Effect of Hay Feeding Methods on Cow Performance, Hay Waste, and Wintering Cost

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The objective of this project was to determine the effect of hay feeding methods on cow wintering cost. A conventional method of rolling bales out on the ground was compared to feeding with a bale processor or feeding in a tapered-cone round bale feeder. The tapered-cone bale feeder reduced waste, decreased the amount of hay required per cow, and decreased wintering cost per cow, while maintaining body condition.

Summary

A three year wintering investigation was conducted to determine the effect of hay feeding methods on cow wintering cost. A conventional method of rolling round bales out on the ground was compared to either shredding round hay bales on the ground with a bale processor or feeding hay in a tapered-cone round bale feeder. The cows used in the study were in the third trimester of pregnancy and were fed for an average of 59 d during the test period. Data recorded from the multiple-year study was then used to prepare an economic analysis model with operating budgets for 100 and 300 head reference herds.

Feeding bales in a tapered-cone round bale feeder increased cow weight gain ($P < 0.01$), resulted in greater positive rib fat depth change ($P = 0.06$), reduced estimated hay consumption an average 10.2% compared to rolling bales out on the ground or using a bale processor to shred hay on the ground ($P < 0.01$), and reduced hay waste in the two years of the study when alfalfa-grass hay was fed, but not when oat hay was fed. Overall, for the three year evaluation period, using the tapered-cone bale feeder reduced wintering cost by 21.0% for a 100-cow reference herd and 17.6% for a 300-cow reference herd compared to feeding with a bale processor.

Introduction

Winter feed cost makes up a large portion of production costs for North Dakota beef cattle producers (Hughes, 1999) and is the single largest variable influencing profitability (Miller et al., 2001). Over the last five years, winter feed costs averaged $144 per head for producers participating in North Dakota's IRM program (Hughes 1999).

The most common method for putting up hay in North Dakota is the large round bale. Rolling round bales out on the ground has been the most common hay feeding method. However, PTO operated bale processors are becoming more popular as labor savings becomes more important. A number of different bale feeders are commercially available. Recently, a tapered-cone round bale feeder has also been introduced.

Michigan State University data suggests feeder type and animal behavior can influence the amount of hay wasted by beef cattle. In a recent study, Buskirk et al. (2003), reported losses of 3.5% (tapered cone), 6.1% (ring), 11.4% (trailer) and 14.6% (cradle feeder). Depending on storage method, length of time forage is stored, forage type, and environmental conditions, forage dry matter losses can range from 2 to 18% (Belya et al., 1985; Baxter et al., 1986; Huhnke, 1987). Hay processors have gained acceptance because they are reported to reduce overall investment in machinery compared to tub grinding and feeding hay with a mixer wagon. While bale processing machines do not have mixing capabilities, they can be used effectively for filling bunks of for feeding on the ground, especially with 'stemmy' hays since the stems are chopped and essentially mixed in the windrow as the cattle are fed, effectively eliminating or reducing sorting problems.

Considering the three methods available for feeding hay during the winter, this study was designed to compare cow wintering performance, hay consumption necessary to maintain cow body condition, labor inputs, wintering cost, and hay waste, when hay was either rolled out on the ground, shredded with a bale processor on the ground, or fed in a tapered-cone round bale feeder.

Materials and Methods

Three hundred-sixty crossbred cows averaging1343 pounds (n = 144 Yr. 1 and n = 108 in both Yrs. 2 and 3, respectively) were assigned randomly to one of twelve five acre wintering lots located at the Dickinson Research Extension Center. There were four pen replicates per treatment.

Treatments:

Conventional Method - Round bales fed by rolling bales out on the ground (Figure 2)

1. Round bales shredded with a PTO-driven bale processor and fed on the ground (Figure 3)

2. Round bales fed by placing the bale in a tapered-cone round bale feeder (Figure 4)

Cows were weighed, visually condition scored, and measured for rib fat depth using real-time ultrasound at the beginning, middle, and end of the 59 d study. Fat depth measurements were taken between the 12^{th} and 13^{th} ribs according to Ultrasound Guidelines Council parameters for carcass measurement. Quantity and quality of hay delivered and feeding time for each system was recorded. Individual bales were weighed and core sampled for subsequent nutrient analysis (Table 1). For years 1 and 2 of the study, an alfalfa-grass mixed-hay was fed. During the last year of the study oat hay was used. Proximate analysis for the forage offered is shown in Table 1. For the purposes of dry matter intake (DMI) prediction, the hay was estimated to contain a net energy for maintenance value of approximately 1.146 Mcal/kg (1.07, 1.14, and 1.31 Mcal/kg for crested, brome and alfalfa hays, respectively). Based on the most current equation for predicting DMI among second/third trimester beef cows (NRC, 1996), initial DMI was estimated using the following formula: $DMI = (SBW^{0.75} \times (0.04997 \times NE_m^2 + 0.04361)/ NE_m)$ where $SBW^{0.75}$ is shrunk body weight (weight, kg x .95) to the 0.75 power, and NE_m is the net energy value of diet for maintenance expressed in Mcal/kg. The DMI value was further adjusted for temperature and postcalving milking ability. Based on mid-point ultrasound fat depth change, the amount of hay delivered to each treatment was increased, if needed, to maintain similar body condition across treatments.

Hay waste was estimated by securing two 40” x 80” carpet pieces to the ground and daily hay deliveries were fed over the carpets for three consecutive days in each of the 12 pen replicates. Twenty-four hours after feeding, the carpets were cleaned and the residual forage and fines were collected, dried (140º F for 72 hrs.), weighed and analyzed for nutrient content. Area of waste was not measured the first year of the study. The second year, area of hay waste was estimated manually by taping the length and width in several locations and the third year the area of waste was measured using GPS spacial mapping. Using an Ag-132 Trimble Receiver the feeding area of waste perimeter was walked. Geolink software, an interface between the Trimble receiver and Arcview software, created a polyline, which was processed by Arcview into a polygon. Arcview and Fujitsu monitor were then used to calculate the area of the polygon.

Cow growth, body condition score, hay intake, fat depth, and waste data were analyzed as a complete randomized design with the GLM procedure of SAS (SAS Inst. Inc., Cary, NC, 2003) using pen as the experimental unit. The model included treatment and year and the two-way interaction between treatment and year. When an interaction was not significant, the data was combined and re-analyzed. Differences were not considered significant when ($P > 0.10$).

Economic Analysis of Winter Feeding Methods

Production measurements and efficiency, time required for feeding, equipment and machinery inputs, and depreciation were used to develop an economic analysis model to compare the three feeding methods using both 100 and 300 head reference herds in the model. The two herd sizes in the model represent the two most common cow herd sizes in North Dakota (ND Agric. Statistics, 2005). The model assumed a winter feeding period of 135 days and hay was priced at $42.50/ton. The tapered-cone round bale feeders were valued at $800.00 each and assumed to feed 13-15 cows. The round bale processor was priced at $15,000. It was assumed bale processor cutting flails would be replaced every 2,500 bales at a charge of $250 including labor. Tractor expenses were based on a 110 horsepower unit in all treatments and allocation was based on typical use in other farm activities of which winter feeding is one of those activities (Lazarus and Selley, 2002). Operation and ownership costs were $27.00 per hour which included a $7.00 per hour labor charge. Based on feeding time measured for each feeding method, tractor time allocation for filling the round bale feeders was calculated to be three minutes per bale and five minutes per bale for the bales either rolled out on the ground or shredded with the PTO driven bale processor.

Results and Discussion

Cows were fed to maintain or improve their starting body condition prior to calving. Cow weight change, hay intake, and body condition score change are summarized in Table 2. Statistically, no year x treatment interactions for growth and BCS were identified, therefore, data for the three years was pooled. Cows fed using the conventional method in which bales are rolled out on the ground gained less ($P < 0.01$) than when cows were fed with either the bale processor or tapered-cone feeder. Starting, ending, and condition score change differed between years, but there were no differences due to treatment ($P = 0.15$).

In addition to visual BCS, an ultrasound fat depth measurement was taken at a rib location between the 12th and 13th ribs to quantify body condition change. Significant variation was measured between years ($P < 0.01$) and within year ($P = 0.06$). During the first two years of the study, cows fed using the tapered-cone feeder had greater rib fat depth increase than either the roll out or bale processor methods (Figure 1). During the third year of the study, rib fat depth change declined from the start to the end of the test feeding period, but the magnitude of the decline did not differ between feeding methods (Figure 1). Cows used during the third year were in better overall body condition at the start of the test feeding period, which may have contributed to the observed condition decline. The decline suggests that the level of energy supplied to all cow groups was not sufficient to maintain starting body condition.

Hay intake to maintain body condition was greatest for those cows fed with the bale processor, intermediate when bales were rolled out, and the least when cows were fed using a tapered-cone bale feeder ($P < 0.01$). On average, when compared to the tapered-cone feeder, 5.0 and 15.3% more hay was fed per cow using the roll out and bale processor methods, respectively.

Waste contributed to the increased amount of hay required among the roll out and bale processor cow groups. An estimate of waste suggested that type of hay and firmness of bales played a significant role in success with the tapered-cone bale feeder. When dense alfalfa-grass hay bales were tied tightly and strings were not removed for feeding (Figure 5), waste around the tapered-cone bale feeder was 4.3 to 5.0 times less than either the roll out or bale processor methods, respectively. However, when loose, poorly tied oat hay bales (Figure 6) were fed in the tapered-cone bale feeder, waste increased numerically, but did not differ compared to the bale processor ($P = 0.30$). Over the three year period, these data suggest that hay waste is minimal with the tapered-cone bale feeder when bales are dense, adequately tied, and strings are not removed prior to feeding.

Economic model analysis suggest that feeding with a tapered-cone round bale feeder offers substantial cost savings per cow arising from reduced hay consumption, equipment cost, and feeding time. Wintering cost per cow for the 100 cow reference herd was $109.10, $127.00 and $100.30 for rolling out bales, shredding with a bale processor, and feeding bales in a tapered-cone feeder (Table 4). The per-cow cost using a 300-cow reference herd was $121.70 as compared to $127.00 for the 100-cow reference herd due to differences in the rate of depreciation between the two herd sizes in the economic model. Using a bale processor to shred bales into windrows before feeding was the most expensive due to greater equipment ownership cost and greater hay intake per cow necessary to maintain comparable condition compared to the tapered-cone bale feeder. Rolling bales out and shredding into windrows with a bale processor increased hay consumption and winter feed cost.

Implications

Using dense, properly tied bales, the tapered-cone feeder was a superior winter hay feeding method when compared to either rolling bales out on the ground or shredding on the ground with a bale processor. Tapered-cone bale feeders reduced waste, decreased the amount of hay required/cow from 5.0 to 15.3%, and decreased wintering cost/cow while maintaining body condition. Economic analysis for the three wintering seasons identified an economic advantage for using the tapered-cone round bale feeding method.

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Table 1. Forage Analysis.

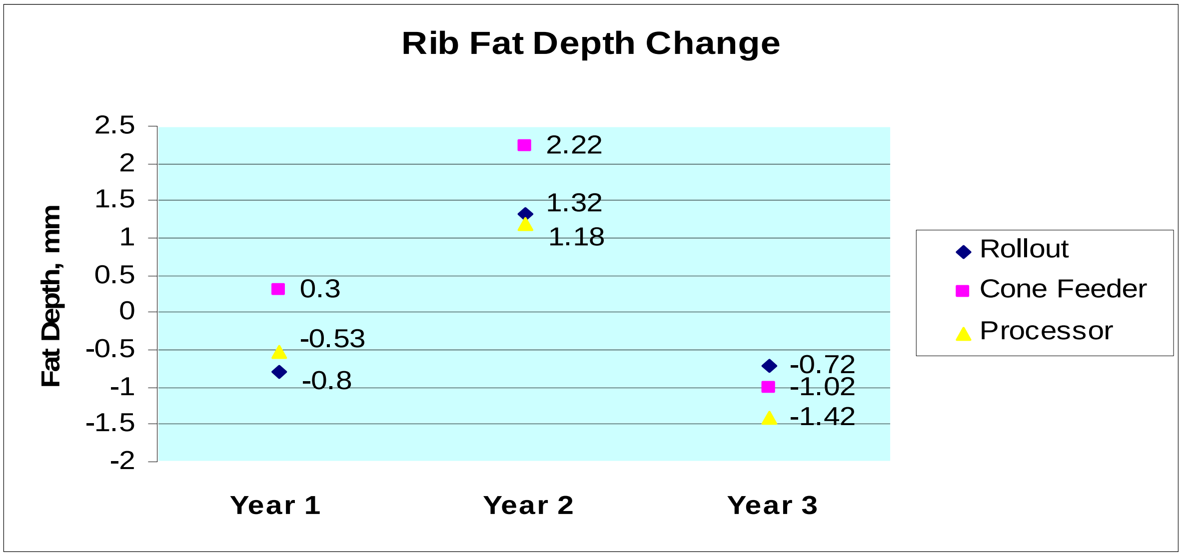
	System			
	Round Bale Rollout	PTO Driven Round Bale Processor	Tapered-Cone Round Bale Feeder	P-Value
Year 1, Alfalfa-Grass Hay				
Dry Matter, %	95.2	94.9	95.1	0.47
Ash, %	9.0	9.2	8.9	0.12
Crude Protein, %	14.6	14.4	14.6	0.87
ADF, %	38.9[a]	39.3[a]	40.7[b]	0.008
NDF, %	53.9	54.6	53.1	0.81
Calcium, %	1.1	1.0	1.0	0.92
Phosphorus, %	.23	.22	.22	0.80
IVDMD, %	59.9	58.1	59.2	0.39
IVOMD, %	58.1	56.2	56.7	0.20
Year 2, Alfalfa – Grass Hay				
Dry Matter, %	95.9	96.8	96.1	<0.01
Ash, %	7.9	8.5	7.4	0.05
Crude Protein, %	9.6	12.1	9.7	0.08
ADF, %	39.3	39.6	41.0	0.42
NDF, %	60.7	60.2	61.5	0.70
IVDMD, %	63.6	63.0	63.5	0.92
IVOMD, %	59.1	57.4	58.9	0.64
Year 3, Oat Hay				
Dry Matter, %	88.9	89.5	88.2	0.17
Ash, %	9.1	9.8	9.6	<0.01
Crude Protein, %	12.8	12.9	13.4	0.02
ADF, %	39.2	39.7	39.2	0.83
NDF, %	70.5	72.9	70.9	0.10
IVDMD, %	62.7	65.1	62.5	<0.01
IVOMD, %	60.7	63.2	60.4	<0.01

Table 2. Three year effect of hay feeding method on cow performance and hay intake.

	Bale Roll Out	Bale Processor	Cone Feeder		P-Value		
				SE	Yr	Trmt	Yr x Trmt
No. Cows	120	120	120				
Days Fed	59	59	59				
Starting Wt., lb.	1358	1352	1363	25.9	0.18	0.96	0.99
End Wt., lb.	1408	1418	1442	23.8	0.07	0.58	0.96
Gain, lb.	50.0[x]	66.0[y]	79[y]	5.98	0.46	<0.01	0.16
ADG, lb.	0.85[x]	1.12[y]	1.34[y]	0.102	0.40	<0.01	0.144
Body Condition Score[a]							
BCS Start	5.88	5.77	5.94	0.087	<0.01	0.38	0.63
BCS End	5.83	5.80	6.01	0.083	<0.01	0.15	0.10
BCS Change	-.04	.029	.07	0.081	<0.01	0.60	0.22
Hay/Cow, lb., Yr 1	1795[x]	1761[y]	1524[z]	31.31	<0.01	<0.01	0.004
Yr 2	2249[x]	2350[y]	2037[z]				
Yr 3	2019[x]	2252[y]	1934[z]				
Hay/Cow/Day, lb., Yr. 1	30.9[x]	29.9[x]	26.3[y]	0.46	<0.01	<0.01	0.0003
Yr. 2	40.9[x]	42.7[y]	37.1[z]				
Yr 3	31.5[x]	35.2[y]	30.2[z]				

[a]1 to 9 scale (1 = extremely thin; 9 = obese)

Figure1.The effect of hay feeding method on rib fat depth change over the three year study[a].



Contrast Values: SE = 0.38, Treatment = 0.06, Year = <0.01, Interaction (Trmt x Yr) = 0.39
[a] Backfat measurement was taken between the 12th and 13th ribs.

Table 3.Quantitative measurement of feeding area waste associated with each feeding method.

	Bale Roll Out	Bale Processor	Tapered Cone Feeder	P-Value			
				SE	Yr	Trmt	Yr x Trmt
Pounds of waste/ feeding area:							
Alfalfa-Grass Hay	135.5	115.6	26.7	21.42	0.09	0.30	<0.01
Oat Hay	106.7	61.8	199.0				

Table 4. Three year economic analysis comparing hay feeding methods for 100 and 300 head cow herds.

	System		
	Round Bale Rollout	**PTO Driven Round Bale Processor**	**Tapered-Cone Round Bale Feeder**
Hay consumed/day, lb.	34.3	35.9	31.2
Hay fed, Tons [a]			
100 cow herd	232.0	242.6	210.5
300 cow herd	695.9	727.9	631.4
Hay Cost/Cow, $	$98.6	$103.1	$89.4
Total Herd Hay Cost, $			
100 cow herd	$9,858	$10,311	$8,945
300 cow herd	$29,574	$30,934	$26,834
Equipment[b]			
100 cow herd	------------	$1,298	$513
300 cow herd	------------	$2,288	$1,538
Tractor operation[c]			
100 cow herd	$1,044	$1,092	$568
300 cow herd	$3,131	$3,275	$1,705
Total non-hay expense			
100 cow herd	$1,044	$2,390	$1,081
300 cow herd	$3,131	$5,564	$3,243
Total expense			
100 cow herd	$10,902	$12,701	$10,026
300 cow herd	$32,705	$36,497	$30,077
Cost per cow			
100 cow herd	$109.0	$127.0	$100.3
300 cow herd	$109.0	$121.7	$100.3
Hay as % of total cost			
100 cow herd	90.4	81.2	89.2
300 cow herd	90.4	84.8	89.2

[a] Tons of hay fed over a 135 day period. Hay was priced at $42.50 per ton.

[b] Each bale feeder cost $800 and fed 13 cows in the analysis model. Bale feeders were depreciated over 12 years. The bale processor cost $15,000. It was depreciated over 12 years for the 100 cow operation and 7 years for the 300 cow operation. Cutting flails were replaced every 2,500 bales at a total replacement cost of $250 including labor charge.

[c] A 110 HP tractor is used regardless of system; model expense referenced from Lazarus and Selley (2002). Ownership expenses calculated assuming the tractor experiences typical use in other farm operation activities. Operation and ownership costs are $27 per hour including a $7 per hour labor charge. Tractor time is three minutes per bale for the bale feeder and five minutes per bale for roll out and bale processor systems.

Figure 2. Bale Rolled Out.

Figure 3. Bale Processor.

Figure 4. Tapered-Cone Bale Feeder.

Figure 5. Dense tightly tied alfalfa-grass bale.

Figure 6. Poorly tied, loose oat-hay bale.