Supplementation Strategies to Reduce Waste in Beef Cattle Systems

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Introduction

Production conditions are rapidly changing for operators in all sectors of the beef industry. The decade beginning in 2000 brought about increases and volatility in input costs, which fortunately have been followed by increases in feeder and fed cattle prices.

Some often cited reasons why both grain and forage prices are and will continue to be high include utilizing corn for ethanol production and the pressure corn grain prices placed on shifting other crop and forage land to corn grain production. Yet, current times of increased income present an ideal opportunity to improve resource management. This will be necessary to permit continued profit under increased input costs and high volatility — the new norm in livestock production conditions. Since 2006, yearly variability (coefficient of variation) in corn grain prices recorded for NW Iowa (starting in October of the year) ranged from 8.4% to 20%. In the same period, variability in prices of dry distillers' grains and for the same region ranged from 8.2% to 24%. Forage price and price variation were not immune to these changes. Prices and volatility of good and fair quality bermudagrass hay in the Southeast have been markedly affected since 2005 (Figure 1; https://www.marketnews.usda.gov/mnp/ls-home).

As hay prices increased, their impact on overall feed costs also increased. From 2008 to 2013, purchased and homegrown feed costs (including mostly hay and some concentrate and mineral supplements) for operations in the Fruitful Rim region (representing Florida and other coastal states) increased from $0.56 to $0.64 for every dollar spent on feeding beef cows (http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx). Due to recent price increases for feeder cattle, the relative contribution of feed costs to feeder breakeven price decreased. Although this may make some beef cattle system operators disregard the impact of feeding costs on profit, we argue that the differential between feed costs and gross feeder calf income must be used to enhance profits while feeder cattle prices are high. The differential should also be used to prepare the enterprise for the inevitable drop in feeder cattle prices already forecast for 2016 by many economists.

This contribution to the 26th Florida Ruminant Nutrition Symposium will focus on managing hay supplies and intake in beef cow-calf operations as a tool to retain biological and economic efficiency. Where appropriate, references to effects of intake

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management on rumen function and ruminant intake control will be made to aid in advancing our knowledge in these areas.

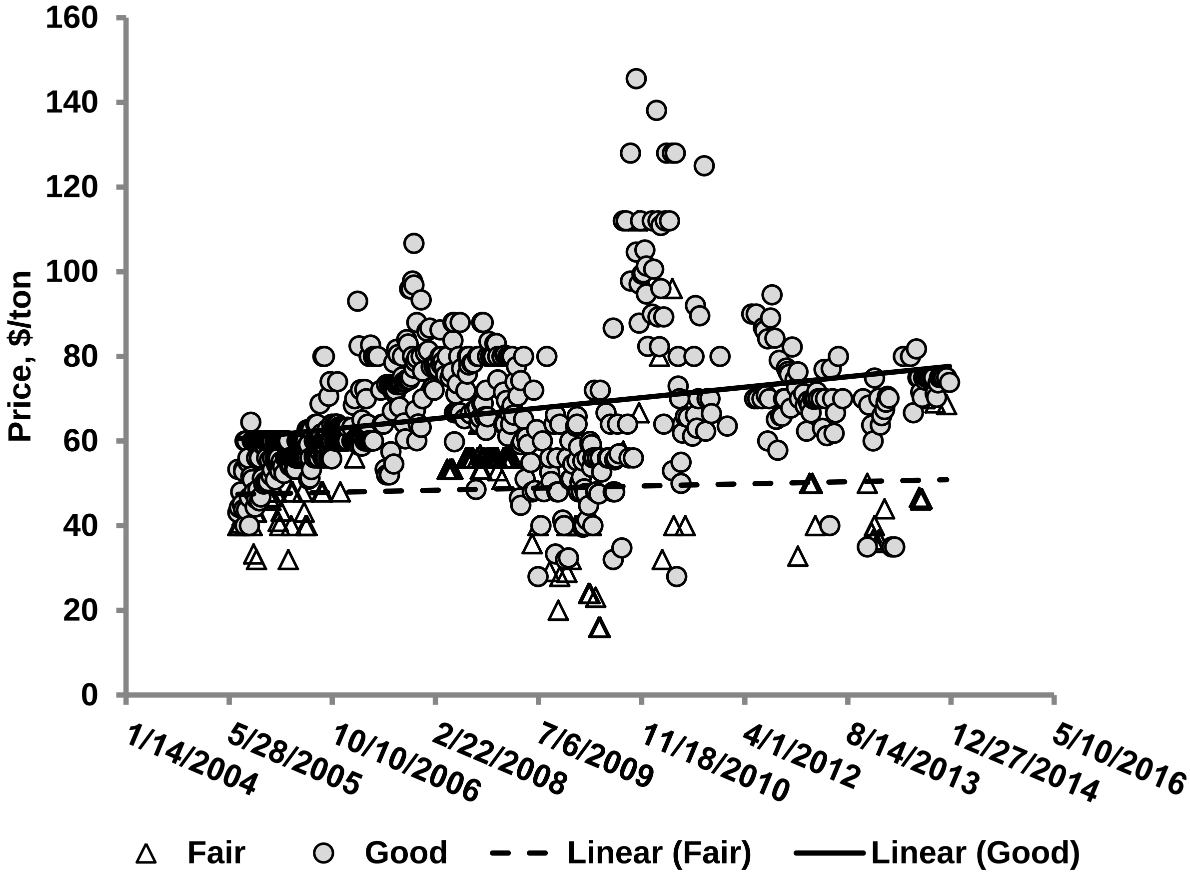

Figure 1. Hay prices ($/ton) recorded by USDA Agricultural Marketing Service for Bermuda grass hay of fair or good quality in the Southeast from September, 2005 to December, 2014.

Hay Procurement and Storage

Under most operating conditions in cow-calf enterprises, hay is purchased as a supplement to homegrown forage supplies due to a shortage of forage of the appropriate quality or reduced supply owing to insufficiency of hay acres, drought or both. A mature, 1,200-lb cow of British × Brahman breeding requires procurement or supply of hay with 52% or 60% TDN during late and early lactation, respectively. Using dry matter intake (**DMI**) guidelines (NRC, 2000), such a cow will consume 2% of her body weight (**BW**) as DMI. This means that cow-calf operators must provide a minimum of 24 lb of DM/cow daily or the equivalent of 740 lb DM/cow monthly. Estimates made from data derived from USDA on feeding hay (http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx) indicate that a supplemental hay feeding period of 120 days is needed. This value translates to a total DM need of 2,880 lb DM/cow, 3,400 lb as-is/cow, or about 3 medium-sized bales per cow. These values assume no losses during storage or feeding.

Hay was stored under protective structures in only 1 out of 3 feedlots regardless of the size or region of the country surveyed (USDA, 2013). Although similar national data for cow-calf operations does not exist, we expect that a similar or smaller proportion of cow-calf operations store their hay under protective structures.

A 100-cow herd will need to store up to 300 hay bales (84% DM). This would require a hay storage building measuring 65’ × 60’ with 16’ height at the eaves. Estimates of building costs for this building range from $35,000 to $60,000 depending on materials, concrete costs and nearness to building suppliers. The reader is referred to specific commercial and university contacts and websites to address questions regarding building size and structure for their individual situation. For a 20-year depreciation schedule, and a building cost of $45,000, the share of structure costs per cow per year would be $22.50/cow or $13.25/ton. At hay feeding costs of $120/cow/year, composite hay (as-is) losses of 19% from procurement to feeding would break even with the costs of building this structure. This hay loss value will be significantly greater if we include measured hay waste losses during storage and feeding under experimental conditions.

Although many extension-based publications report hay losses during storage, it is generally difficult to reference the original research articles from which these publications are sourced. Yet, DM losses from 1,000-lb large round bales (fixed-chamber baler) of bermudagrass hay stored on the ground in a single row for 8 months ranged from 3.4% for bales stored in a barn to 9.7% or 14.1% for bales stored outside with the axis-oriented North-to-South or East-to-West, respectively (Huhnke, 1990a). Thus, although 100% reduction in storage losses is impossible, a reduction in hay DM loss from 14% or 10% to 3% through storage in a barn is feasible. More importantly, hay in vitro DM digestibility (**IVDMD**) decreased significantly ($P < 0.01$) from 56.1% or 52.3% at the beginning to 48.9% or 45.2% at the end of the storage period for bales stored outside in a single row with the axis-oriented from North-to-South or East-to-West, respectively. This decrease in IVDMD reduced the energy concentration of hay beyond the minimum required to feed late-gestating beef cows. Although IVDMD from hay in bales stored in a barn also decreased significantly ($P < 0.01$; 57.9% vs. 54.5% at the beginning and end of storage period, respectively), the magnitude of the decrease was 50% less (Huhnke, 1990a). The author of the study reported similar effects of weathering on DM and IVDMD losses in large round wheat hay bales during storage in a separate study (Huhnke, 1990b).

Hay Feeding

Current State of Knowledge

Most cattle producers in the U.S. feed hay to cattle in the form of a round bale for the simplicity of handling and management. Depending on herd size, facilities and equipment, producers deliver hay to last for at least one day. Options for managing feed intake by producers with small herds and no access to equipment are few. When relying on bale feeders, the minimum feeding unit is a bale. Because a single mature cow accounts for disappearance (intake and waste) of up to 40 lb DM, when single bales (weighing 1,000 lb) are placed on feeding sites, producers need approximately 25 cows to use an entire bale in a single day. Alternatives to bale feeder feeding are rolling the bale out on the pen surface, or investing in feeding delivery equipment and concrete or wooden bunks to manage intake at increments on par with the number of cows in the group.

As expected, feeding forage on the pen surface and delivering forage at amounts greater than needed for a single day leads to greater forage wastage. Relative to hay waste of 5% in a hay ring feeder, cows fed loose hay on the pen surface wasted from 11% when offered a 1-day supply to 31% when offered a 4-day supply (Smith et al., 1974). Similarly, forage DM waste was 24% (Year 1) to 34% (Year 2) when calves were permitted to graze windrowed forage, whereas offering forage from the same source as the dried hay in a ring feeder led to forage DM waste of 12% to 13% DM for years 1 and 2, respectively (Volesky et al. 2002). Results from this study were confounded by moisture concentration of forage and forage placement.

The extent of waste management by using feeding structures varies widely. Cows given free-choice access to hay delivered in a manner to prevent the feeder from being empty in a 24-h period wasted more hay from trailer- and cradle-type feeders than cows given access to hay delivered in a ring or cone feeder (cone over a ring) (Buskirk et al., 2003). Measures of cow behavior, particularly, negative interactive behaviors, apparently arising from hay feeder design were correlated with hay waste. Cradle design feeders led to more aggressive behavior at the feeder, caused cows to access the feeder in a manner inconsistent with the manufacturer’s projections, and caused greater feeder occupancy (Buskirk et al., 2003).

Alternatively, limiting access to the hay feeder is an option to reduce waste that is particularly appropriate for small herds owned by operators who have off-farm jobs. In a recent study, lactating beef cows (with calves) were permitted limited access to hay ring feeders for 4 or 8 hours or given 24-hour access (Cunningham et al., 2005). Cows given access for 4, 8 or 24 hours consumed 20.1, 28.2 or 29.3 lb of DM daily and wasted 2.4, 4.0 or 6.4 lb of DM daily, respectively. In this study, total disappearance (intake + waste) but not waste alone increased linearly with access time. In a similar study, cows in their last trimester of gestation were given access to hay in ring-type feeders for 6, 9 or 24 hours (Miller et al., 2007). There was a linear trend for cows given longer access time to consume more hay, but a quadratic trend for cows to waste more hay. The latter was because less hay was wasted when cows were given access to hay for 9 hours, than for 6 or 24 hours. Estimates of hay waste for cows offered access for 9, 6, and 24 hours were 8.5% vs 16.1% and 16.4% of DM offered, respectively.

Interactive Hay and Supplement Feeding Factors Affecting Waste

It is clear that a variety of factors including amount of forage offered, feeder type (as illustrated above or lack thereof), intrinsic forage or supplement characteristics (processing or supplement type) and access time to forage all interact to influence the amount of forage or supplement waste. For a series of experiments, we hypothesized that hay placement, hay processing and energy supplement type and placement (in a feeder or on the pen surface) each affect DMI and hay or energy supplement waste. We further hypothesized that greater access time to round bale feeders would result in greater hay intake and waste.

Materials and methods

In a series of 3 short-term (10-day), experiments with Latin Square designs, we examined whether hay processing (whole or ground) and placement (hay ring feeder or bunk vs. pen surface; Experiment 1), energy supplement placement (bunk, tire or on the pen surface) and type (wet beet pulp or dry corn grain screenings; Experiment 2; hay was fed in hay ring feeder) and access time to hay (6, 14 or 24 hours; Experiment 3; hay was fed in hay ring feeder) would affect hay, energy supplement or mineral supplement DMI or waste by late-gestating beef cows. Cow BW was measured at the start and end of each Latin Square period after withdrawing feed and water for 16 hours to eliminate effects of gut fill on weight.

In all experiments energy, protein, vitamins and minerals required for maintenance and gestation were determined based on breed and weight (NRC, 2000), and feed was offered accordingly. A 5-yr-old, 1,350-lb Angus cow at a body condition score of 5 (250 d in gestation) was used as a model to calculate nutrients required for maintenance and gestation. The original calculation for DMI was based on brome hay containing 56% total digestible nutrients (**TDN**) and 10.5% crude protein (**CP**). Estimating a DMI of 1.9% of BW yielded an expected intake of 26 lb of brome hay/cow daily with a 0.48 Mcal NE_m energy deficit. Wet beet pulp (**pulp**) or dry corn grain screenings (**screenings**) containing 65 or 87% TDN, respectively (Table 1) were used to supplement energy in Experiment 2 resulting in the need to feed 10 lb of pulp DM or 2.7 lb of screenings DM to eliminate the energy deficit. The projected daily NE_m deficit was ignored in Exp. 1 due to the short term of this experiment and the objective of focusing on effects of hay processing and placement in this experiment.

In experiments 1 (1,343 lb; 12 cows/group and 3,600 ft^2/cow) and 2 (1,418 lb; 10 cows/group and 4,800 ft^2/cow), cows had access to a 225-lb vitamin and mineral supplement tub rated by the manufacturer to supply sufficient nutrients for 25 to 30 head (Table 1). Consumption of 0.25 to 0.50 lb daily was expected. Each treatment group had free choice access to a 50-lb white-salt block. In Experiment 3 (1,327 lb; 8 cows/group and 546 ft^2/cow), cows had access to a free choice, loose complete vitamin and mineral mixture to meet their mineral needs (Table 1). Loose complete vitamins and minerals were mixed at a 50:50 ratio with granulated white-salt. Water was accessible at all times.

Feed offered in the form of hay or supplement was weighed immediately before delivery. Individual round bales were sampled by taking 15 cores per bale from the twine or round side of the bale before delivery for nutrient analyses and the twine was removed. Supplement samples were collected for analyses at the start of every period by collecting 5 random grab samples. All feed samples were then frozen for further analyses.

Table 1. Nutrient concentration means of grass hay, wet beet pulp and dry corn screenings (dry matter basis) and guaranteed analyses (as-is) of mineral supplement for each experiment

	Hay [1]			Mineral supplement		Beet pulp	Corn screenings
Experiment:	1	2	3	1 and 2	3	2	2
Nutrient							
DM, %	89	89.6	90	96.9	-	26.6	89.8
CP, %	10.4	10	8.8	9.7	-	7.4	6.8
ADF, %	36.8	37	46.4	0.01	-	34.7	3.4
NDF, %	58.3	59.1	68.1	0.7	-	53.5	10.9
ASH, %	6.3	6.3	7.5	29.4	-	17.3	2.2
TDN, %	63.8	63.7	52.1	81.4	-	64.7	86.9
Ca, %	-	-	-	5	13	-	-
P, %	-	-	-	3.5	6	-	-
Mg, % max	-	-	-	1.5	1.5	-	-
K, % min	-	-	-	4	1.5	-	-
Zn, ppm	-	-	-	3,750	3,600	-	-
Mn, ppm	-	-	-	1,250	3,600	-	-
Cu, ppm	-	-	-	1,250	1,200	-	-
Co, ppm	-	-	-	30	12	-	-
I, ppm	-	-	-	68	60	-	-
Se, ppm	-	-	-	13	27	-	-
Vit A, IU/lb	-	-	-	80,000	300,000	-	-
Vit D3, IU/lb	-	-	-	20,000	30,000	-	-
Vit E, IU/lb	-	-	-	100	300	-	-
NaCl, %	-	-	-	-	25	-	-

[1] Average nutrient concentration across experimental periods.

Deliveries occurred daily for cows fed hay in bunks or those supplemented with screenings or pulp. Hay deliveries to ring feeders as whole round bales were made after visual observations of the amount of hay left in the ring. Additional bales were not delivered if the hay left in the feeder was expected to last over 12 hours. Hay deliveries on the pen surface were based either on projected intake (processed hay piled on the pen surface) or by rolling a whole bale out on the pen surface. Daily hay deliveries to feed bunks were based on estimates of intake and waste (29 lb DM/cow) for that group. Delivery time and amount were recorded at the time of delivery.

Hay or supplement waste (left on the pen surface or in the structure where it was delivered) was collected when additional hay or supplement was delivered by measuring the overall waste area and randomly sampling the hay within a 1-ft^2 metal quadrat placed on the hay to obtain representative sub-samples. Subsamples were collected from an area approximately 2% of the size of the total area occupied by the waste and waste samples were frozen for further analysis. Waste was expressed as a percentage of measured DMI. This was done to present results in terms of required feed inventory (feed intake + waste) rather than as percentage of feed offered (feed offered is based on estimated intake and waste).

Experiment 1 results: Effects of hay processing and hay placement

Feeding long or ground hay to beef cows in a feeder (hay ring or feed bunk) or on the pen surface did not affect ($P > 0.33$) hay intake expressed as lb/d or proportion of cow BW (Table 2). Hay waste was greater ($P < 0.01$) when hay was fed on the pen surface rather than in a feed bunk or hay ring. Intake of mineral supplement was affected by hay processing. Cows fed processed hay (on the pen surface or in a bunk) consumed more ($P < 0.01$) mineral supplement than those fed long or whole hay (on the pen surface or in a hay ring feeder). A trend for greater ($P = 0.08$) mineral supplement intake by cows fed on the pen surface was observed. Similarly, a trend ($P = 0.058$) for an interaction between feeder type and processing was observed for mineral supplement intake because cows fed long hay in a ring feeder consumed the least amount of mineral supplement. Yet, cows fed ground hay in a bunk or on the pen surface consumed the greatest amount of mineral supplement; consumption of mineral supplement by cows fed long hay on the pen surface was intermediate. Total DMI averaged 2% of the cow's BW and was not affected by hay feeding method or processing.

Estimates of waste resulting from placing hay in a feed bunk or hay ring feeder were similar to those reported previously. Estimates of waste from placing processed or unprocessed hay on the pen surface were also similar to those reported previously. Thus, feed inventory required when using a hay ring feeder or a feed bunk would need to be nearly 5% greater than the expected intake or it would need to provide an additional 1.35 lb DM/cow daily. The feed inventory required if a feeder is not used would need to include an extra 5 lb DM/cow daily over the expected DM intake or be about 19% greater than the expected daily DM intake of the cow.

We did not expect hay feeder or hay processing to impact mineral supplement intake. Cow eating behavior and eating rate may have been affected by hay processing, which may have resulting in greater mineral supplement intake by increasing the hay intake rate. Dairy cows fed alfalfa hay chopped to a theoretical length of 15 mm ate at a faster rate (11% more lb/min) than those fed the same hay chopped to a theoretical length of 30 mm (Nasrollahi et al., 2014). Absence of a feeder likely resulted in increased trampling and led to the greater hay waste measured when hay was placed on the pen surface. This likely prompted cows to spend more time at the mineral supplement feeder to compensate for the perceived lack of “good feed” at the site where the hay was fed.

Table 2. Hay, mineral supplement and total DM intake and waste by cows fed whole or processed hay in structures (ring feeder or feed bunk) or on the pen surface (Experiment 1)

	Placement		Processing			*P*-values		
Item	Pen surface	Structure	Whole	Processed	SE[1]	Placement	Processing	Placement x Processing
Hay								
Intake, lb/day	24.9	26.2	25.8	25.4	1.1	0.33	0.70	0.50
Intake, % BW	1.9	2	1.9	1.9	0.1	0.33	0.70	0.40
Waste, % [2]	19.1	4.6	13.6	10.1	2.2	<0.01	0.26	0.60
Mineral supplement								
Intake, lb/day	1.5	1.3	1.1	1.7	0.1	0.08	<0.01	0.06
Total								
Intake, lb/day	26.5	27.6	26.9	26.9	1.1	0.42	0.97	0.40
Intake, % BW	2	2.1	2	2	0.1	0.42	0.98	0.40
Waste, % [2]	18.1	4.4	13	9.5	2	<0.01	0.22	0.6

[1] Standard error.

[2] Waste expressed as a proportion of intake

Experiment 2 results: Effects of supplement type and placement

Feeding cows hay and no energy supplement or hay and screenings in a feed bunk led to greater ($P < 0.05$) hay consumption than other approaches (Table 3). Feeding cows hay and screenings in a tire led to intermediate consumption of hay, which was greater ($P < 0.05$) than hay consumption by cows fed hay and pulp delivered in a bunk or tire.

Table 3. Hay, supplement and total DM intake and waste by cows fed wet or dry energy supplements (suppl.) placed in structures (ring feeder or feed bunk) or on the pen surface (Experiment 2)

	Control	Wet beet pulp			Dry corn screenings		
Item	No suppl.	Bunk	Tire	Pen surface	Bunk	Tire	SE[1]
Hay							
Intake, lb/d	29.1[a]	22.7[c]	24.3 [c]	25.6[bc]	28.7[a]	26.5[b]	1.1
Intake, %BW	2.1[a]	1.6[c]	1.7[c]	1.8[bc]	2.0[a]	1.9[ab]	0.1
Waste, % [2]	9.8[a]	18.1[c]	10.4 [ab]	11.7[ab]	11.2[ab]	12.1[b]	1.2
Energy suppl.							
Intake, lb/day	0.0[a]	7.7[b]	7.7 [b]	6.6[c]	2.9[d]	2.9[d]	0.2
Waste, % [2]	0.0[a]	2.1[a]	2.4 [b]	21.9[c]	0.00[a]	0.00[a]	1.1
Mineral suppl.							
Intake, lb/day	1.0[a]	0.7[d]	0.9[abcd]	0.9[abc]	0.7[cd]	0.8[bcd]	0.1
Total							
Intake, lb/day	30.2	30.9	32.4	33.5	32.4	30.2	1.3
Intake, % BW	2.1	2.2	2.3	2.4	2.3	2.1	0.1
Waste, % [2]	9.5[bc]	13.5[a]	8.1[c]	12.8[a]	9.9[bc]	10.6[b]	1.1

[a,b,c,d] Within a row, least square means without common superscript letters differ ($P < 0.05$).

[1] Standard error.

[2]Waste expressed as a proportion of intake.

Mineral supplement intake was lower ($P < 0.05$) for cows fed pulp in a bunk compared to those fed no supplement or pulp on the pen surface. Mineral supplement intake was similar ($P > 0.10$) among cows fed pulp in a bunk or tire or those fed screenings in a bunk or tire. Mineral supplement intake was greater ($P < 0.05$) for cows fed no energy supplement than those beet pulp in a bunk or screenings in a bunk or tire.

Hay or supplement waste differed based on supplement type and placement. None of the screenings was wasted when it was fed; resulting in a similar ($P > 0.10$) energy supplement waste value to that in cows fed no energy supplement. Hay waste was greatest ($P < 0.05$) when pulp was placed in a bunk; yet, energy supplement waste was greatest ($P < 0.05$) when wet beet pulp was placed on the pen surface. Both of these treatments resulted in the greatest ($P < 0.05$) total feed waste in spite of giving lower supplement and hay waste, respectively. Feeding pulp in a tire resulted in relatively low hay and supplement waste, which resulted in among the lowest total feed waste values.

When feeding pulp, delivering the supplement in a tire feeder led to less total feed waste comparable to other placements for the supplement or to feeding screenings in the tire. Nevertheless, feed wastes were substantially lower when cows were fed screenings in the tire or bunk versus feeding pulp in the bunk or on the pen surface. Cows fed wet beet pulp in the bunk may have had among the lowest mineral intakes because they spent more time at the bunk than at the mineral feeder. The greater time spent at the bunk on this treatment may explain why more hay was wasted on this treatment than others.

Experiment 3 results: Effects of access time

Cows given access to hay feeder rings for 24 hours consumed and wasted more ($P < 0.05$) hay than those given 6 or 14-hour access (Table 4). Cows given access to hay for 6 hours consumed and wasted less ($P < 0.05$) hay than those given access for 14 hours.

Table 4. Hay DM intake and waste by cows given access to hay in feeder rings for 6, 14, or 24 hours (Experiment 3)

	Access to hay rings, hours				Contrast *P*-values	
Item	6	14	24	SE[1]	6- or 14-hour access vs. 24-hour access	6 vs. 14 hours
Hay						
Intake, lb/day	21.2	24.5	27.3	0.2	< 0.01	< 0.01
Intake, %BW	1.6	1.8	2.1	0.0	< 0.01	< 0.01
Waste, % [2]	0.1	4.3	7.7	0.5	< 0.01	< 0.01

[1] Standard error.
[2] Waste expressed as a proportion of intake.

Average BW was not affected by access time to hay feeders; therefore, on all treatments, the energy consumed from hay was sufficient to maintain BW and fetal growth. Assuming that 11.43 Mcal NE_m/d were required for these functions for cows weighing 1,327 lb (94 kcal NE_m/kg $BW^{0.75}$), then cows in each of these treatments consumed 102, 91 and 79 g DM/kg $BW^{0.75}$ for maintenance and fetal growth. These values reflect NE_m concentrations achieved when cows consumed feed for 24 hours (ad libitum) or for 14 or 6 hours of 0.92, 1.03 or 1.19 Mcal/kg DM, respectively (g DM/kg $BW^{0.75}$ divided by NE_m expressed as kcal/kg BW $^{0.75}$). Corresponding ME concentrations were 1.76, 1.87 and 2.04 Mcal/kg DM. The expected ME concentration based on chemical analyses of hay fed to these cows was 1.88 Mcal/kg DM. Therefore, cows given 14-hour access to hay feeders achieved the expected diet metabolizability of hay.

Cattle limit-fed a high-energy diet had greater diet dry matter digestibility (Klinger et al., 2007) than those fed a high-forage diet ad libitum. In the present experiment, DE concentration derived from ME reflected the finding that cows given access for 14 hours digested hay at expected values while those fed for ad libitum access had 6.1% less energy digestibility. Cows given access to hay for 6 hours had 9.4% greater energy digestibility.

Conclusion

When forage and grain prices are high, cow-calf operators should focus management efforts to preserve feed resources. The value of hay DM lost during storage nearly pays for construction costs of a new hay barn. Hay DM waste during feeding can range from a minimum of 5% when hay ring feeders are used to as much as 10 to 18% when wet energy supplements are fed. Therefore, when hay losses during storage and feeding are considered, the total hay waste could be as much as 30% of the harvested or purchased hay.

Zero waste is impossible, but literature values and those from the current experiment place hay waste at feeders at 5% and hay losses during storage at 3%. At current hay prices ($70/ton) and projected needs for a cow fed hay for 120 days (1.7 ton as-is), the value of differential loss between cumulative 30% or 8% losses is $26/cow or $2,600 in a 100-cow herd. As indicated above, construction costs for a hay barn of $45,000 depreciated over 20 years in a 100-cow herd were determined to be $22.50/cow. Thus, it may be more cost-effective to invest in a hay barn than continuing to store hay outside in situations where hay waste is high during either storage or feeding or if wastage of hay is increased because of poor choice and placement of an energy supplement.

When no energy supplement was used in Experiment 1, mineral supplement intake was at least 75 to 100% greater than that recommended by the manufacturer. The site selection for mineral feeders was far from water or feed sites and surface area allocation per cow in these experiments was nearly 1 tenth of an acre. Effects of cold weather could not be discounted. Under these conditions, consumption of mineral at intakes recommended by the manufacturer were only achieved when cows were fed long hay. Further evidence that energy supplementation reduces excessive mineral supplement consumption was provided by the observation that energy supplementation with either dry supplements or a wet supplement (placed in a bunk), prevented over consumption of the mineral supplement (Experiment 2). In this experiment, cows fed no energy supplement consumed the mineral at nearly the same rate as cows in

Experiment 1 (1 vs 0.9 lb/d, respectively). Energy supplementation to prevent over consumption of mineral supplements is not recommended, but cow-calf operators are encouraged to manage mineral supplementation by limiting the rate at which they replace minerals in feeders after cows empty them.

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SESSION NOTES