Effects of Stocking Rate and Corn Gluten Feed Supplementation on Performance of Two-year Cows Grazing Stockpiled Forage during Winter

A.S. Leaflet R2065

Jim Russell, professor of animal science; Ronda Driskill, graduate student in animal science; Dan Morrical, professor of animal science; Daryl Strohbehn, extension beef specialist; Steve Barnhart, professor of agronomy; John Lawrence, director, Iowa Beef Center

Summary and Implications

For two years, four 6.25 and 8.75-acre pastures containing endophyte-free tall fescue-red clover pastures were stocked with pregnant two-year old cows at rates of .34 (low) or .48 (high) cows/acre to strip-graze from October to March. Eight similar cows were allotted to two dry lots and fed tall fescue-red clover hay. Corn gluten feed was supplemented to cows in two pastures at each stocking rate and in the dry lots to maintain a condition score of 5 on a 9-point scale. Cows in the remaining pastures were supplemented with corn gluten feed when snow and ice limited grazing. At the end of the winter feeding period, body condition scores of cows maintained in the dry lot were greater than those grazing stockpiled forage in year 1, but did not differ in year 2. Post-winter body condition scores of grazing cows supplemented with corn gluten feed at the high level were greater than those supplemented at the lower level at the high stocking rate in year 2. Cows maintained in dry lots required an average of 5195 lb hay DM/cow and 69 lb corn gluten feed DM/cow to maintain body condition. Cows supplemented at the high and low levels of corn gluten feed were 241 and 19 lb corn gluten feed DM/cow. As a result, average winter production costs for cows grazing stockpiled forage at the high and low stocking rates were $0.90 and $1.22/cow/day compared to $1.35/cow/day for cows maintained in a dry lot. Grazing of stockpiled forage is an effective management system to lower winter production costs of young pregnant cows compared to hay feeding even in winters with above average snowfall. The production costs for winter grazing of stockpiled forage can be reduced by increasing the stocking rate and supplementing corn gluten feed.

Introduction

Because feeding stored feeds like hay is the largest cost associated with beef cow-calf production, profitability of cow-calf enterprises may be optimized by extending the length of the grazing season into the fall and winter. Grazing stockpiled grass-legume forage during the fall and winter has reduced the amounts of hay needed to maintain pregnant spring-calving cows and lactating fall-calving cows without affecting subsequent reproduction.

In addition to nutrient needs for maintenance and fetal growth, pregnant heifers or young cows also have nutritional needs for growth. Furthermore, as a percentage of body weight, feed intake of heifers is less than mature cows. Consequently, young cattle require forage with greater nutritional value than mature cattle and the nutritional value and/or availability of stockpiled forage might be inadequate to meet the nutritional needs of young cattle. However, in 2001 and 2002, pregnant heifers only needed 0 to 94 lb supplemental corn gluten feed per heifer over the winters to sustain body weight gains of 1.8 to 2.2 lb/day. Because weather during these winters was relatively mild; averaging just 15.9 inches per winter, the results of these experiments may not be indicative of winters with more severe weather. Furthermore, two year old cows in their second pregnancy may have even greater nutritional requirements than heifers because they may have to replace body condition lost during first lactation.

The objective of this experiment was to determine the amounts of corn gluten feed needed to maintain body condition of pregnant two-year old cows fed hay or grazing stockpiled forage at two stocking rates.

Materials and Methods

Two 30-acre pastures at the ISU Beef Nutrition Farm near Ames containing ‘Fawn’ endophyte-free tall fescue and red clover were each further divided into two 6.25- and two 8.75-acre pastures. In each year, forage was harvested as hay in early June and August. Nitrogen was applied to each pasture at 45 lb/acre as urea immediately after the second cutting of hay and the forage was allowed to stockpile until the initiation of grazing in late October.

On October 22, 2003 (year 1) and October 20, 2004 (year 2), 32 cows in their second gestation were allotted to the pastures at stocking rates of 0.34 (low stocking rate) or 0.48 (high stocking rate) cows/acre or to dry lots at 4 cows/dry lot. In 2003, cows were Angus x Simmental crosses with initial body weights, body condition scores, and ages of 1192 lb, 4.92, and 31 months. In 2004, cows were Angus with initial body weights, body condition scores, and ages of 1140 lb, 5.00, and 29 months. Cows in the dry lots were fed large round bales of tall fescue-red clover hay *ad libitum*. Corn gluten feed was fed to cows in two pastures at each stocking rate and in each dry lot to maintain mean body condition scores of 5.0 on a 9-point scale (high supplementation level). Corn gluten feed was supplemented to cows in the remaining two pastures at each stocking rate when excessive snow or ice prevented grazing of stockpiled forage (low supplementation level). To prevent excessive loss of body condition, corn gluten feed would have been fed to cows in pastures supplemented at the low level if the average body condition of cows in these pastures decreased to an average of 4.33 on a 9-point scale; however, this body condition score was never reached in any pasture. All cows had free-choice access to a mineral and vitamin supplement.

Each pasture was divided into eight paddocks and strip-grazed for 147 days in both years. The length of the grazing period for each paddock was calculated from the mean initial forage mass of all pastures, assuming utilization rates of 50 and 70% for cows stocked at the low and high rates and forage dry matter intakes of 2.5% of body weight. From these estimates, cows were moved to a new paddock every 19 days in both years of the experiment.

Prior to grazing, pastures were sampled at two 0.25-m^2 locations in each paddock. Samples were hand-sorted into dead forage or live grass, legume, and weed forage. Forage fractions were weighed and dried to calculate botanical composition of the pastures. During grazing, pastures were sampled monthly in two 0.25-m^2 locations in each grazed and ungrazed paddock except in months when sampling was prevented by excessive snow. Each large round hay bale was core-sampled to a depth of 30 inches prior to feeding. To determine the composition of forage that was selected by cattle grazing stockpiled forage or consuming hay, forage selected by one steer fitted with a rumen fistula in each pasture or dry lot was collected after 2 hours of grazing or hay feeding following ruminal evacuation on two consecutive days in November and March of each year. Simultaneous to collection of selected forage, available forage was collected from two 0.25-m^2 locations in each grazed paddock. All forage samples were weighed, dried, and analyzed for in vitro digestible dry matter (IVDMD), crude protein (CP), and acid detergent insoluble nitrogen (ADIN). Feeding selectivity by the fistulated steers was calculated as the ratio of the concentration of each component in the selected forage to its concentration in the available forage.

Cows were weighed at the initiation and termination of grazing after being fed tall fescue-red clover hay for 3 days to equalize gut fill. During the experiment, cows were weighed every 14 days without a shrink. Cows were visually scored for body condition on a 9-point scale weekly by two individuals. Amounts of hay or corn gluten feed fed were weighed at each feeding.

An economic analysis of the systems was conducted to estimate winter production costs using a partial budgeting model developed by Justin Clark in a previous winter grazing project. Costs of pasture establishment, perimeter and cross fences, and watering systems were estimated from previous extension publications. Allocation of annual pasture rental to grazing of stockpiled forages was based on the proportion of total annual forage production harvested for hay or stockpiled forage winter grazing. The number of acres necessary for winter grazing per cow was calculated from the initial forage masses and utilization rates. Assumed prices were $75/ton for corn gluten feed, $50/ton for hay, $60/acre for pasture rent, and $.20/head/day for dry lot yardage.

All data were analyzed by the Proc Mixed model of SAS using pasture as the experimental unit.

Results and Discussion

Mean temperatures from October through March were 33.5 and 35.3^{o}F in years 1 and 2 of the project which were 1.6 and 3.1^{o}F above the 30-year average. Total snowfalls during the seasons were 45.5 and 26.1 inches in years 1 and 2 compared to the 30-year average of 36.2 inches. These differences in snowfall resulted in 62 and 34 days with snow covers greater than 1 inch in years 1 and 2.

There were no effects of stocking rate or supplementation level on the botanical composition of pasture forage in October of year 1 or 2. Stockpiled pastures had a greater ($P = 0.01$) proportion of dead material in the total forage dry matter than pastures in year 1 (17.1%) than year 2 (10.9%). The proportions of grass ($P = 0.04$) and legume ($P = 0.03$) in the live dry matter were 90.0 and 6.4% in year 1 and 83.0 and 13.1% in year 2. The proportions of broadleaf weeds in the live dry matter were 3.8% and did not differ between years.

In spite of the differences in stocking rate and supplementation, there were no main effects nor interactions of stocking rate or supplementation level on the forage masses of grazed and ungrazed paddocks in year 1 or 2. In both years, consumption of forage resulted in greater ($P < 0.01$) disappearance of forage dry matter from grazed paddocks:

Forage mass, lb/acre = 2581 – 12.2 x days (Year 1)
Forage mass, lb/acre = 2796 – 13.3 x days (Year 2)
than ungrazed paddocks:
Forage mass, lb/acre = 3159 – 5.46 x days (Year 1)
Forage mass, lb/acre = 3265 – 3.36 x days (Year 2)

The greater rate of dry matter loss from the ungrazed paddocks in year 1 was likely caused by greater weathering associated with the greater amounts of snowfall.

Because of the differences in stocking rates, the allowance of ungrazed forage per 100 lb body weight over the 147 day grazing season were greater ($P < 0.01$) for cows grazing pastures stocked at the low rate:

Forage allowance, lb DM/100 lb BW/day = 4.63 – 0.01 x day (Year 1)
Forage allowance, lb DM/100 lb BW/day = 5.68 – 0.01 x day (Year 2)
than cows grazing pastures at the high stocking rate:
Forage allowance, lb DM/100 lb BW/day = 3.32 – 0.01 x day (Year 1)
Forage allowance, lb DM/100 lb BW/day = 3.91 – 0.01 x day (Year 2)

Greater pasture forage masses and lighter cow body weights in year 2 than year 1 resulted in greater ($P < 0.01$) forage allowances in year 2 than year 1. However, in both years, forage allowance at the high stocking rate fell below the level of 3 to 5% of body weight needed sustain forage intake for a considerable period of the grazing seasons.

Mean concentrations of CP in hay over the winter feeding season were greater ($P < 0.01$) than ungrazed stockpiled forage in years 1 and 2 (Table 1). Mean IVDMD concentrations of hay and stockpiled forage did not differ ($P = 0.71$) in yr 1, but the IVDMD concentration of stockpiled forage was greater ($P = 0.01$) than hay from October to December of year 2. Concentrations of CP and IVDMD decreased more rapidly in stockpiled forage than hay in yr 2 (forage x month, $P < 0.01$) because of weather damage. Mean concentrations of ADIN did not differ between forages in yr 1, but were greater ($P = 0.05$) in stockpiled forage than hay in yr 2. The lower digestibility of stockpiled forage in year 1 than year 2 was likely caused by the high proportion of dead material in the stockpiled forage in year 1 resulting from dry conditions during the stockpiling period.

The concentration of IVDMD in forage selected by steers consuming hay was greater ($P = 0.09$) than forage selected by grazing steers (Table 2). However, grazing steers selected forage with higher ($P < 0.02$) IVDMD concentrations than steer fed hay in April of year 1 and November of year 2. Steers consuming hay in dry lots selected forage with a greater concentration of CP ($P = 0.04$) than steers grazing stockpiled forage in November in year 1. However, in spite of the greater concentration of CP in the hay, CP concentrations of forage selected by steers consuming hay or grazing stockpiled forage did not differ in April of year 1 or November and April of year 2. The proportions of CP bound as ADIN in forage selected by hay-fed steers was lower ($P < 0.01$) than those of grazing steers in November and April of year 1 and April of year 2.

Differences in the composition of forage selected by grazing and hay-fed steers resulted from increased selectivity by grazing steers. Selectivity indices for steers grazing stockpiled forage were greater ($P < 0.04$) for CP and IVDMD in November and March of both years than steers consuming hay (Table 3). The selectivity indices for CP in forage selected by steers grazing stockpiled forage were 38 and 15% greater ($P < 0.06$) than steers consuming hay in March of yr 1 and 2. Similarly, the selectivity indices for IVDMD in forage selected by steers grazing stockpiled forage were 36 and 14% greater ($P < 0.02$) than steers fed hay in March of yr 1 and 2, respectively. In spite of the differences in forage allowance, the only significant effect of stocking rate on forage selection occurred in March of year 1 when the selection index for CP by steers grazing at the low stocking rate (1.22) was greater ($P = 0.08$) than that of steers grazing at the high stocking rate (1.09) Although grazing steers consumed forage with greater ($P < 0.01$) concentrations of ADIN than steers in dry lots, smaller ($P < 0.01$) selectivity indices for grazing steers than steers consuming hay indicated that steers grazing stockpiled forage were more selective against ADIN than steers fed hay.

In year 1, body condition scores of cows fed hay were greater ($P < 0.10$) than those grazing stockpiled forage from 14 days until the end of the winter feeding period (Figure 1). However, neither stocking rate nor corn gluten feed supplementation affected body condition score of cows grazing stockpiled forage. In year 2, body condition scores of cows fed hay did not differ from cows grazing stockpiled forage after 2 weeks of grazing (Figure 2). Within grazing treatments, the body condition scores of cows fed corn gluten feed at the high level were greater ($P < 0.10$) than cows fed minimal corn gluten feed particularly at the high stocking rate from 14 weeks until the end of the winter feeding period. Regardless of treatment, mean body condition scores never dropped below 4.5 at any time in either year.

In years 1 and 2, cows maintained in a dry lot were fed 5,642 and 4,747 lb hay DM/cow (Table 4). In addition, these cows were supplemented with 5 and 134 lb corn gluten feed DM/cow in these years. In year 2, 248 and 20 lb corn gluten feed DM/cow were fed to grazing cows supplemented at the high and low levels ($P = 0.07$). Similarly, in year 1, the amount of corn gluten feed fed to cows at the high supplementation level (234 lb/cow) tended to be greater than cows supplemented at the low level (17.5 lb/cow). In both years, corn gluten feed was supplemented to cows at the low level only for short periods when excessive snow and ice limited availability of forage for grazing.

Because of the amounts of hay fed, winter production costs were \$1.37 and \$1.32/cow/day for cows maintained in the dry lots in years 1 and 2 (Table 5). Production costs of cows grazing stockpiled forage were lower than those of cows in the dry lots. Furthermore, maintenance of cows in the dry lots was more sensitive to a change in the price of hay than grazing of cows was to a change in the cost of pasture rental. However, because less land was required at the high stocking rate, average production costs at the high stocking rate were \$0.34 and \$0.31/cow/day lower than the low stocking rate. Supplementation with corn gluten feed to the condition score of 5 only increased winter production costs by \$0.05/cow/day compared to minimal supplementation.

The results of this experiment imply that grazing of stockpiled forage is an effective system to reduce winter maintenance costs for beef cows without adversely affecting body condition even in a winter with above average amounts of snow. Winter production costs of cows grazing stockpiled forages can be further limited by increasing the stocking rate and compensating with supplemental corn gluten feed.

Table 1. Predicted values of forage composition for ungrazed stockpiled tall fescue-red clover forage[a] and hay.

	Month						Significance		
	October	November	December	January	February	March	Forage (F)	Month (M)	F x M
					Year 1				
CP, % DM									
Stockpile	10.0	10.0	9.2	8.9	-	10.0	<0.01	0.16	0.49
Hay	12.1	12.3	12.2	11.8	11.8	12.0			
IVDMD, % DM									
Stockpile	55.0	53.8	52.5	51.4	-	47.7	0.71	<0.01	0.15
Hay	56.2	55.6	55.0	54.4	53.8	53.2			
ADIN, % N									
Stockpile	9.0	9.6	10.2	10.8	-	12.6	0.39	0.95	<0.01
Hay	6.7	6.1	5.5	4.9	4.4	3.8			
					Year 2				
CP, % DM									
Stockpile	10.8	9.3	8.7	-	8.9	9.8	<0.01	<0.01	0.01
Hay	10.5	10.2	10.2	10.7	10.2	10.2			
IVDMD, % DM									
Stockpile	59.0	57.2	55.4	-	51.7	48.1	0.01	<0.01	<0.01
Hay	54.4	54.3	54.2	54.1	54.0	53.8			
ADIN, % N									
Stockpile	6.2	6.8	7.7	-	8.6	9.9	0.05	<0.01	<0.01
Hay	6.9	6.8	6.8	6.7	6.6	6.6			

[a] Means of samples collected for pastures stocked at two rates and fed at two supplementation levels

Table 2. Mean composition of forage selected by steers grazing stockpiled tall fescue-red clover or consuming hay in dry lots.

	Forage species		
	Hay	Grazing	Significance
	Year 1		
November			
CP, % DM	11.9	10.6	0.04
IVDMD, % DM	65.3	62.6	0.09
ADIN, % N	4.8	8.7	<0.01
March			
CP, % DM	9.8	9.5	0.65
IVDMD, % DM	54.2	57.0	0.02
ADIN, % N	5.0	10.6	<0.01
	Year 2		
November			
CP, % DM	10.7	10.8	0.86
IVDMD, % DM	52.4	57.8	0.01
ADIN, % N	7.4	6.5	0.17
March			
CP, % DM	8.1	8.7	0.10
IVDMD, % DM	52.4	53.6	0.49
ADIN, % N	6.9	8.6	0.01

Table 3. Selection indices[a] of steers grazing stockpiled tall fescue-red clover or hay in November and March.

	Forage system		
	Hay	Grazing	Significance
	Year 1		
November			
CP	0.99	1.29	0.01
IVDMD	1.11	1.27	0.02
ADIN	0.99	0.83	0.07
March			
CP	0.84	1.16	<0.01
IVDMD	1.01	1.37	<0.01
ADIN	1.41	0.80	<0.01
	Year 2		
November			
CP	1.04	1.22	0.03
IVDMD	0.97	1.07	0.04
ADIN	1.10	0.76	<0.01
March			
CP	0.85	0.98	<0.01
IVDMD	0.99	1.13	<0.01
ADIN	1.18	0.80	<0.01

[a] Ratio of concentration in selected forage to concentration in available forage.

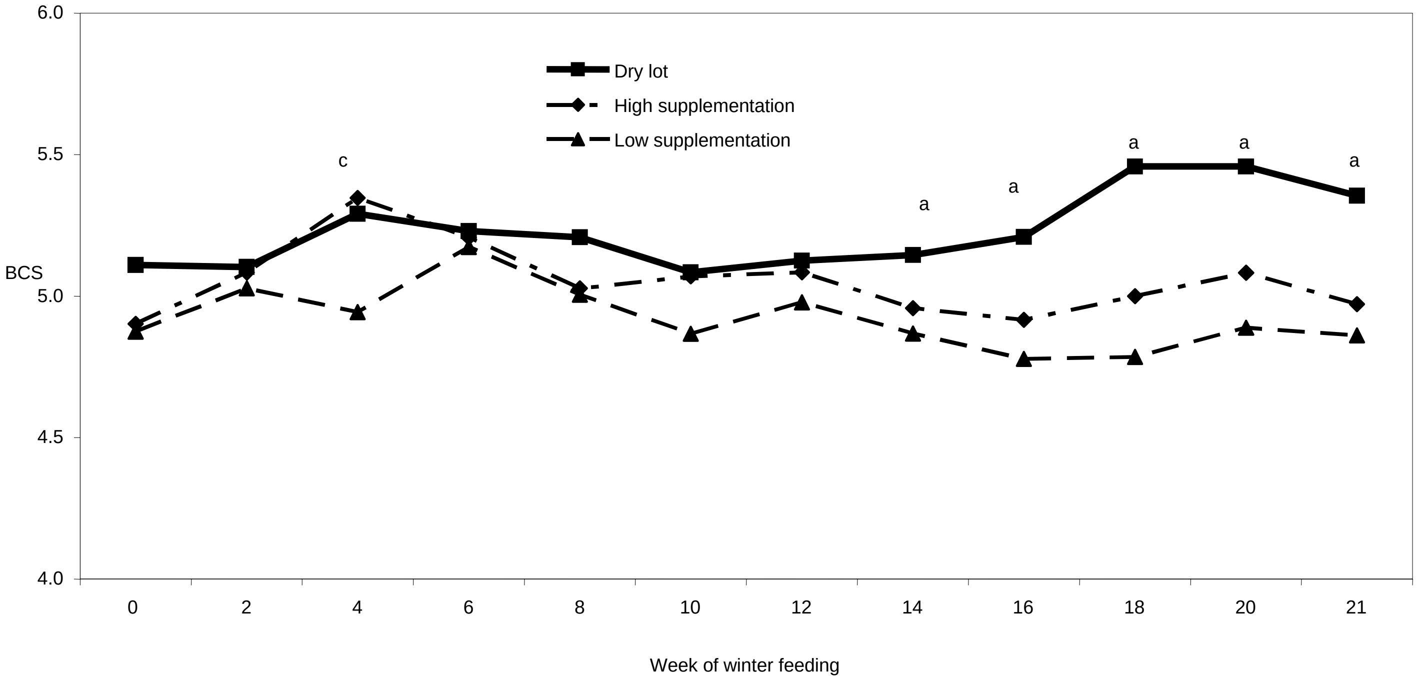

Figure 1. Body condition score of cows grazing winter stockpiled tall fescue-red clover or consuming hay in dry lots in year 1. Treatment effects: a = difference in dry lot and grazing; and c = difference in supplementation level; *P* < 0.10.

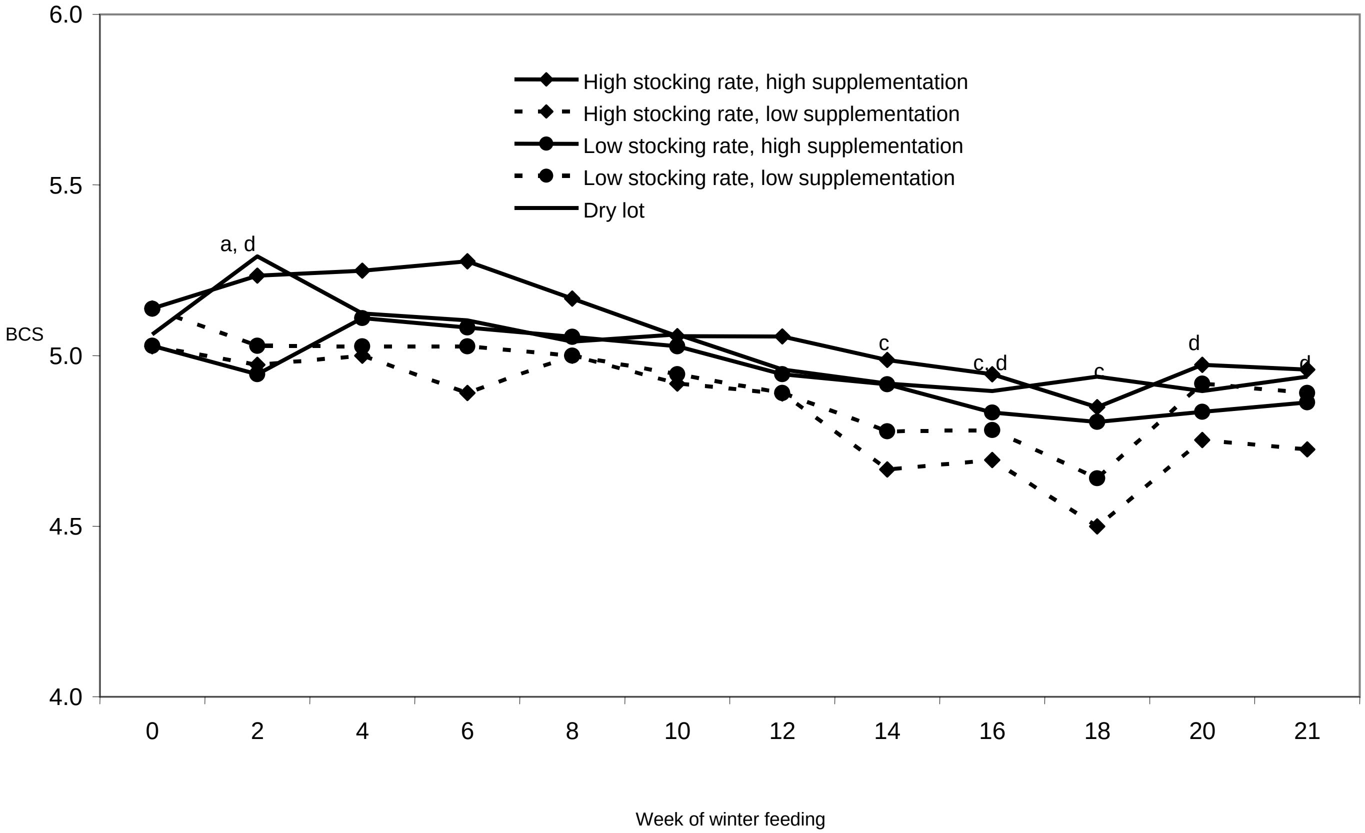

Figure 2. Body condition score of cows grazing winter stockpiled tall fescue-red clover or consuming hay in dry lots in year 2. Treatment effects: a = difference in dry lot and grazing; c = difference in supplementation level; d = stocking rate x supplementation level; *P* < 0.10.

Table 4. Amounts of corn gluten feed and hay fed to cows grazing stockpiled tall fescue-red clover forage or hay

	Stocking rate and corn gluten feed supplementation				
	High[a]		Low		
	High[b]	Low	High	Low	
Year 1	lb/cow				
Corn gluten feed	189	19	279	16	5
Hay	0	0	0	0	5642
Year 2					
Corn gluten feed	210	20	286	20	134
Hay	0	0	0	0	4747

[a] High stocking rate: 0.48 cows/acre, low stocking rate: 0.34 cows/acre
[b] High supplementation- cows maintained at body condition score 5, low supplementation- cows maintained at minimum body condition score 4.33

Table 5. Estimated winter production costs ($ cow^{-1} d^{-1}) for cows grazing stockpiled tall fescue-red clover or fed hay in dry lots supplemented with corn gluten feed.

	Stocking rate and supplementation level				Dry lot
	High[a]		Low		
	High[b]	Low	High	Low	
			Year 1		
Dry lot yardage	0.00	0.00	0.00	0.00	0.20
Pasture rent	0.38	0.38	0.53	0.53	0.00
Pasture maintenance	0.53	0.53	0.71	0.71	0.00
Corn gluten feed	0.05	0.01	0.06	0.01	0.01
Hay	0.00	0.00	0.00	0.00	1.16
Total	0.96	0.92	1.30	1.25	1.37
20% increase/decrease pasture rent	+/- 0.08	+/- 0.08	+/- 0.11	+/- 0.11	0.00
20% increase/decrease hay price	0.00	0.00	0.00	0.00	+/- 0.23
			Year 2		
Dry lot yardage	0.00	0.00	0.00	0.00	0.20
Pasture rent	0.34	0.34	0.47	0.47	0.00
Pasture maintenance	0.48	0.48	0.64	0.64	0.00
Corn gluten feed	0.05	0.01	0.08	0.01	0.04
Hay	0.00	0.00	0.00	0.00	1.08
Total	0.87	0.83	1.19	1.12	1.32
20% increase/decrease pasture rent	+/- 0.07	+/- 0.07	+/- 0.10	+/- 0.10	0.00
20% increase/decrease hay price	0.00	0.00	0.00	0.00	+/- 0.22

[a] High stocking rate, 0.48 cows/acre, low stocking rate, 0.34 cow/acre
[b] Cows supplemented at the high and low levels were fed corn gluten feed to maintain body condition score of 5.0 and 4.33.

Acknowledgements

This project was supported, in part, by the Leopold Center for Sustainable Agriculture. The authors gratefully acknowledge the assistance of Rod Berryman and the animal caretakers at the Iowa State University Beef Nutrition Farm in the care of the cattle in this experiment. The authors also appreciate the assistance of Mat Haan and undergraduate students including Adam Mueller.