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Effect of feed bunk management on feedlot steer intake[1]

J. S. Schutz, J. J. Wagner,[2] PAS, K. L. Neuhold, S. L. Archibeque, PAS, and T. E. Engle, PAS
Department of Animal Science, Colorado State University, Fort Collins 80523-1171

ABSTRACT

Twelve pens of yearling steers were used to determine the effects of bunk management on DMI and the pattern of feed disappearance from the feed bunk. Three 0630 h target bunk scores were compared: 0 = a bunk devoid of feed particles; 1/2 = a bunk containing up to 0.25 kg of feed/steer; and 1 = a bunk containing greater than 0.25 and up to 1.0 kg of feed/steer. Steers were fed twice daily at 0700 (round 1) and 1130 h (round 2), and bunks were observed by a single observer at 1630, 2200, 0200, and 0630 h. Daily DMI for steers fed to a target score of 0 (9.74 kg) was lower ($P < 0.05$) than that for steers fed to a target score of 1/2 (10.37 kg), which was lower ($P < 0.01$) than that for steers fed to a target score of 1 (11.21 kg). In addition, a treatment-by-time interaction ($P < 0.001$) for the estimated disappearance of feed from the bunk suggests that eating patterns differed by treatment. Even though adequate feed was available in all bunks from 0700 until 1600 h to support similar DMI during this time period for all treatments, steers fed to a target score of 0 consumed less feed during the day (0730 until 1600 h) than did steers fed to a target score of 1/2 ($P < 0.001$), which consumed less feed from delivery through 1600 h than did steers fed to a target score of 1 ($P < 0.01$). These data indicate that slick bunk management systems may restrict DMI in feedlot steers and alter feed consumption patterns.

Key words: cattle, dry matter intake, feed bunk management, feedlot management

INTRODUCTION

Developing a feed bunk management system for feedlot cattle that achieves maximum performance and avoids digestive upsets is challenging. The primary difficulty is that although intake and performance of individual cattle are of primary concern, feedlot production practices are most conducive to managing pens of cattle and not individual animals. Multiple factors can contribute to digestive upsets including environment, management, diet type, intake, feeding behavior, social behavior, and cattle type (Galyean and Eng, 1998). Schwartzkopf-Genswein et al. (2003) estimated that digestive upsets may decrease performance, which increases economic losses by \$15 to \$20 per animal.

A feed bunk management system needs to be easy to use and sensitive enough to detect changes in feed consumption. Adequate feed bunk management should ensure that day-to-day variation in feed intake is minimized and overall feed intake is enhanced while providing the correct type and amount of nutrients to individual animals without leaving excess feed in the bunk (Duff, 2001). Pritchard and Bruns (2003) suggested that feed bunk management affects cattle intake by reducing overconsumption and altering cattle behavior to ensure reduced daily intake variation.

Feed bunk management has changed over the years. The original objective of the cattle feeder was to keep bunks full and provide feed at all times for the cattle. This approach often resulted in spoiled feed that was either wasted or may have contributed to reduced intake if cattle were forced to clean the bunk. In recent years slick bunk systems have become popular. These systems purposely allow bunks to become empty at some point during the night in an attempt to eliminate wasted feed and restrict feed intake.

Restricted feeding programs have been reported to improve feed efficiency (Galyean, 1999; Duff, 2001) and reduce digestive upsets associated with overconsumption of feed (Schwartzkopf-Genswein et al., 2003; Drager et al., 2004). However, excessive intake restriction can reduce ADG, resulting in reduced profitability. Additional evaluation of the effects of bunk management system on DMI and eating behavior is needed. Therefore, the objective of the present study was to determine whether man-

[1] Mention of a proprietary product or trade name does not constitute a guarantee or warranty of the product by Colorado State University or the authors and does not imply its approval to the exclusion of other products that may also be suitable.
[2] Corresponding author: john.wagner@colostate.edu

Table 1. Southeast Colorado Research Center feed bunk reading and feed call score system[1]

Score[2]	Amount in bunk, kg	Feed delivery changes
0	0	Increase feed by 0.23 kg/steer every third morning
1/2	Trace–2.26	Remains the same
1	2.27–9.05	Decrease feed by 0.91 kg/steer; on the third morning, scoop[2]
2	9.06–18.18	Decrease feed by 1.82 kg/steer; on the third morning, scoop[2]
3[3]	>18.19	Decrease feed by 2.27 kg/steer; on the third morning, scoop[2]

[1]Slick bunk treatment group required a call of 0, trace bunk treatment group required a call of 1/2, and the ad libitum group required a call of 1.

[2]Due to rain or a bunk score of 1 or 2 for 3 d or a call of 3 for 1 d, feed bunks were scooped. Orts were weighed and recorded, and a sample was collected for DM analysis.

[3]On the first day the feed bunk is slick (0) the pen will get one-half of the total kilograms reduced back.

aging feed bunks under a slick bunk system would reduce DMI and influence the pattern of DM disappearance from feed bunks.

MATERIALS AND METHODS

Experimental Design

Prior to the initiation of this experiment, care, handling, and sampling of the animals defined herein were approved by the Colorado State University Animal Care and Use Committee. One hundred twenty-seven crossbred steers (497 ± 19 kg) housed in 12 pens of 9 to 13 steers per pen were used in this experiment. The experiment was conducted during the early summer months (June and July) at Colorado State University's Southeast Colorado Research Center (**SECRC**) feedlot facility. Steers were housed in pens measuring 6.1 × 18.3 m with a single continuous-flow automatic water fountain shared between every 2 pens. Feed was delivered to steers in fence-line (3.7 m in length) concrete feed bunks allowing for 28.5 to 41.1 cm of linear bunk space per steer and which had a 6.1-m-wide concrete apron adjacent to the feed bunk and water fountain to provide a solid area for steers to stand while eating or drinking. Before the initiation of the experiment, steers were pen weighed. Steers used were cattle on hand at SECRC and were of varied days on feed and BW at the initiation of this experiment; therefore, pens were assigned to 3 blocks of 4 pens based on days on feed and BW.

The experiment was conducted as a 3 × 3 Latin square with 1 group of 4 pen replicates assigned to each cell of the square. Periods consisted of an acclimation to diets followed by a 4-d data-collection period. For period 1, each cell of the square was randomly assigned to 1 of 3 feed bunk management treatments. Treatments were then rotated among the groups during each of 2 additional periods so that the 4 pens in each cell of the square were fed according to each of the 3 feed bunk management treatments over 3 periods.

The feed bunk scoring system used was developed based on ease of implementation and sensitivity (Table 1). Feed bunk score treatments were based on the amount of feed left in the bunk at 0630 h before the morning feed deliveries. During the development of the bunk scoring system at SECRC in 1996, feed left in the bunk for each score was weighed over a period of several weeks (J. J. Wagner, personal communication). Feed bunk score treatments consisted of the following: 0 = a feed bunk devoid of all feed particles (slick); 1/2 = a bunk that contained traces up to 2.26 kg of as-fed feed (0.17 to 0.26 kg of as-fed feed/steer); 1 = a bunk that contained 2.27 to 9.05 kg of as-fed feed (ad libitum, 0.18 to 1.01 kg/steer). Overall, at the 0630 h bunk reading, the slick bunk steers had a score of 0 51% of the time, a score of 1/2 49.5% of the time, and a score of 1 0.05% of the time.

An adaptation period of 10 d was implemented for each period before 4 d of data collection. The adaptation period was intended to ensure the cattle were gradually transitioned from their previous feed bunk score treatment to their new feed bunk score treatment to avoid digestive disorders. It is not known whether a 10-d adaptation period is long enough for a study like this. Traditional adaptation periods for transitioning new cattle to high-concentrate diets are often 5 to 7 d for each step-up diet. During the 4-d data-collection phase, all feed bunks were read at 1600, 2200, and 0200 h and 0630 h the next morning.

Each morning after the feed bunk scores were assigned, feed intake from the previous day was determined by weighing the orts in each feed bunk, determining DM of the orts by drying for 48 h in a 60°C forced-air oven, and subtracting the result from the total amount of DM delivered the previous day and dividing by steers in the pen. Feed adjustments were made each morning before feeding based on the collected bunk scores, and total feed amounts per pen were adjusted daily. After 3 d of a feed bunk score of 3 (Table 1), the feed remaining in the feed bunk was sampled, weighed, and discarded. Following each rainfall event and at the end of each 4-d data-collection period, all feed from all feed bunks was weighed, sampled for DM analysis, and discarded.

Diets were manufactured immediately before each feeding. All steers were fed 2 times daily, with 60% of the daily feed allotment being delivered starting at 0700 h (round 1) and the remaining 40% of the daily feed being delivered beginning at 1130 h (round 2). All treatments were fed a common steam-flaked-corn-based finishing diet containing 13.5% CP, 3.5% CP equivalent from nonprotein nitrogen, 4% NDF from corn silage, 0.7% calcium, 0.7% potassium, 33 mg of monensin per kilogram of DM, and 11 mg of tylosin per kilogram of DM. Diets were formulated to meet or exceed all nutrient requirements for finishing steers (NRC, 1996).

The amount of as-fed feed that remained in the bunk at the end of each period, when bunk score readings were obtained, was estimated using the following assumptions: a score of 0 corresponded to 0 kg of as-fed feed in the bunk; a bunk with a score of 1/2 was assumed to contain 1.13 kg of as-fed feed (the average as-fed kilograms of a bunk score call of 1/2); and bunks with scores of 1, 2, or 3 were estimated to contain 5.68, 13.64, and 20 kg of as-fed feed (the average as-fed kilograms of a bunk score call of 1, 2, 3), respectively. The amount of DM remaining in the bunk was calculated by multiplying the as-fed feed estimate by the DM concentration of the diet (80.1%). Estimated DM disappearance from feed delivery to 1600 h was calculated by subtracting the estimated amount of DM remaining in the bunk at 1600 h from the sum of the total kilograms of DM delivered to the bunk at 0700 and 1130 h. Estimated DM disappearance from 1600 to 2200 h, from 2200 to 0200 h, and from 0200 to 0630 h was calculated by subtracting the amount of DM estimated in the bunk at 2200, 0200, and 0630 h from the 1600, 2200, and 0200 h estimates, respectively. The amount of DM that disappeared from each bunk during each period was then divided by steer count to express the results on a DMI per steer basis.

Weather data were collected daily from the National Oceanic and Atmospheric Administration's National Weather Service for the point forecast reference in Lamar, Colorado, 38.07°N, 102.63°W (elevation 1,117 m). The weather station is located approximately 2 km from SECRC.

Statistical Analysis

Statistical analyses of data were performed using mixed model procedures as described by SAS (release 9.2, SAS Institute Inc., Cary, NC) using methods appropriate for a Latin square experimental design with replication. Pen served as the experimental unit. Weather analysis included the fixed effects of weather and treatment. The model analyzing DMI included the fixed effects of bunk score treatment, period, and treatment-by-period interaction. Pen within treatment by period was the random effect. Bunk score and DM disappearance data were initially analyzed using a repeated measures analysis. Fixed factors in the models included bunk score treatment as a class variable, hour post delivery as a continuous variable (9, 15, 19, and 23.5 h representing the 1600, 2200, 0200, and 0630 h bunk readings), and hour by treatment. Pen within treatment by period was the subject of the repeated statement. Autoregressive order 1, compound symmetry, and unstructured covariance structures were tested as described by SAS using the Akaike information criterion and the Bayesian information criterion, and compound symmetry was found to be the most satisfactory fit for the bunk score data and unstructured covariance structure the most satisfactory fit for the DM disappearance data. Because the unstructured covariance structure provided the best fit for the DM disappearance data, suggesting no correlation between DM disappearance estimates at adjacent time points, DM disappearance data expressed as either kilograms per steer or percentage of total disappearance were analyzed using bunk score treatment, period, treatment by period, time, time by treatment, and time by period as fixed classification effects. Pen within treatment by period was the random effect. Treatment, time, period, and the interactions were considered to be significant if $P < 0.05$.

An additional model was used to generate a quadratic prediction equation for bunk score for each treatment. Fixed effects in this model included bunk score treatment as a class variable, treatment by the continuous variable hour, and treatment by hour by hour. The NOINT and HTYPE = 1 options were requested in the model statement to generate a separate equation for each treatment and to provide sequential sums of squares, which are appropriate for polynomial models (Littell et al., 2000). The subject of the repeated statement was pen within treatment by period. Compound symmetry covariance structure was used as determined by the Akaike information criterion and Bayesian information criterion fit statistics described by SAS.

RESULTS AND DISCUSSION

The effects of feed bunk management treatment on DMI were significant ($P < 0.0001$). Daily DMI for the slick bunk steers fed to a target score of 0 (9.74 kg) was lower ($P < 0.05$) than that for steers fed to a target score of 1/2 (10.37 kg), which was less ($P < 0.01$) than that for the ad libitum steers fed to a target score of 1 (11.21 kg). Period of the study and the period-by-treatment interactions were not significant ($P > 0.25$) sources of variation describing DMI. Feeding consistency is a common factor needed for any feed bunk management system to be successful (Milton, 2000). Therefore, every effort must be made to deliver feed to cattle at consistent intervals and in the appropriate quantities. In this experiment, steers were fed at a consistent rate in accordance with the required feed bunk score treatment.

Summertime heat in the Great Plains can decrease performance and increase cattle mortality (Davis et al., 2003; Mader, 2003). No steers were treated for any type of morbidity, including metabolic disorders, during the duration of this experiment. To ensure that adverse weather patterns were not influencing intake data, ambient temperature effects were analyzed. Average minimum and maximum temperature for each period, rainfall per period, and wind speed per period had no effect on DMI. The average daily minimum and maximum temperature for periods 1, 2, and 3 were 11 and 31.5°C, 16.5 and 32.8°C, and 17.5 and 35.0°C, respectively. Average wind speed for period 1, 2, and 3 was 6.8 km/h, 10.5 km/h, and 12.5 km/h, respectively. Average total precipitation for period 1, period 2, and period 3 was 0.03, 0.01, and 0.32 cm, respectively. Based on data obtained from the National Oceanic and Atmospheric Administration, all weather data were within the normal average climate ranges collected from 1971 to 2000. Normal minimum and maximum temperatures for this time of year in southeast Colorado are 16.0 and 33.0°C, respectively, and average precipitation is 5.8 cm/mo.

Feed bunk scores were collected 4 times daily at 9, 15, 19, and 23.5 h after round 1 feeding (representing the 1600, 2200, 0200, and 0630 h bunk readings). Round 1 (first feed delivery of the day, 0700 h) was used as a reference point because 60% of the daily feed allotment was delivered at this time. The effect of treatment on bunk score is displayed in Figure 1. Treatment ($P < 0.0001$), hour ($P < 0.0001$), and treatment by hour ($P < 0.05$) were significant sources of variation describing bunk score. By design, bunk scores were greater for pens fed to a score of 1 as compared with bunk scores for pens fed to a score of 1/2 ($P < 0.0001$) or 0 ($P < 0.0001$). However, average bunk scores for pens fed to a score of 0 and 1/2 were similar ($P > 0.53$) and averaged 0.63 and 0.73, respectively. At 0630 h each morning (23.5 h after initial feeding), bunk score averaged 0.30 ± 0.04 and 0.36 ± 0.07 for pens fed to bunk scores of 0 and 1/2, respectively, indicating that significant differences between the slick and trace bunk management systems were not established.

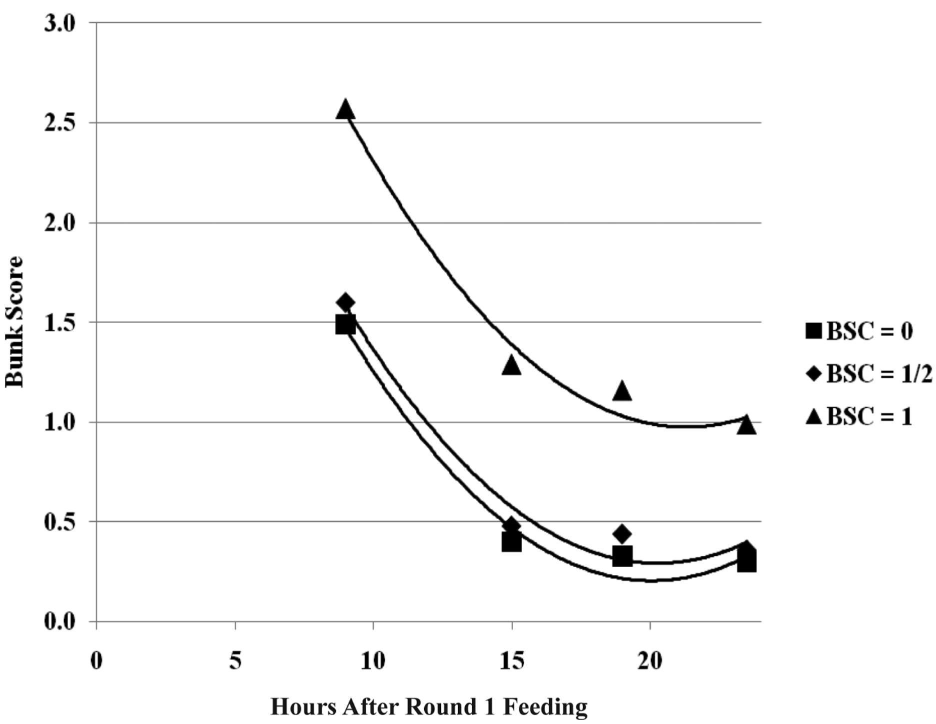

Figure 1. Feed bunk score treatments (**BSC**) consisted of the following: 0 = a feed bunk devoid of all feed particles (slick); 1/2 = a feed bunk that contained a few crumbles up to 2.26 kg of as-fed feed (trace); and 1 = a feed bunk that contained from 2.27 to 9.05 kg of as-fed feed (ad libitum). Round 1 feeding was the first of 2 feed deliveries made. During round 1, 60% of the total daily feed allotment was delivered. Each data point represents 12 observations.

The presence of a treatment-by-time effect ($P < 0.05$) for bunk score indicates that treatment influenced the amount of feed remaining in the bunk at the various time intervals. Figure 2 shows the estimated amount of orts remaining in the bunk at each time point. For each time period of bunk reading (1600, 2200, 0200, and 0630 h) the slick bunk group had an estimated 7.32, 1.06, 0.72, and 0.65 ± 0.58 kg of DM in the bunk; the trace bunk group had 8.19, 1.57, 1.40, and 1.07 ± 0.58 kg of DM in the bunk; and the ad libitum group had an estimated 13.72, 6.23, 5.33, and 3.72 ± 0.57 kg of DM in the bunk

Table 2 shows the disappearance of DM per steer from the bunk from the initial round 1 feeding at 0700 h through 1600 h, from 1600 through 2200 h, from 2200 through 0200 h, and from 0200 through 0630 h. Dry matter disappearance estimated from bunk scores was affected ($P < 0.0001$) by treatment and time of day ($P < 0.0001$) and averaged 7.73, 8.24, and 8.84 kg/steer daily for the slick, trace, and ad libitum treatments, respectively. These estimates were approximately 2 kg/steer less than the observed (weighed) DMI estimates for each treatment. The interaction between bunk score treatment and time was significant ($P < 0.001$) for DM disappearance expressed on a kilograms per steer basis, suggesting that the effects of treatment on DM disappearance depended on time of day. The only time period when treatment differences in kilograms of DM disappearance per steer were significantly different ($P < 0.05$) was from 0700 to 1600 h (bunk score 0 versus bunk score 1/2, $P < 0.01$; bunk score 1/2 versus bunk score 1, $P < 0.01$). Differences between treatments for the percentage of total feed that disappeared during each time period were not different (treatment-by-time interaction, $P < 0.17$).

Although treatment differences for DM disappearance from 0200 to 0630 h were not different, there appeared to be numerically more feed available for consumption by steers during the early morning hours before feed de-

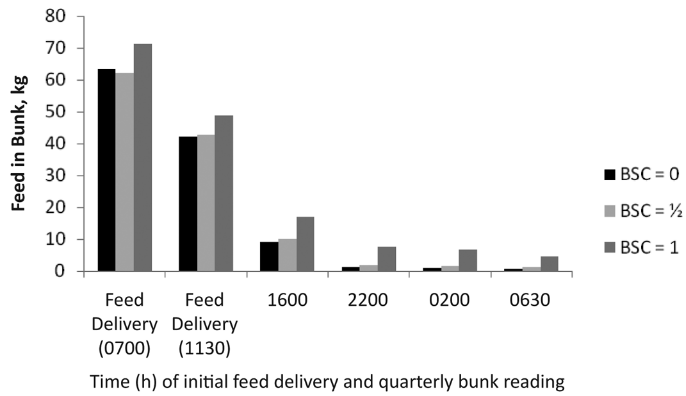

Figure 2. Average estimate (±0.34 kg) of amount of feed in bunk based on initial feed deliveries and bunk scores, for pens of feedlot steers fed at specific levels of DMI to meet the desired feed bunk score. Feed bunk score (BSC) treatments consisted of the following: 0 = a feed bunk devoid of all feed particles (slick); 1/2 = a feed bunk that contained a few crumbles up to 2.26 kg of as-fed feed (trace); and 1 = a feed bunk that contained from 2.27 to 9.05 kg of as-fed feed (ad libitum). There were 12 observations per treatment.

livery for the ad libitum fed steers as compared with the trace or slick bunk steers. It is interesting to note that the majority of treatment differences in DMI may have been due to differences in feed disappearance from 0700 to 1600 h and apparently not due to disappearance differences from 2200 to 0630 h. Steers fed to bunk scores of 0 or 1/2 appeared to consume less feed from 0700 to 1600 h even though the final feed deliveries for the day started at 1130 h and were likely completed by 1230 h.

Research conducted at the University of Saskatchewan has shown that major periods of eating are around sunrise, sunset, and midnight (Gonyou and Stricklin, 1984). If the feed bunk is slick by the evening before the last eating of the day, it is highly likely that some cattle did not consume their maximum daily intake. A study conducted by Putnam and Davis (1963) using photoelectric relays and operation recorders to determine feeding patterns of beef steers fed ad libitum in drylots found that 79% of the total time spent at the feeder occurred between 6 a.m. and 6 p.m. but that cattle also went to the bunk for short intervals of time all through the night. Therefore, to achieve maximum DMI, a bunk management system needs to ensure that feed is available to all cattle for most the evening to accommodate cattle eating patterns.

Slick feed bunk or limit-fed feed bunk management is a system that aims for all feed delivered to a pen to be consumed on a daily basis with a slick feed bunk for a preplanned duration of the time before the next day's feed delivery (Erickson et al., 2003). The success of this system is based on the premise that ADG will not be reduced and feed efficiency will be improved when DMI is restricted by 10 to 15% of maximum DMI (Pritchard, 1998). Loerch (1990) assessed restricted versus ad libitum intake in a series of 3 experiments, where Exp. 1 was conducted to determine the effects of restricted intake of high-energy diets on cattle performance and diet digestibility, Exp. 2 was conducted to determine the effects of supplemental protein source and monensin on growing and finishing performance of cattle fed all-concentrate growing diets at a restricted intake, and Exp. 3 was conducted to determine the effects of limit feeding during the growing period on performance of steers fed 85 or 100% concentrate diets in the finishing period. In all experiments, steers were fed 1) a corn silage based diet ad libitum, 2) a high-moisture corn and corn silage based diet with intake restricted to 20% of treatment 1, or 3) a high-moisture corn based diet with intake restricted to 30% of treatment 1. It was concluded that DMI could be successfully restricted without significantly affecting finishing performance; however, in Exp. 1 and 2 ADG tended to be lower in the restricted groups than in the ad libitum group. In contrast, Drager et al. (2004) conducted an experiment investigating the effects of feeding cattle 1) ad libitum for 151 d; 2) 75% of treatment 1 DMI

Table 2. Estimated disappearance of dry matter from feed bunks for pens fed to various feed bunk score treatments (12 observations per treatment)

	Bunk score = 0		Bunk score = 1/2		Bunk score = 1	
Time[1,2]	kg/steer[3]	%[4]	kg/steer	%	kg/steer	%
0700 to 1600 h	7.12[a]	92.12	7.56[b]	91.83	7.88[c]	89.14
1600 to 2200 h	0.57	7.37	0.62	7.55	0.72	8.15
2200 to 0200 h	0.036	0.46	0.026	0.31	0.087	0.99
0200 to 0630 h	0.004	0.05	0.025	0.31	0.153	1.73
Total	7.73	100.00	8.24	100.00	8.84	100.00

[a–c]Means in the same row with different superscripts are different, $P < 0.01$.

[1]Effect of time for the kilogram per steer analysis, $P < 0.0001$.

[2]Effect of time for the percentage of total disappearance analysis, $P < 0.0001$.

[3]Effect of treatment for the kilogram per steer analysis, $P < 0.0001$. Effect of treatment by time for the kilogram per steer analysis, $P < 0.001$.

[4]Effect of treatment for the percentage of total disappearance analysis, $P = 1.00$. Effect of treatment by time for the percentage of total disappearance analysis, $P < 0.17$.

for 65 d, 95% of treatment 1 DMI for 65 d, and ad libitum access for 21 d; 3) 80% of treatment 1 DMI for 65 d, 100% of treatment 1 intake for 65 d, and ad libitum access to feed for 21 d; or 4) 85% of treatment 1 DMI for 65 d, 105% of treatment 1 DMI for 65 d, and ad libitum access to feed for 21 d. By restricting feed intake of finishing steers, ADG was reduced and carcasses had lower marbling scores, HCW, LM area, and KPH percentages when compared with controls.

Ad libitum feed bunk management describes a feed delivery system that allows for feed to be in the feed bunk in amounts that allow for a complete TMR to be present from the end of one feeding to the beginning of another feeding. If cattle are allowed to consume feed ad libitum and intake variation remains less than 1.8 kg per day, performance levels and incidence of acidosis should not be increased (Cooper et al., 1999).

By measuring the total amount of feed per day that was removed from each of the feed bunks for each treatment, a difference existed ($P < 0.001$) between the total amount of feed that was placed in the feed bunk and the amount of uneaten feed remaining in the feed bunk that required removal (Figure 3). Over all periods, the slick bunk group averaged 0.57 ± 0.63 kg of removable orts, the trace group averaged 1.36 ± 0.63 kg of removable orts, and the ad libitum group averaged 6.65 ± 0.63 kg of removable orts per bunk. If too much feed is fed, cattle will sort feed, and there could be an increased amount of orts that would not represent the TMR remaining in the feed bunk. The goal of any feed bunk management system should be to provide nutritionally balanced, clean feed in a manner that allows for optimum performance at the lowest level of cost and labor. If producers were to implement a feed bunk management system that allowed ad libitum access to feed, the importance of accurate feed bunk readings and consistent feed deliveries would likely increase to prevent feed from becoming spoiled and requiring removal. The key component to a successful bunk management system is to ensure that the system is simple enough in practice to ensure that feed is delivered consistently to cattle daily. Feed bunk management should encompass diet type, cattle, changes in climatic conditions, and feed bunk space (Pritchard and Bruns, 2003).

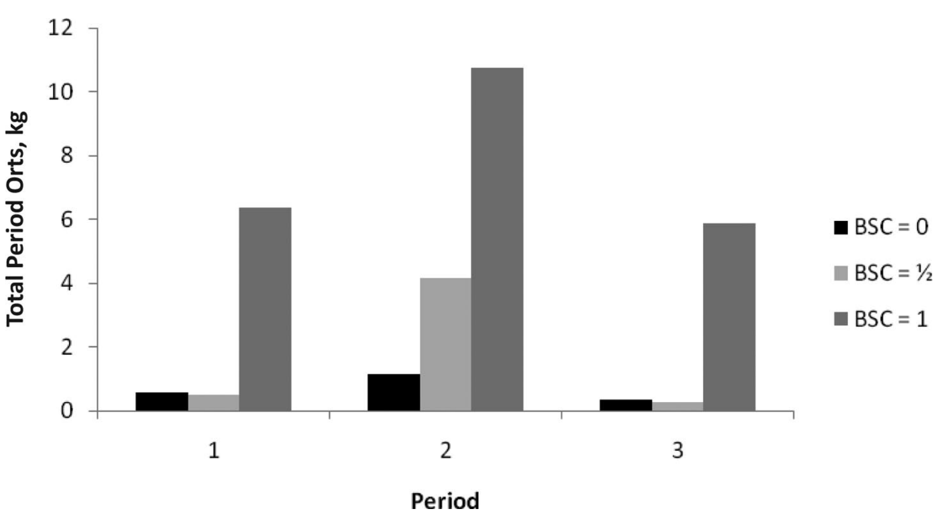

Figure 3. Total amount of orts scooped from feed bunks in each treatment per period. Bunk score (BSC) 0: 0.57 ± 0.63 kg; BSC 1/2: 1.36 ± 0.63 kg; BSC 1: 6.65 ± 0.63 kg for pens of feedlot steers fed at specific levels of DMI to meet the desired feed BSC. Feed BSC treatments consisted of the following: 0 = a feed bunk devoid of all feed particles (slick); 1/2 = a feed bunk that contained a few crumbles up to 2.26 kg of as-fed feed (trace); and 1 = a feed bunk that contained from 2.27 to 9.05 kg of as-fed feed (ad libitum). There were 12 observations per treatment.

IMPLICATIONS

Results of this study suggest that feed bunk management strategy affects DMI of feedlot steers. Delivering adequate feed to allow ad libitum access to feed over a 24-h period increased DMI. In addition, it appears that most of the differences in DMI could be attributable to differences in DM disappearance from the bunk from 0700 to 1600 h. Additional research is warranted to determine why steers fed to a target bunk score of 0 appeared to consume less DM from 0700 to 1600 h even though all feed delivered for the day was present in the bunks hours before 1600 h.

LITERATURE CITED

Cooper, R. J., T. J. Klopfenstein, R. A. Stock, C. T. Milton, D. W. Herold, and J. C. Parrott. 1999. Effects of imposed feed intake variation on acidosis and performance of finishing steers. J. Anim. Sci. 77:1093.

Davis, M. S., T. L. Mader, S. M. Holt, and A. M. Parkhurst. 2003. Strategies to reduce feedlot cattle heat stress: Effects on tympanic temperature. J. Anim. Sci. 81:649.

Drager, C. D., M. S. Brown, M. B. Jeter, and P. F. Dew. 2004. Effects of feed intake restriction on performance and carcass characteristics of finishing beef steers. Prof. Anim. Sci. 20:255.

Duff, G. C. 2001. Feedlot bunk management: Slick bunk versus ad libitum. Moorman's Feed Facts. 11:6.

Erickson, G. E., C. T. Milton, K. C. Fanning, R. J. Cooper, R. S. Swingle, J. C. Parrott, G. Vogel, and T. J. Klopfenstein. 2003. Interaction between bunk management and monensin concentration on finishing performance, feeding behavior, and ruminal metabolism during an acidosis challenge with feedlot cattle. J. Anim. Sci. 81:2869.

Galyean, M. L. 1999. Review: Restricted and programmed feeding of beef cattle-definitions, application, and research results. Prof. Anim. Sci. 15:1.

Galyean, M. L., and K. S. Eng. 1998. Application of research findings and summary of research needs: Bud Brittion Memorial Symposium on Metabolic Disorders of Feedlot Cattle. J. Anim. Sci. 76:323.

Gonyou, H. W., and W. R. Stricklin. 1984. Diurnal behavior patterns of feedlot bulls during winter and spring in northern latitudes. J. Anim. Sci. 58:1075.

Littell, R. C., G. A. Milliken, W. W. Stroup, and R. D. Wolfinger. 2000. SAS System for

Mixed Models. 4th printing. SAS Institute Inc., Cary, NC.

Loerch, S. C. 1990. Effects of feeding growing cattle high-concentrate diets at a restricted intake on feedlot performance. J. Anim. Sci. 68:3086.

Mader, T. L. 2003. Environmental stress in confined beef cattle. J. Anim. Sci. 81:E110.

Milton, T. 2000. Managing nutritional disorders with high-grain rations in beef cattle. Pages 65–80 in Proc. Inter-Mountain Nutr. Conf., Salt Lake City, UT. Utah State Univ., Logan, UT.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th ed. Natl. Acad. Press, Washington, DC.

Pritchard, R. H. 1998. Bunk management—Observations from research. Page 68 in Plains Nutr. Council Spring Conf. Texas A&M Res. Ext. Publ. AREC 98–24.

Pritchard, R. H., and K. W. Bruns. 2003. Controlling variation in feed intake through bunk management. J. Anim. Sci. 81:E133.

Putnam, P. A., and R. E. Davis. 1963. Ration effects on drylot steer feeding patterns. J. Anim. Sci. 22:437.

Schwartzkopf-Genswein, K. S., K. A. Beauchemin, D. J. Gibb, D. H. Crews Jr., D. D. Hickman, M. Streeter, and T. A. McAllister. 2003. Effect of bunk management on feeding behavior, ruminal acidosis and performance of feedlot cattle: A review. J. Anim. Sci. 81(E. Suppl. 2):E149–E158.