Effects of bale feeder type and processing on hay waste, intake, and performance of beef cattle

A. J. Sexten, C. P. McMurphy, G. L. Mourer, C. J. Richards, C. Jones, R. Huhnke, and D. L. Lalman

STORY IN BRIEF

Four experiments were conducted to evaluate the effects of hay processing and bale feeder type on hay waste, intake, and performance of beef cattle. Experiment 1 used 64 crossbred gestating beef cows with two levels of hay processing (long stemmed [L] and pre-cut [PC]) and two levels of hay feeder type (conventional ring feeder [**RING**] and cone [**CONE**]). There was less hay waste from L than PC at 8.31% and 12.97% respectively ($P < 0.05$). CONE feeders were more efficient at 6.77% compared to RING feeders at 14.51% ($P < 0.05$). There was no effect on DMI due to hay or feeder type. Experiment 2 utilized 57 crossbred, weaned calves to evaluate the effect of hay type on intake preference. Calves were provided with two hay feeders in each pen with one of each of the hay treatments, L and PC. There was a trend for a preference to the PC hay by the calves ($P = 0.06$). The third experiment utilized 96 crossbred, weaned calves to determine the effect of hay type on post weaning performance. Calves fed the L hay had an ADG of 1.83 lb/d, as compared with calves fed the PC hay that had an ADG of 1.78 lb/d ($P < 0.55$). In the final experiment, cow/calf pairs were used to evaluate the effect of hay type on hay waste and intake. All pastures used Bextra modified cone bale feeders. There was less (P < 0.03) wastage with L (4.99%) compared with PC (12.87%) hay. There were no differences between hay types regarding DMI. Based on all experiments it was conclude that hay type and feeder type can have a dramatic effect on hay utilization by beef cattle and thus potential for profitability.

Key Words: beef cattle, hay feeders, hay feeding, hay waste, pre-cut hay

INTRODUCTION

Harvesting forage during the summer months for delivery during winter is a common practice for most cow/calf producers. Survey data from Oklahoma State University found that 45% of all producer respondents fed hay between 91 and 120 d each winter (Vestal et al., 2007). When evaluating standardized performance analysis, hay costs are a major contributor to the cost of production in cow/calf operations. Large round bales are the form of hay typically provided to cows in the Southern Great Plains and Midwest during the winter months.

Numerous round bale feeding methods are used including unrolling, feeding whole bales with no hay ring, and feeding whole bales with the use of some type of a hay feeder or ring. Hay fed with no ring feeder resulted in 45% hay waste, while waste was limited to 9% when a ring feeder was used (Bell and Martz, 1973). However, dozens of hay ring designs are on the market today ranging in cost from approximately $200 to $2500. Buskirk et al. (2003) compared four different round bale feeder types and found that cone feeders were the most effective at limiting hay waste (3.5%) followed by the typical hay ring (6.1%). These scientists also found that, with the typical hay ring, cows more often reached over the top to consume hay as compared to the cone model.

Processing of dry roughage has been shown to increase particulate passage rate, resulting in an increase in DM intake (NRC, 2000). If hay could be coarsely cut or chopped during the baling process, hay intake and thus, animal performance may be improved with minimal increase in cost due to processing. Therefore, the objective of this study was to determine the effects of hay feeder type and hay processing on hay waste, hay intake and animal performance.

MATERIALS AND METHODS

Hay Production. Four lots of first cutting hay, three which contained primarily a mix of big bluestem, little bluestem, switch grass, and Indian grass, and one which contained primarily common bermudagrass, were baled on July 14 and 15, 2009. Hay was baled either by a conventional round baler (John Deere, Ottumwa, IA: Model 568) or another of the same baler type that was fitted with a mechanism to cut the hay as it was fed into the baler. Bales produced by the conventional baler were the conventional long stemmed round bales (L), while those produced by the pre-cutting baler were denoted as pre-cut bales (PC). Both balers operated in the same hay meadow at the same time to insure that hay quality was similar among treatments. The round bales were removed from the field within 1 wk of baling and sorted by source or hay meadow and stacked on the ground in rows until fed. Two weeks prior to the onset of the experiments bales were sampled for nutritive analysis. The proximate analysis results for the native range hay were: 93.9% DM, 6.29% CP, 42.56% ADF, 69.74% NDF, and 0.13% ADIN on a % DM. The bermudagrass hay proximate analysis results were 93.7% DM, 11.04% CP, 38.43% ADF, 73.8% NDF and 0.14% ADIN. Ruiz et al. (1995) reported that NDF concentration is negatively related to the energy concentration of feeds and positively related to the gut fill effect of the diet, potentially limiting DMI. Additionally, Coblentz et al., (2000) found that ADIN was positively related to incidences of spontaneous heating within round bales. Considering this, the bales were sorted into feeding order within treatment based off of NDF and ADIN values. This was designed to insure that treatment groups were receiving hay of similar nutritive value.

Experiment 1. Sixty-four crossbred beef cows (1300 ± 129lb) in late gestation were used in a 4x4 Latin square experiment to determine the effects of hay processing prior to baling and round bale feeder type on hay waste and intake. Sixteen cows were randomly assigned to one of four previously grazed two-acre pastures that each contained a 40 x 25 ft^2 concrete feeding pad. The experiment was set up in a with a 2 × 2 factorial treatment arrangement. The pastures were assigned one of two different round bale feeder types: Cone (CONE) or a Conventional Ring (RING) feeder. The pastures were also assigned one of two bale treatments: L or PC. The treatments were rotated between each pasture so that each pasture received each treatment combination once during the experiment.

During a collection period the cows were adapted to the treatment combination for 10 d. They had ad libitum access to the hay and received 2 lb/head of supplemental dried distiller's grains with soluble **(DDGS)** daily. On d 10 the remaining hay in the feeder was removed and all manure was cleaned off of the feed pad. After cleaning, the feeder was put back onto the feed pad and a fresh bale was weighed and placed into the feeder. Waste was defined as hay outside of the feeder and orts were defined as hay inside of the feeder. Waste was sorted into manure contaminated and uncontaminated groups and different dry matter values were calculated for each of the groups to better determine the amount of waste for each bale. Waste was collected, weighed and sampled at 24 and 48 h after initial placement of the bale into the feeder. Orts were collected weighed and sampled 48 h after the initial placement of the bale into the feeder. After the collection period was complete the feed pads were again cleaned and fresh bales were placed in the feeders and the process was repeated for another 48 h, providing two replicates of each treatment combination from each pasture. Once the second replicate for the treatment combination was complete the feed pads were again cleaned and the treatments were rotated to a different pasture and a new collection period was started. Results were analyzed using the MIXED model of SAS, with the fixed effects being feeder type and hay type. The random effects were pasture and period, with pasture as the experimental unit.

Experiment 2. Fifty-seven crossbred, weaned calves (658 ± 93lb) were used in a completely random design to evaluate hay preference. Calves were randomly allotted by weight to one of three pastures, each equipped with two identical round bale feeders. Within each pasture, one bale of each hay type, L and PC, was placed in one of the two feeders. Calves had ad libitum access to both hay types as well as to creep feeders and water. The creep feeders contained a balanced ration that utilized salt to limit intake of the feed by the calves.

Each collection period was 1 wk long, with the exception of the 1st wk which was shortened to 5 d due to inclement weather. Waste was not collected during the experiment due to weather and the potential of contaminated samples due to the feeders being located in the pastures. Orts were collected at the end of each collection period as well as weighed and sampled. Hay disappearance was calculated by subtracting the ort weight from the initial bale weight. Waste data from Experiment 1was used to calculate and adjust the average intake of each hay type within a pasture.

Experiment 3. Ninety-six crossbred weaned calves (573.7 ± 64.5lb) were used to conduct a randomized complete block designed experiment to evaluate the effect of hay processing on the post-weaning performance of beef calves. The calves were ranked by weight within gender and randomly allotted to 1 of 8 pens equipped with a RING feeder and automatic waterer. Each pen was then randomly assigned one of two hay type treatments, L or PC, for the duration of the experiment. This supplied 2 pens of each hay type within each gender. Calves were weighed on d 0, 1, 44 and 45 and the average of d 0 and 1 were used to calculate calves' beginning weight, while the weights from d 44 and 45 were averaged to calculate ending weight. Ad libitum access to the hay was provided along with 5 lb of DDGS per head daily. Results were analyzed using the MIXED model of SAS, with the main effect being hay type, and the random effect being pen within block. Pen was the experimental unit.

Experiment 4. Forty eight crossbred, lactating cows and their calves were used in a randomized complete block design to assess the effect of bale processing on hay waste and intake. Pairs were ranked by weight so that cow weight, calf weight and calf age were equal across all pastures. The average pair weight was 1433 ± 9.9lb. Twelve pairs were allotted to each of the four pastures used in Experiment 1. Pairs remained in the same paddock throughout the experiment. Hay treatments, L and PC, were randomly allotted to two of the four pastures. Pairs had ad libitum access to the hay and were provided with 3 lb of DDGS daily. There was a 10-day adaptation for the pairs to become familiar with the paddocks as well as the Bextra modified cone feeders being used in the experiment. Upon completion of the adaptation period each collection period was 48 h long. Similarly to Experiment 1 the feed pads were cleaned of manure and hay and a fresh bale was placed in the feeders. Waste was collected, weighed and sampled at 24 and 48 h. Orts were collected, weighed and sampled at 48 h. Upon the completion of the collection period the feed pads were cleaned and a fresh bale was provided to begin the next collection period. This was done for a total of four replications. Results were analyzed using the MIXED model of SAS with hay type being the main effect, pen being the random effect, and period being the repeated measure. Pen was the experimental unit throughout the experiment.

RESULTS AND DISCUSSION

Experiment 1. The effects of hay type and feeder type on hay waste are shown in Table 1. There was no hay type by feeder type interaction (P = 0.50). Therefore, data are presented for main effects only. There was a difference in hay waste between the two hay types. Feeding L hay resulted in 8.31% waste whereas feeding PC hay resulted in 13.0% waste ($P < 0.05$).
Use of RING feeders resulted in 7.7% ($P < 0.05$) more waste compared with CONE feeders. This is consistent with the findings of Buskirk and others who found that CONE feeders reduced waste more effectively than RING feeders, yielding 3.5 and 6.1% waste respectfully. Comerford et al., (1994) also found that CONE feeders were more efficient than RING feeders at reducing waste citing losses of 1.9% and 8.0%, respectively.

Table 1. Effects of hay type and feeder type on hay waste

	Treatments					
Bale Waste, %	L	PC	RING	CONE	SEM	*P*-value
Hay	8.3	13.0			1.1	< 0.01
Feeder			14.5	6.8	1.1	< 0.01

The effects of hay and feeder type on hay intake is in Table 2. There was no hay type x feeder type interaction (P = 0.49). No difference was found regarding DMI between hay types. Total pen 48-h intake was calculated as the initial bale weight offered less than the total combined waste and orts weight. Cows consuming L hay ate an average of 0.6 lbs/d less than cows consuming PC hay ($P < 0.53$). Feeder type did not influence DMI. The CONE feeder had an average DMI of 1.7 lb/d more than the RING feeder ($P < 0.23$).

Table 2. Effects of hay and feeder type on hay intake

	Treatments					
DMI, lb/d	L	PC	RING	CONE	SEM	*P*-value
Hay	23.0	23.6			24.5	0.53
Feeder			22.3	24.0	24.5	0.23

Experiment 2. The effects of hay processing on beef calf preference is in Table 3. Hay disappearance, which was calculated as initial bale weight less the orts weight, was greater for the PC hay compared to the L hay ($P < 0.06$). Applying waste averages drawn from Experiment 1 to data, average pen intake was calculated. The average pen intake for the PC hay was 67.4% greater than for the L hay ($P < 0.06$). We conclude that there is a trend for a preference of the beef calves for the pre-cut hay. However, more research regarding hay preference with collection of actual waste data needs to be conducted to verify these results.

Table 3. Effects of hay type on beef calves intake preference

Item	Treatments L	PC	SEM	*P*-value
Disappearance, lb	389.2	648.1	109.6	0.059
Average DMI, lb	306.8	513.7	101.3	0.059

Experiment 3. The effects of hay type on post weaning performance of beef calves are presented in Table 4. Post weaning performance of calves was not statistically different between the two hay types. Calves consuming the long stemmed hay had a 2.8% higher ADG than calves that were fed the PC hay (P < 0.55). Similar to Experiment 1, intake was not affected by hay type. Thus we concluded that if the only difference between treatments is cut length then the calves are expected to perform the same.

Table 4. Effects of hay type on post weaning performance of beef calves

Item	Treatments L	PC	SEM	*P*-value
ADG, lb	1.83	1.78	0.1	0.55

Experiment 4. The effects of hay type on hay waste when prairie hay was fed to fall calving cows and their calves, is in Table 5. Hay waste was influenced by hay types in this study, similar to Experiment 1 when dry pregnant cows consumed L or PC prairie hay. Waste was 7.9% less when cows consume L compared with PC hay (*P* < 0.03).

Table 5. Effects of hay type on hay waste

Item	Treatments L	PC	SEM	*P*-value
Bale Waste, %	4.99	12.87	1.06	0.03

The effects of hay type on DMI is Table 6. Similarly to Experiment 1, there were no differences between the two hay types in relation to DMI. DMI was calculated as initial bale weight less waste and orts weights divided by the number of cow/calf pairs in the pen. Pairs consuming L hay ate 0.85 lb/pair less than pairs offered PC hay (*P* < 0.67). We concluded that cattle consumed similar amounts no matter the hay type offered.

Table 6. Effects of hay type on DMI

Item	Treatments L	PC	SEM	*P*-Value
DMI, lb/Pair/d	26.6	27.5	1.23	0.66
DMI as %PW[a]	1.87	1.91	0.08	0.71

[a]PW= Pair weight

Processing (cutting or chopping) hay during the baling process has potential to improve efficiency by eliminating the need to process baled hay prior to incorporation in a total mixed ration **(TMR)**. Beef cattle enterprises that frequently use processed hay in TMRs include feed yards, back grounding yards, receiving yards and some livestock markets. In this experiment, we evaluated the use of PC hay in enterprises where unprocessed hay is traditionally fed to cows and yearlings. While we discovered that feeding PC hay in RING feeders results in more hay waste, this waste can be minimized by utilizing CONE feeders that are commercially available.

LITERATURE CITED

Bell, S., and F. A. Martz. 1973. Res. Rep. Univ. of Missouri Agric. Exp. Sta. Columbia, MO.

Buskirk, D. D., A. J. Zanella, T. M. Harrigan, J. L. Van Lente, L. M. Gnagey, and M. J. Kaercher. 2003. Large round bale feeder design affects hay utilization and beef cow behavior. J. Anim. Sci. 81:109.

Coblentz, W. K., J. E. Turner, D. A. Scarbrough, K. E. Lesmeister, Z. B. Johnson, D. W. Kellogg, K. P. Coffey, L. J. McBeth, and J. S. Weyers. 2000. Storage characteristics and nutritive value changes in bermudagrass hay as affected by moisture content and density of rectangular bales. Crop Sci. 40:1375-1383.

Comerford, J. W., D. R. Buckmaster, and E. H. Cash. 1994. Effects of three storage methods on nutrient losses from harvest, storage, and feeding of large bales. J. Anim. Sci. 72(Suppl. 2):130 (Abstr.).

National Research Council. 1996. Nutrient requirements of beef cattle. 7th Rev. Ed. Natl. Acad. Sci., Washington, DC.

Ruiz, T. M., E. Bernal, and C. R. Staples. 1995. Effect of dietary neutral detergent fiber concentration and forage source on performance of lactating cows. J. Dairy Sci. 78:305 319.

Vestal, M., W. Clement, D. Doye, and D. Lalman. 2007. Cow-calf production practices in Oklahoma Part 1. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-4570/AGEC-245web.pdf Accessed July 10, 2010.

ACKNOWLEDGEMENTS

The authors would like to thank Tim Kraus and the entire team at John Deere, Ottumwa Works for funding, as well as the use of equipment during this research.