Comparison of Low-Moisture Block and Conventional Dry Mineral Systems for Delivering Mineral to Cattle Fed Low-Moisture Block Protein Supplements

Final Report

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Introduction

Low-moisture molasses blocks (LMB) are self-fed supplements that can be used provide protein, mineral and other nutrients to livestock. These highly palatable supplements can be used to lure cattle to graze underutilized rangeland (Bailey and Welling, 1999; Bailey et al. 2001). Low-moisture molasses blocks were more attractive than conventional dry mineral mixes (CDM) for luring cattle to graze underused areas within a pasture (Bailey and Welling 2002). In addition, individual variation in visits to LDM by cows was less than for CDM.

Some LMB products designed for supplementing protein have lower concentrations of mineral than other products. Manufacturers have recommended feeding a CDM along with these products to provide higher levels of minerals on rangeland and pasture. Certain LMB products are designed to provide supplemental minerals rather than protein and could be used as an alternative to CDM. The objective of this study was to compare intake and variability of visits to a low-moisture molasses mineral block (LMB-M) and a CDM with cattle supplemented with a low-moisture molasses protein supplement (LMB-P).

Methods

Study sites. The study was conducted at 2 locations, Thackeray Ranch and Northern Agricultural Research Center. The Thackeray Ranch is located in foothill rangeland about 17 miles south of Havre, MT. Northern Agricultural Research Center is located 7 miles southwest of Havre, MT on shortgrass prairie. Cattle were fed supplement and observed in 2 pastures at the Thackeray Ranch, Arches and Anderson pastures. 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 Arches pasture was grazed from October 5 to October 31, 2001. Measurements and observations were collected from October 5 to October 23, 2001. The Anderson pasture is 815 acres of rangeland composed primarily of Kentucky bluegrass and rough fescue. Bullhook Creek bisects the Anderson pasture. The Anderson pasture was grazed from November 1 to December 18, 2001. Measurements were collected from November 1 to December 6, 2001. At Northern Agricultural Research Center (NARC), the Upper Creek pasture is 239 acres. Beaver Creek bisects the pasture. Vegetation in the pasture was heavily grazed prior to the study. Cattle received virtually all of their forage from grass and grass/alfalfa hay (approximately 20 lbs / head / day). Observations and measurements were collected from January 7 to March 13, 2002.

Cattle. A total of 172 non-lactating crossbred cows grazed Arches pasture. In the Anderson pasture, a total of 162 cows were used. (Ten of the open cows that were used in Arches were sold). In the Upper Creek pasture, 154 cows were observed for the first 4 weeks (January 7 to February 18, 2002). For the last 2-week period, only 107 cows were observed. Forty-seven cows were moved to a different pasture at NARC because they were due to calve. Cows used in the Upper Creek pasture had grazed earlier at the

Thackeray Ranch. Cows varied in age from 3 to 9 years and were of Hereford, Tarentaise, Angus, Charolais, Piedmontese and Salers breeding.

Supplement. Throughout the study, cows were provided a LMB-P with 27% crude protein at a rate of 1 barrel (250 lb.) for every 20 to 25 cows. The LMB-P was placed in a rectangular pattern with the barrels placed about 50 to 80 yards apart (Fig. 1). Four white salt blocks (50 lb.) were available through out the study. For the LMB-M and CDM, barrels or CDM feeders (open tub made from a tire) were placed at a rate of 1 for every 75 cows. The LMB-M barrels used at the Thackeray Ranch were 125 lbs., and 250 lbs barrels were used at NARC. The CDM feeders held 50 to 100 lbs of product. Nutrient analyses and ingredients used in the LMB-M and CDM are available upon request.

The study was divided into 2-week periods. At the Thackeray Ranch there were 3 periods (1 in Arches and 2 in Anderson), and at NARC there were 3 periods in Upper Creek pasture. Within a period, LMB-M was available for 1 week and CDM was available for the other week. All supplements were replaced every 2 weeks.

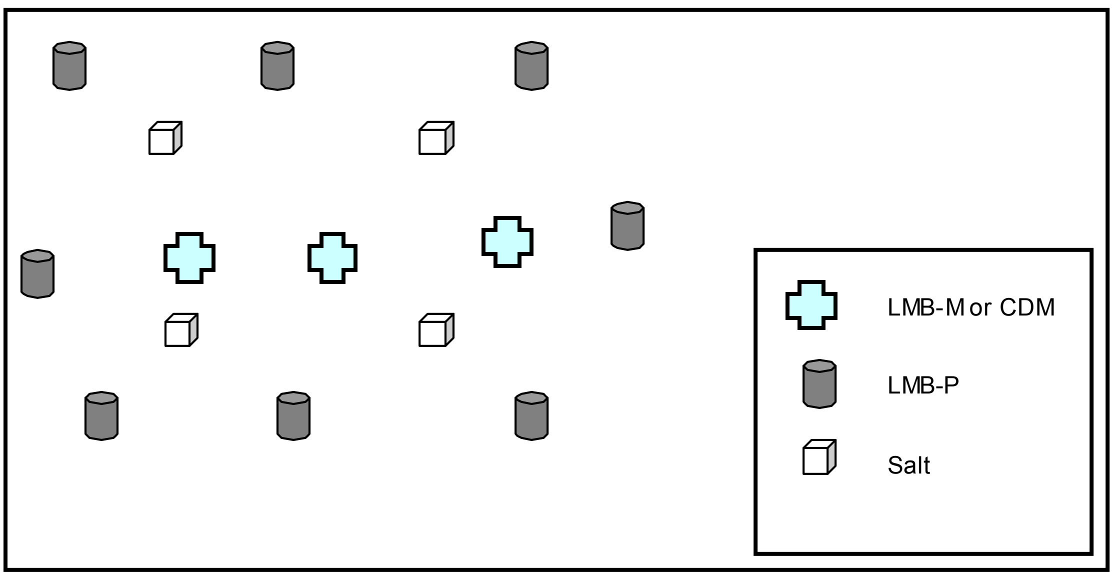

Figure 1. Diagram of supplement placement of LMB-P, salt and LMB-M or CDM. LMB-M was available for 1 week and CDM was available for the other week at the same location during a 2-week period.

Intake. Disappearance of LMB-P, LMB-M and CDM was measured every week and disappearance of white salt was measured every 2 weeks. Average individual daily intake was calculated by dividing the disappearance of supplement by the product of number of cows in the pasture and the number of days between measurements.

Visits to supplement. Seven to 14 randomly-selected cows were tracked over a 2-week period using Lotek GPS 2200 collars. These collars can record the geographical position with an accuracy within 7 to 10 yards (Moen et al. 1997). At the Thackeray

Ranch, cow locations were recorded every 15 minutes for days 1 and 2 of a period and then every 5 minutes for days 3 to 7. The LMB-M or CDM was exchanged on day 8. On days 8 and 9, cow locations were recorded every 15 minutes. On days 10 to 14, cow locations were recorded every 5 minutes. At NARC, cow locations were recorded every 5 minutes on days 1 to 14. A total of 50 cows were tracked during the study (20 cows at the Thackeray Ranch and 30 cows at NARC). During period 3 (Anderson pasture), 9 of 11 collars failed.

A **visit** was defined as a cow location within 10 meters (yards) of supplement (LMB-P, LMB-M, CDM or salt). Visits were further categorized into total time (every fix within 10 m of a supplement was multiplied by 5 minutes) and into active time (total time minus resting time). Vertical movement sensors in the collars were used to identify fixes when the animal was not active or resting. If there were less than 25 vertical head movements per minute the cow was considered resting. Previous observations with this equipment and cows (Bailey et al. submitted to Appl. Anim. Behav. Sci., May 2002) found that this criteria agreed with vibracorder and visual observations on at least 90% of the comparisons. The following dependent variables were calculated from tracking data. Percentage of days that collared animals visited supplement, percentage of days that collared animal visited supplement based on active time, total time near supplement (within 10 m) per day and active time near supplement per day (time animal was within 10 m of supplement and was not resting).

Fecal loading. A total of 68 sample plots were established at the Thackeray Ranch in the Arches and Anderson pastures. Plots were 1 x 40 meters in size. Prior to the study all fecal pats were removed from the plots. Stubble height and associated forage utilization levels were determined at the beginning and end of each 2-week period using height-weight relationships. At the end of each period, the abundance of feces (lbs. / acre on a air dry basis) was determined using the procedures of Tate et al. (2000).

Statistical Analyses. For evaluating intake, 2 statistical models were used. For comparing intake of LMB-P, the model initially included site (Thackeray Ranch or NARC), period (1 to 6), treatment (LMB-M or CDM) and the treatment by site interaction. The interaction was not important ($P = 0.6$) and was dropped from the model. For the intake of LMB-M, CDM and salt, the model only included site.

For evaluating time at supplement (total and active) and the percentage of days that animals visited supplement, the statistical model included treatment (LMB-M or CDM), site (Thackeray Ranch or NARC), site by treatment interaction, period, cow, and the cow by treatment interaction. Time at supplement and the percentage of days that animals visited supplement are repeated measures. Cow was used to test for difference among sites, and the cow by treatment interaction was used to test for differences between treatments and to test the treatment by type interaction.

To compare the number of users and non-users of LMB-M and CDM, a 2 x 2 chi-square test was used. User versus non-user and LMB-M versus CDM were used in the table. A sign test was also used to compare user versus non-users of LMB-M and CDM.

Cow was used for pairing. Animals that used both LMB-M and CDM or that did not use LMB-M or use CDM were considered ties and removed from the analyses.

For the fecal loading portion of the study, simple correlations were calculated between forage utilization, number of fecal pats, and dry weight of feces (lbs/acre) within the plot. A statistical model that included period (1 to 3), distance to water, distance to supplement and slope was used to analyze the number of fecal pats, abundance of feces and forage utilization for each plot. A second model that included period, distance to water, distance to supplement, slope, location type (protected or unprotected, in other words in or out of a coulee), interaction between location type and distance to water and the interaction between location type and distance to supplement.

Results

Intake. Average daily intake of LMB-P was greater ($P = 0.045$) at NARC than at the Thackeray Ranch (Table 1). Intake of LMB-P was lower ($P = 0.017$) when LDM-M was available than when CDM was available (Table 2).

Average daily intake of LMB-M was similar ($P = 0.66$) at the Thackeray Ranch and NARC (Table 1). However, intake of CDM was lower ($P = 0.006$) at the Thackeray Ranch than at NARC. Intake of salt was similar ($P = 0.38$) at both sites.

Table 1. Average daily intake of low moisture molasses protein supplement (LMB-P), low moisture molasses mineral supplement (LMB-M), conventional dry mineral mix (CDM) and salt at the Thackeray Ranch and NARC sites.

	Thackeray Ranch	NARC – Upper Creek
Supplement Type	lb. / head / day	lb. / head / day
LMB-P / LMB protein (lb/hd/d)	0.54 ± 0.03	0.65 ± 0.03
LMB-M / LMB mineral (lb/hd/d)	0.24 ± 0.02	0.25 ± 0.02
CDM / conventional dry mineral (oz/hd/d)	1.17 ± 0.25	3.04 ± 0.25
White salt (oz/hd/d)	0.50 ± 0.14	0.70 ± 0.14

If font colors within a row are not the same, treatment means differ ($P \leq 0.05$)

Table 2. Average daily intake of the low-moisture molasses protein supplement (LMB-P) in the presence of the low-moisture molasses mineral supplement (LMB-M) and the conventional dry mineral mix (CDM).

LMB-P protein supplement	LMB-M available	CDM available
Intake (lb/hd/d)	0.52 ± 0.03	0.67 ± 0.03

If font colors within a row are not the same, treatment means differ ($P \leq 0.05$)

Visits – Total Time. The percentage of days that cows visited LMB-P was lower (P = 0.03) at the Thackeray Ranch than at NARC (Table 3). Cows spent similar (P = 0.2) amounts of time at LMB-P when they were at the Thackeray Ranch as compared to NARC.

Cows spent a smaller (P = 0.04) percentage of days at supplemental mineral locations (LMB-M and CDM pooled) when they were grazing at the Thackeray Ranch than when they were at NARC. Cows spent similar amounts of time (P = 0.18) at supplemental mineral locations at both sites. The percentage of days that cows were observed near salt was less (P = 0.04) at the Thackeray Ranch than NARC, but the time spent near salt was similar (P = 0.3) at both sites (Table 3).

The percentage of days that cows visited LMB-P was similar among treatments (P = 0.3). Cows spent less time (P = 0.005) at LMB-P when LMB-M was available than when CDM was available. The percentage of days and time spent at salt did not differ (P > 0.10) among treatments (Table 4).

Cows visited supplemental mineral locations on a greater (P < 0.001) number of days when LMB-M was available than when CDM was available (Table 4). In addition, cows spent more (P = 0.002) total time at supplemental mineral locations when LMB-M than when CDM was available.

Table 3. Least-squares means for the Thackeray Ranch and Northern Agricultural Research Center (NARC) sites based on visits to supplements within 10 m using total time.

Variables based on total time	Thackeray Ranch	NARC – Upper Creek
Low-moisture blocks for protein – LMB-P		
Percent of days cows visited LMB-P (%)	43.5 ± 8.0	65.1 ± 4.9
Time within 10 m of LMB-P (min/d)	34.9 ± 13.5	55.2 ± 8.3
Supplemental mineral locations (LMB-M and CDM)		
Percent of days cows visited locations (%)	20.7 ± 4.2	36.8 ± 2.6
Time within 10 m of mineral (min/d)	8.9 ± 4.4	15.7 ± 2.7
White salt		
Percent of days cows visited salt (%)	21.8 ± 4.4	32.7 ± 2.7
Time within 10 m of salt (min/d)	4.6 ± 1.8	6.7 ± 1.1

If font colors within a row are not the same, treatment means differ (P ≤ 0.05).

Table 4. Least-squares means of cow visits within 10 m of supplements when low-moisture molasses blocks with higher concentrations of mineral (LMB-M) and when conventional dry mineral mixes (CDM) were available based on total time.

Variables based on total time	LMB-M present	CDM present
Low-moisture blocks for protein – LMB-P		
Percent of days cows visited LMB-P (%)	51.9 ± 3.1	56.7 ± 3.1
Time within 10 m of LMB-P (minutes/d)	34.9 ± 6.9	55.2 ± 4.8
Supplemental mineral locations (LMB-M or CDM)		
Percent of days cows visited locations (%)	39.3 ± 4.1	18.1 ± 4.1
Time within 10 m of mineral (%)	19.9 ± 3.3	4.7 ± 3.3
White salt		
Percent of days cows visited salt (%)	29.3 ± 3.1	25.2 ± 3.1
Time within 10 m of salt (%)	5.8 ± 0.7	5.5 ± 0.7

If font colors within a row are not the same, treatment means differ ($P \leq 0.05$).

Only one cow (8083 at the Thackeray Ranch) did not visit LMB-P during the study based on total time. Five of the 50 collared cows (both locations) did not visit a supplemental mineral location when LMB-M was present, but 16 of the 50 collared cows did not visit a supplemental mineral location when CDM was present. At the Thackeray Ranch, 2 out of 20 cows did not visit LMB-M and 9 cows out of 20 cows did not visit CDM. At NARC, 3 out of 30 cows did not visit LMB-M and 7 out of 30 cows did not visit CDM.

Visits – Active Time (Best data for evaluating visits to supplement). The percentage of days that cows visited LMB-P tended to be lower ($P = 0.09$) at the Thackeray Ranch than at NARC. Cows spent similar ($P = 0.2$) amounts of time at LMB-P when they were at the Thackeray Ranch than when they were at NARC (Table 5).

Cows spent a smaller ($P = 0.003$) percentage of days at supplemental mineral locations when they were grazing at the Thackeray Ranch than when they were at NARC. Cows tended to spend less time ($P = 0.08$) at supplemental mineral locations at the Thackeray Ranch as compared to NARC. Visits to salt were (percentage of days and time near salt) were similar at both sites ($P > 0.1$).

The percentage of days that cows visited LMB-P was similar among treatments ($P = 0.2$). Cows spent less time ($P = 0.004$) at LMB-P when LMB-M was available than when CDM was available. The percentage of days and time spent at salt did not differ ($P > 0.10$) among treatments (Table 6).

Cows visited supplemental mineral locations on a greater ($P < 0.001$) number of days when LMB-M was available than when CDM was available (Table 6). In addition, cows spent more ($P < 0.001$) total time at supplemental mineral locations when LMB-M than when CDM was available.

Table 5. Least-squares means for the Thackeray Ranch and Northern Agricultural Research Center (NARC) sites based on visits to supplements within 10 m using active time.

Variables based on active (non-resting) time	Thackeray Ranch	NARC – Upper Creek
Low-moisture blocks for protein – LMB-P		
Percent of days cows visited LMB-P (%)	43.5 ± 8.5	60.6 ± 5.2
Time within 10 m of LMB-P (minutes/d)	23.8 ± 10.4	39.6 ± 6.4
Supplemental mineral locations (LMB-M or CDM)		
Percent of days cows visited locations (%)	18.1 ± 4.0	32.7 ± 2.4
Time within 10 m of mineral (minutes/d)	4.4 ± 1.9	8.2 ± 1.1
White salt		
Percent of days cows visited salt (%)	22.7 ± 4.2	28.8 ± 2.6
Time within 10 m of salt (minutes/d)	3.7 ± 1.1	4.3 ± 0.7

If font colors within a row are not the same, treatment means differ ($P \leq 0.05$).

Table 6. Least-squares means of cow visits within 10 m of supplements when low-moisture molasses blocks with higher concentrations of mineral (LMB-M) and when conventional dry mineral mixes (CDM) were available based on active (non-resting) time.

Variables based on total time	LMB-M present	CDM present
Low-moisture blocks for protein – LMB-P		
Percent of days cows visited LMB-P (%)	48.9 ± 3.4	55.2 ± 3.4
Time within 10 m of LMB-P (minutes/d)	25.6 ± 2.9	37.7 ± 2.9
Supplemental mineral locations (LMB-M or CDM)		
Percent of days cows visited locations (%)	37.1 ± 4.0	13.6 ± 4.0
Time within 10 m of mineral (%)	11.2 ± 1.5	1.4 ± 1.5
White salt		
Percent of days cows visited salt (%)	29.0 ± 3.0	22.5 ± 3.0
Time within 10 m of salt (%)	4.0 ± 0.6	4.0 ± 0.6

If font colors within a row are not the same, treatment means differ ($P \leq 0.05$).

Only 2 cows (8083 at the Thackeray Ranch and 8267 at NARC) did not visit LMB-P during the study based on active (non resting time) time. Six of the 50 collared cows (both locations) did not visit a supplemental mineral location when LMB-M was present, but 20 of the 50 collared cows did not visit a supplemental mineral location when CDM was present. At the Thackeray Ranch, 2 out of 20 cows did not visit LMB-M and 9 cows out of 20 cows did not visit CDM. At NARC, 4 out of 30 cows did not visit LMB-M and 11 out of 30 cows did not visit CDM (Table 7). Using both chi-square and sign tests, more cows visited LMB-M than visited CDM ($P < 0.01$).

Table 7. Percentage of users and non-users of low-moisture molasses blocks with higher mineral concentrations (LMB-M) and conventional dry mineral mixes (CDM) based on active (non-resting) time near barrels or feeders (within 10 m).

	Number of cows and percent of cows	
	Users (visited barrels or feeders at least once)	Non-Users (did not visit barrels or feeders)
Thackeray Ranch (n=20)		
LMB-M	18 (90%)	2 (10%)
CDM	11 (55%)	9 (45%)
NARC – Upper Creek (n=30)		
LMB-M	26 (87%)	4 (13%)
CDM	19 (63%)	11 (37%)

After pooling the data, more cows visited LMB-M at least once than did CDM ($P < 0.01$).

Fecal loading. As expected, the number of fecal pats and the weight of the feces within the plot were correlated ($r = 0.81$, $P < 0.001$). However, forage utilization was not correlated to fecal abundance ($r = -0.01$, $P = 0.9$). Forage utilization was not useful for predicting fecal abundance or the number of fecal pats using multiple regression models ($P > 0.1$). Fecal abundance was correlated to distance from water ($r = -0.38$, $P = 0.001$), but was not correlated to slope ($r = -0.13$, $P = 0.3$) and distance to supplement ($r = -0.16$, $P = 0.19$).

After accounting for period, slope, distance to water and distance to supplement, only distance to water was related to fecal abundance ($P = 0.017$). For every 100 m increase in distance from water, fecal abundance decreased by 13 lbs. / acre.

It was apparent that cows were resting in coulees that were protected from the wind and in coulees where streams were present (also protected from the wind). Plots that were in coulee bottoms (protected) were identified and accounted for in another statistical model. Plots in protected areas had higher fecal abundance ($P < 0.001$) than plots in unprotected areas. Average fecal abundance in protected areas was 304 lbs / acre and in unprotected areas it was only 48 lbs / acre. Protected areas near water had the greatest abundance of feces. Distance to water was an important predictor of fecal abundance in this model. Slope was not useful in predicting fecal abundance in this model ($P = 0.9$). However, distance to supplement was useful important for predicting fecal abundance if the site type was considered. Protected sites near supplement had higher abundances of feces. In unprotected plots, there was no reliable relationship between fecal abundance and distance to supplement.

Forage utilization in this study was related to distance from supplement ($P = 0.003$), distance to water ($P = 0.013$), and slope ($P = 0.048$). Forage utilization dropped by 1.3 percentage points for every 100 m increase in distance from supplement. Forage utilization decreased by 1.1 percentage points for every 100 m increase in distance from water. Forage utilization decreased by 6.5 percentage points for every 10-degree increase in slope.

Discussion

Intake and visits. Cows consumed less LMB-P when LMB-M was used as a supplemental mineral source. The molasses in LMB-M may have sufficed part of the animal's attraction for molasses-based supplements. The collar data (active and total time) supported the intake data. **(Note: Active or non-resting time is the best data for evaluating visits to supplement. Time that cows spent lying down or resting near supplement was excluded.)** Cows spent less active and total time at LMB-P when LMB-M was available as compared to that when CDM was available.

Cows consumed less LMB-P at the Thackeray Ranch where the pasture size was at least 3 times larger than at NARC. Collar data (active and total time) did not support the intake data. There was some indication of a trend of cows visiting LMB-P more often and spending more time at LMB-P when they were at NARC. However, there were no statistically significant differences between the sites. Cows visited LMB-P about every other day and spent 20 to 40 minutes per day at LMB-P at both locations

Intake of LMB-M was almost identical at the Thackeray Ranch on large pasture and in the smaller pasture (Upper Creek) at NARC. Intake of CDM was lower at the Thackeray Ranch than at NARC. The collar data (active and total time) generally did not support an interaction between treatment (LMB-M versus CDM) and site (NARC versus Thackeray Ranch) for the percentage of days and time spent at supplemental mineral locations. Cows spent similar amounts of total time at supplemental mineral locations for both sites. However, cows tended to spend less active time at supplemental mineral locations on the Thackeray Ranch as compared to NARC. Eighty seven percent (26 out of 30) of the cows at NARC and 90% (18 of 20) of the cows at the Thackeray Ranch visited LMB-M at least once based on active time. Only 63% (19 out of 30) of the cows visited CDM at NARC, and 65% (11 out of 20) of the cows visited CDM at the Thackeray Ranch.

Individual variation (active time near supplement). Almost every cow (48 out of 50, 98% based on active time) visited the LMB-P at least once. Only two cows (8083 and 8267) were not observed within 10 m of LMB-P. Previous studies (Bailey and Welling 2002) found that about 85% of the cows visited a low-moisture molasses block. Earlier studies did not use as frequent of sampling time (10 or 15 minutes versus 5 minutes in this study). More cows visited LMB-M (44 out of 50, 88%) than did visit CDM (30 out of 50, 60%). In a previous study at the Thackeray Ranch (Bailey and Welling 2002), only 55% of the cows visited a CDM, while 74% of the cows visited a low-moisture molasses block.

Fecal loading. One of the objectives of this part of the study was to determine if fecal loading was correlated or could be predicted from forage utilization. If fecal loading could be predicted from forage utilization, previous work (Bailey and Welling 1999, Bailey et al. 2001) could be used to estimate the effectiveness of using low moisture molasses blocks for modifying fecal loading patterns. Results from this study suggest that forage utilization is a poor predictor of fecal loading. There was virtually no correlation between fecal loading (lbs of feces / acre) and forage utilization. The most likely reason that fecal loading and forage utilization are not related is because fecal abundance is highest in cattle resting sites. In this study, cattle often rested in protected areas (e.g., coulee bottoms) and streams. Steams were also located in coulee bottom and were protected from the wind. Fecal abundance was almost 6 times higher in protected areas than in unprotected areas. Protected areas near supplement had higher fecal loading areas than similar areas far away from supplement. Thus, strategic placement of supplement may be a tool to modify fecal loading patterns, but the supplement placement strategy must consider where cattle prefer to rest. Placing supplement near preferred resting sites that are away from water could reduce the potential for fecal material to enter waterways.

In any case, specific measurements of fecal abundance (lbs of feces / acre) or cattle use patterns of the pasture (total time, resting and grazing) must be used to evaluate the success of any management strategies for modifying fecal loading patterns. Forage utilization measurements are not adequate to predict fecal loading patterns.

Conclusions

Low-moisture molasses blocks with higher mineral concentrations (LMB-M) were a superior delivery system for providing supplemental minerals than conventional dry mineral mixes (CDM). Intake of the protein supplement (LMB-P) was less when LMB-M was available. Intake of CDM was much higher in the smaller pasture than a range situation, while intake of LMB-M was nearly identical in large and small pastures. Most importantly, individual variation in use of LMB-M was lower than for CDM. More cows visited LMB-M (88%) at least once than did CDM (60%). Cows also visited LMB-M more regularly than they did LMB-M. Cows visited LMB-M about every 2.5 days and CDM about every 7 days.

Fecal loading patterns have the potential to be modified and improved by strategic placement of low moisture molasses supplements. However, supplement placement strategies should consider the impact of the placement on cattle resting sites. Fecal abundance is higher in areas where cattle rest than in areas where they graze. Forage utilization patterns are poor predictors of fecal loading patterns. Specific measurements of fecal abundance and/or measurements of pasture or landscape use (grazing and resting time) by cattle must be used to quantify the success of management strategies designed to modify fecal loading patterns. Forage utilization measurements may differ from fecal abundance measurements.

As observed in earlier research, forage utilization was higher near supplement. As the distance from supplement increased, forage utilization decreased.

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