supplement and 613 yards from water. These values are greater than pasture averages in three of the four study pastures (Table 10). Average use of slopes (8.3 degrees) by collared cows (both treatments pooled) was less than pasture averages. The average elevation of areas occupied by collared cows was less than the average available in all pastures. However, when attributes of slope, vertical distance to water and horizontal distance to water were combined in an index, cows fed LMB appeared to use more difficult terrain than cows fed liquid supplement.

Table 10. Pasture average terrain attributes. Pasture averages are based on the attributes (distance to water, elevation, and slope) of all possible 9 x 9 yard grid cells within a pasture.

Pasture	Distance to water, yards	Elevation, feet	Slope, degrees
Anderson	716	3720	8.8
Arches	531	3990	10.5
Horse	399	4144	11.3
Rakes Draw	467	3996	12.5

Supplements apparently worked similarly for the crossbred and Hereford cows. Differences between crossbred and Hereford cows were due to differences in terrain in the corresponding pastures.

Analyses of forage utilization measurements suggested that cows fed liquid supplement used pasture more uniformly with respect to distance to water. However, subsequent analyses of forage utilization data did not corroborate this conclusion. There were no statistically significant relationships between forage utilization and distance to water when data from the two treatments were analyzed independently. Changes in forage use in the higher elevations were similar between treatments.

Activity. Scan samples of cattle activity by horseback observers suggested that cows fed liquid supplement grazed less and spent more time near water than cows fed LMB. However, data collected by GPS collars does not corroborate these observations. Cows in both treatments were observed at similar distances from water on a 24-hour basis. If cows fed liquid spent more time near water, the distance from water would be expected to differ between treatments. Motion sensors in the GPS collars also did not indicate any differences in activity between treatments.

Conclusions and Implications

Molasses-based supplements that are self-fed can be used to lure animals to graze areas that typically receive little use. Previous research comparing hand-fed and self-fed supplements demonstrated that cattle will spend more time in areas where self-fed supplements are placed. In this study, terrain use of dry cows fed low-moisture blocks and liquid supplements in lick-wheel tanks was similar. Cows spent similar amounts of time within 100 yards of both supplement types. Both types of supplement worked well as an attractant for dry cows during the fall.

The major differences between low-moisture blocks and liquid supplements were cost and ease of transport. Weight changes of cows fed low-moisture blocks were at least equivalent to, if not more favorable than, weight changes of cows fed liquid supplement, even though the daily intake of the liquid product on a dry basis was about three times higher than for low-moisture blocks. The cost of providing liquid supplement to cows was about two times higher than the cost of supplementing with low-moisture blocks. Low-moisture blocks can be transported to rough topography using ATV's while the only practical method of transporting liquid supplement is trucks, which limits access to many areas in rugged rangeland.

Literature Cited

Bailey, D.W. and G.R. Welling. 1999. Modification of cattle grazing distribution with dehydrated molasses supplement. J. Range Manage 52:575-582.

Bailey, D.W., G.R. Welling and E.T. Miller. 2001. Cattle use of foothills rangeland near dehydrated molasses supplement. J. Range Manage. 54:338-347.

Bailey, D.W., D. Jensen, and H. VanWagoner. 2004. Effects of self-fed and hand-fed protein supplements on cattle grazing patterns: low-moisture blocks vs. range cake. Abstr., Soc. Range Manage., Salt Lake City, UT.

Time Table

Week	Monday	Tuesday	Wednesday	Thursday	Friday
Sept 29 – Oct 3				Wean calves	
Oct 6 - 10	Separate groups. Preliminary training – LMB and liquid supplements out.				
Oct 13 - 17	Preliminary training cont'd. Obtain initial forage abundance (standing crop)		Collar cows. Place cows in pastures		
Oct 20-24	Horseback observations		Horseback observations		Horseback observations
Oct 27 – 31		Retrieve collars	Move supplement	Collar cows	
Nov 3 – 7	Horseback observations		Horseback observations		Horseback observations
Nov 10 - 14			Retrieve collars	Retrieve collars	Collect vegetative data
Nov 17 - 21	Put on collars and move cows to other pasture		Collect vegetative data, move supplement		Horseback observations
Nov 24 – 28	Horseback observations		Horseback observations	Thanksgiving	
Dec 1 - 5	Retrieve collars	Retrieve collars	Move supplement	Collar cows	Collars cows
Dec 8 – 12	Horseback observations		Horseback observations		Horseback observations
Dec 15 – 19			Retrieve collars and weigh cows	Retrieve collars and weigh cows	Vegetative measurements
Dec 22 – 26	Vegetative measurements				

Supplement Locations

Period	Anderson	Arches	Horse	Rakes Draw
Oct 15 to 29	Liquid west C10	LMB west F11	LMB east by upper gate to Rakes	Liquid west 1B blue
Oct 30 to Nov 17	Liquid east X10	LMB east N19	LMB west near upper corrals	Liquid east 4D green
Nov 19 to Dec 3	LMB east U15	Liquid west E7	Liquid east by blue tank	LMB west 3A orange
Dec 4 to Dec 22	LMB west K18	Liquid east S13	Liquid west S of wood tank	LMB east 8D yellow

Appendix 1. Total and active time spent within 100, 400 and 600 yards of low-moisture block (LMB) and liquid supplement.

Variable	LMB	Liquid	Pooled SE	P-value
Total time within 100 yards of supplement, min/d	238	260	29	0.61
Total time within 400 yards of supplement, min/d	574	667	73	0.40
Total time within 600 yards of supplement, min/d	710	876	81	0.19
Active time within 100 yards of supplement, min/d	122	122	12	0.98
Active time within 400 yards of supplement, min/d	276	333	32	0.25
Active time within 600 yards of supplement, min/d	351	445	36	0.10
Visits to supplement, total time, min/d	69	45	5	0.01
Visits to supplement, active time, min/d	43	32	4	0.09

Visits were based on within 10 yards for LMB and within 13.5 yards for liquid supplement lick tanks to account for differences in shape between feeding apparatuses.

Appendix 2. Terrain use of cows fed low-moisture block (LMB) and liquid supplements.

Variable	LMB	Liquid	Pooled SE	P-value
Index of terrain use based on total time	56.4	65.4	3.2	0.08
Index of terrain use based on active time only	55.7	63.8	2.9	0.08
Slope, degrees	8.27	8.28	0.42	0.99
Elevation, m	1197	1196	3	0.82
Horizontal distance to water, m	618	608	31	0.83

Index (total and active time) ranges from 0 to 100. A value of 100 indicates easy terrain with gentle slopes less than 4.5 degrees, vertical distance to water less than 35 m (100 ft), and horizontal distance to water less than 1600 m (1 mile). A value of zero represents terrain that is basically considered unusable for cattle grazing based on the literature. A value of zero can occur if slopes are greater than 27 degrees, vertical distance to water is greater than 80 m (262 ft), or horizontal distance to water is greater than 3200 m (2 miles).

The index is based on:

Holechek, J.L., R.D. Pieper, and C.H. Herbel. 2001. Range management principles and practices, 4th Ed. Prentice Hall, Upper Saddle River, NJ.

Roath, L.R. and W.C. Krueger. 1982. Cattle grazing and behavior on a forested range. J. Range Manage 35:332-338.

Appendix 3 - Economic Analyses Worksheet

LMB - Low-moisture blocks

Crude protein concentration (as fed) – 30%
Study length – 56 days
Number of cows – 114
Cost - $ 578 / ton

Labor - $ 10 / hour to place LMB barrels and check cattle. Five hours per trip to place barrels, replace empty barrels and check cattle. A total of 9 trips were required.

Travel – $0.36 per mile at 55 miles per trip.

Total costs:

LMB supplement – 4116 lbs	$1,189.40
Travel – 495 miles	$ 178.20
Labor – 45 hours	$ 450.00
Total	$ 1817.60

Cost per head per day - $ 0.28

Liquid supplement

Crude protein concentration (as fed) – 32%
Study length – 56 days
Number of cows – 114
Cost - $ 300 / ton

Labor - $ 10 / hour to move lick tanks and check cattle. Five hours per trip to refill tanks and check cattle. A total of 10 trips were required.

Travel – $0.36 per mile at 55 miles per trip.

Total costs:

Liquid supplement – 18,713 lbs	$2,806.92
Travel – 550 miles	$ 198.00
Labor – 50 hours	$ 500.00
Rental for lick tanks	$ 50.00
Total	$3,554.92

Cost per head per day - $ 0.55