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EFFECTS OF LEVEL OF CONCENTRATE AND FORAGE AVAILABILITY ON THE PERFORMANCE OF BEEF COWS GRAZING WINTER RANGE[1]

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Summary

Two winter grazing trials were conducted on consecutive years to determine the effect of level of concentrate supplement and amount of forage available on performance of cows grazing dormant winter range. Simmental x Angus cows were fed concentrate supplements containing combinations of corn and soybean meal at either high, medium or low levels. Supplements were formulated to provide .7 lb of crude protein during year 1 and .51 lb of rumen degradable crude protein in year 2. Two pastures with differing amounts of available forage were grazed each year. In year 1, the amount of available forage had a greater effect on body weight and condition score change than did level of concentrate fed. Cows receiving higher levels of supplement actually gained less weight. The interaction between level of supplement and amount of available forage showed higher levels of concentrate supplement may be more detrimental when amount of available forage is limited. The amount of available forage was considerably greater in both pastures the second year with cows gaining more weight on the high available forage pasture. Cows receiving higher levels of concentrate supplement gained more weight and body condition than those receiving lower levels of supplement. There was no interaction between forage availability and level of concentrate in year 2.

(Key Words: Beef Cattle, Winter Grazing, Supplement, Forage Availability.)

Introduction

Typically, protein is considered the most limiting nutrient in low quality forages such as native winter range. Research has shown that protein supplementation will decrease winter weight and condition score losses by improving intake and digestibility of mature, low protein forages. Recent research also suggests that supplements with high levels of starch may be detrimental to cow performance. It has been thought by some that the advantage of feeding higher levels of concentrate supplement may depend on the amount of forage available to be grazed. The objective of this study was to determine the effect of level of concentrate supplement and forage availability on the performance of dry, pregnant cows.

Materials and Methods

A winter grazing study using 120 (year 1) and 126 (year 2) pregnant Simmental x Angus cows grazing native winter range was replicated over 2 years at the SDSU Range and Livestock Research Station near Cottonwood. Cows were allotted by age and weight to three soybean meal-corn supplement treatments (Tables 1 and 2) and grazed on a pasture of either high or low forage availability during January and February. Concentrate supplements were balanced to provide .7 lb of crude protein in year 1 and .51 lb of rumen degradable crude protein in year 2 (Table 2). In year 1, 1.91, 4.88, and 7.85 lb of dry matter per cow were fed for the low, medium, and high levels of concentrate supplements, respectively. Amount of concentrate

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Table 1. Supplemental treatments[a]

Item	Low	Medium	High
	Year 1		
Soybean meal	87.43	14.55	-
Corn	-	73.57	87.90
Dicalcium phosphate	5.23	1.23	.25
Potassium chloride	6.81	3.07	2.17
Molasses	.52	5.97	7.77
Bentonite	-	1.84	1.91
	Year 1		
Soybean meal	81.16	21.27	8.44
Corn	-	71.16	86.42
Dicalcium phosphate	6.22	1.17	.09
Potassium chloride	9.88	3.86	2.56
Molasses	2.50	2.51	2.51

[a] Percentage on a dry matter basis.

Table 2. Composition of daily supplemental intake per cow

Item	Low	Medium	High
	Year 1		
Dry matter, lb	1.91	4.88	7.85
Crude protein, lb	.70	.70	.70
Rumen degradable protein, lb[a]	.60	.38	.24
Metabolizable energy, Mcal[b]	2.31	6.70	10.92
Calcium, lb	.030	.022	.014
Phosphorus, lb	.029	.027	.027
Potassium, lb	.101	.124	.156
	Year 2		
Dry matter, lb	1.67	4.93	7.92
Crude protein, lb	.69	.94	1.09
Rumen degradable protein, lb[a]	.51	.51	.51
Metabolizable energy, Mcal[b]	1.93	6.69	11.29
Calcium, lb	.027	.019	.007
Phosphorus, lb	.030	.030	.029
Potassium, lb	.110	.140	.166

[a] Calculated from NRC ruminant nitrogen usage tables.
[b] Calculated from NRC feed tables.

supplement per cow per day fed in year 2 was 1.67, 4.93, and 7.92 lb, respectively, for the low, medium and high levels of supplements (Table 2). Supplements were fed in pelleted form (3/8 in. diameter) and were balanced to exceed NRC requirements for calcium, phosphorus, and potassium (Table 2).

The two pastures used in the study were dominated by western wheatgrass (Table 3). The low available forage pasture (270 acres) was grazed for 3,684 animal unit days during November just prior to both trials to create a difference in quantity of available forage. The high available forage pasture (351 acres) had not been grazed since the previous April in either year. Estimates of forage standing crop were made on November 29 and 30 in year 1 and on December 21 in year 2. Forage was estimated on 50 plots (.25 m^2) in each pasture at each sampling period. Plots were located using stratified random sampling based on range site. Fifteen of the 100 total plots estimated at each sampling period were also clipped by hand, sorted by species, oven dried (60 °C), and weighed. The relationship between estimated forage standing crop and actual values was determined using linear regression, and all unclipped estimates were calibrated using those equations.

From early December to early February, cows were gathered every morning, sorted into treatment groups, and bunk fed their respective diets. At the beginning and end of the trial, cows were weighed in the morning on two consecutive days after overnight removal from feed and water. Initial and final cow weights were the average of the two consecutive weights. Condition scores (1 to 9, 1 = extremely emaciated) were assigned by two technicians at the beginning and end of the trial. Cows were bred to either Angus or Simmental bulls and had mean calving dates of February 27 and March 26 for first calf heifers and mature cows, respectively. Data from three cows that calved prior to the end of the trial were deleted in year 2.

In early January of each year, forage samples were collected with four esophageally fistulated steers that grazed with the cows. The four steers were grazed together on each pasture for two consecutive days. Steers were allowed to graze with screened collection bags for 25 minutes after morning supplementation was completed. Extrusa samples were frozen, lyophilized and ground for later analysis. Ground samples were microhistologically analyzed for forage composition and analyzed for chemical composition (Table 4). Hand

Table 3. Availability of predominant grass species[a]

Item	Low		High	
	Year 1			
Western wheatgrass	270.6	(30.9)	491.8	(46.6)
Japanese brome	78.9	(8.5)	54.9	(9.7)
Shortgrasses[b]	112.3	(7.8)	99.3	(24.8)
Total	461.8		646.0	
	Year 2			
Western wheatgrass	870.8	(76.6)	1141.6	(125.6)
Japanese brome	20.2	(9.0)	22.8	(8.0)
Shortgrasses[b]	334.8	(27.9)	313.4	(37.9)
Total	1225.8		1477.8	

[a] Expressed in lb/acre.
[b] Undifferentiated mixture of buffalograss and blue grama.

Table 4. Composition of forage samples collected in early January 1991 and 1992

	Forage available			
	Year 1		Year 2	
Item	Low	High	Low	High
Esophageal samples, % species composition by weight[a]				
Western wheatgrass	96.63 (.94)	94.05 (.86)	98.79 (.57)	98.68 (.68)
Japanese brome	2.15 (.63)	1.19 (.58)	.00 (.10)	.29 (.12)
Other grasses	1.22[c] (.84)	4.76[d] (.78)	1.21 (.55)	1.03 (.65)
Esophageal samples, % organic matter basis[ab]				
Crude protein	3.73[c] (.17)	5.45[d] (.16)	4.68 (.31)	4.93 (.38)
Acid detergent fiber	57.56[c] (.71)	53.54[d] (.65)	53.51[e] (.29)	52.48[f] (.35)
Neutral detergent fiber	82.57 (.85)	80.76 (.78)	82.83 (.53)	83.50 (.65)
Acid detergent lignin	8.21[g] (.49)	6.87[h] (.45)	5.35 (.22)	5.22 (.27)
Clipped samples, % organic matter basis				
Crude protein	3.79	5.04	3.57	3.68
Acid detergent fiber	49.86	47.83	54.36	54.23
Neutral detergent fiber	80.38	77.35	83.77	84.35
Acid detergent lignin	4.90	5.17	4.93	4.67
Clipped samples, % dry matter basis				
Calcium	.26	.31	.34	.30
Phosphorus	.07	.10	.05	.05
Potassium	.19	.22	.24	.18
Ash	5.42	5.69	6.91	7.37

[a] Least squares means followed by standard errors.
[b] Uncorrected for salivary contamination.
[c,d] Means within year with uncommon superscripts differ ($P<.05$).
[e,f] Means within year with uncommon superscripts differ ($P=.06$).
[g,h] Means within year with uncommon superscripts differ ($P=.07$).

clipped samples similar to cow diets were also taken at this time (Table 4).

Data were analyzed by the GLM procedure of SAS with treatment means separated by the PDIFF option.

Results and Discussion

Greater precipitation during the growing season in year 2 (Figure 1) caused the large difference in the amount of forage available between years (Table 3). Western wheatgrass was the predominant species of grass consumed with lesser amounts of Japanese brome, buffalograss, blue grama and sideoats grama being consumed (Table 4). Esophageal sampling in year 1 indicated that cattle grazing the high forage pasture selected forage that was higher ($P=.001$) in crude protein and lower in acid detergent fiber ($P=.002$) and lignin ($P=.07$; Table 4). Clipped samples also indicated that higher quality forage was available to cattle grazing the pasture with more forage available (Table 4). In year 2, cattle grazing the low available forage pasture selected forage higher ($P=.06$) in acid detergent fiber (Table 4), but other indicators of forage quality were similar. Clipped samples also indicated that forage in the high and low available forage pastures was similar (Table 4). The difference in

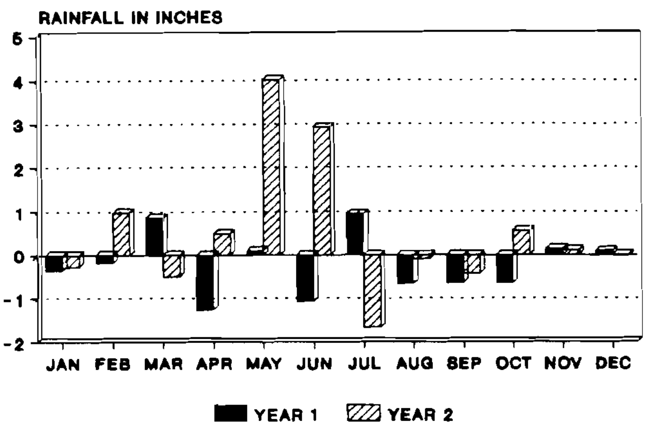

Figure 1. Year 1 and year 2 deviation from long term average precipitation at SDSU Range and Livestock Research Station near Cottonwood.

available forage during the first year caused cows on the low forage pasture to be less selective in their forage consumption, resulting in a lower quality diet than cows on the high forage pasture. During the second year when the amount of forage in both pastures was much higher, the quality of forage consumed in the low and high forage pasture was more similar.

In year 1, the amount of available forage had a greater effect on cow performance than did the level of concentrate supplement (Table 5). Cows grazing the high available forage pasture gained 51.5 lb more (P<.001) than cows grazing the low forage pasture. This difference in weight gain was probably due to cows on the high forage pasture being able to select a higher quality diet than cows on the low forage pasture (Table 4). Cows fed higher levels of supplement actually gained less weight (P<.001) and lost more condition score (P<.01; Table 5). In other words, cows gained less weight as the amount of corn per day in the concentrate supplement increased. Similar research conducted at the Gudmundsen Sandhills Laboratory near Whitman, Nebraska, found that cows grazing native winter range exhibited greater weight loss when additional energy was supplemented in the form of ear corn as compared to feeding a protein supplement without ear corn. The Nebraska results and results from several other research projects indicate that increasing levels of starch in the diet cause negative effects on digestibility and intake of mature forage. The interaction between amount of forage and level of concentrate for weight change (P=.10) and condition score change (P=.07) the first year shows that increasing the level of concentrate was more detrimental to cow performance on the low forage pasture (Table 6).

In the second year, cows grazing the high available forage pasture gained only 11.1 lb more (P=.04) than cows grazing the low forage pasture (Table 5). Increasing the level of concentrate supplement resulted in increased weight gains and body condition scores. Cows receiving the high level of supplement gained 25 more pounds (P=.001) and more body condition (P=.001) than cows receiving the medium level of supplement and 38.4 more pounds (P=.001) and more body condition (P=.001) than cows receiving the low level of supplement (Table 5). There was no interaction between amount of available forage and level of concentrate for weight change and body condition change in the second year. Greater weight gains by all groups in the second year may have been due to adverse weather prior to the start of the trial causing cows to weigh less and have less body condition at the beginning of the trial.

Numerous research trials have demonstrated that providing a small amount of an all natural protein supplement to cows consuming mature, low protein forages will increase forage digestibility and forage consumption. The results from the first year of this study indicate that providing additional energy in the form of a high starch supplement, like corn, will not improve cow weight change but may in fact be detrimental. In some cases it has been thought that, when the amount of available forage is limited, feeding a higher amount of a concentrate supplement is beneficial. But in the first year of this study, even when the amount of forage available to be grazed was lower, increasing the amount of supplement caused cows to gain less weight and lose more body condition. Results from year 2 seem to contradict the earlier year's results. Cows receiving higher levels of supplement gained more weight and body condition during the second year.

These results suggest that benefits from feeding a high level of concentrate supplement may depend on the amount of forage available to be grazed. In year 1 when amount of available forage was lower and cows

Table 5. Cow performance[a]

Item	Level of supplement: Low	Medium	High	Available forage: Low	High
			Year 1		
No. cows	40	40	40	60	60
Initial wt, lb	1089 (15.4)	1089 (15.8)	1084 (15.7)	1094 (13.5)	1080 (14.5)
Initial condition score, 1-9	5.5 (.11)	5.6 (.11)	5.6 (.11)	5.6 (.10)	5.6 (.10)
Wt change, lb	57.2[b] (5.0)	46.0[c] (5.1)	27.5[d] (5.1)	17.8[b] (4.4)	69.4[c] (4.7)
Condition score change	.0[b] (.09)	.0[b] (.09)	-.3[c] (.09)	-.2[b] (.08)	.1[c] (.08)
			Year 2		
No. cows	41	42	40	60	63
Initial wt, lb	1074 (16.5)	1076 (19.0)	1080 (19.0)	1074 (16.9)	1079 (16.8)
Initial condition score, 1-9	5.1 (.07)	5.1 (.08)	5.1 (.08)	5.1 (.07)	5.1 (.07)
Wt change, lb	61.9[b] (6.4)	75.3[c] (7.0)	100.3[d] (7.4)	73.7[b] (6.6)	84.7[c] (6.5)
Condition score change	-.2[b] (.06)	-.1[c] (.07)	.2[d] (.07)	0 (.07)	0 (.07)

[a] Least squares means followed by standard errors.
[b,c,d] Means within main effect with uncommon superscripts differ ($P<.05$).

were less able to select a high quality diet, high levels of concentrate supplement high in starch were detrimental to cow performance. Since supplements from year 1 were formulated on an equal crude protein basis, the possibility exists for a rumen degradable crude protein deficiency in cows fed the medium and high levels of supplements. This may have occurred due to the lower rumen degradability of crude protein in corn and may have contributed to lower weight gains and body condition losses. In year 2, when the amount of forage available was not limiting the selectivity of the cows and supplements contained similar amounts of rumen degradable crude protein, increasing the level of concentrate supplement high in starch improved cow weight gains and body condition. In years when forage is abundant, we would expect cow weight change to be greater and high levels of supplement for additional weight gain may not be necessary. Supplementation is more likely needed when the amount of forage available is limited. In this case, additional energy supplemented in the form of grain can actually be detrimental.

Future studies are planned to determine how forage conditions affect the optimum level of supplementation. With the information available, it is still advisable that the major goal of supplementing cows grazing dormant winter range should be to provide a high protein, all natural supplement to increase digestibility and consumption of forage. Providing additional energy in the form of grain for additional weight gains is probably not advisable even when forage is limited.

Table 6. Cow performance for the interaction of supplement treatment and forage availability[a]

Forage available	Low			High		
Level of supplement	Low	Medium	High	Low	Medium	High
			Year 1			
No. cows	20	20	20	20	20	20
Initial weight, lb	1095 (19.1)	1098 (20.3)	1089 (19.8)	1082 (20.8)	1080 (20.0)	1078 (20.4)
Initial condition score, 1-9	5.5 (.14)	5.7 (.15)	5.6 (.14)	5.6 (.15)	5.4 (.14)	5.7 (.15)
Weight change, lb	38.4^{d} (6.18)	15.8^{c} (6.55)	-1.1^{b} (6.38)	75.9^{f} (6.72)	76.2^{f} (6.47)	55.9^{e} (6.58)
Condition score change	.0^{cd} (.11)	-.2^{bc} (.12)	-.5^{b} (.11)	.0^{cd} (.12)	.2^{d} (.12)	-.1^{cd} (9.12)
			Year 2			
No. cows	20	21	19	21	21	21
Initial weight, lb	1064 (20.0)	1080 (22.2)	1079 (22.9)	1083 (20.3)	1073 (22.0)	1082 (21.7)
Initial condition score, 1-9	5.0 (.09)	5.1 (.10)	5.0 (.10)	5.1 (.09)	5.1 (.10)	5.1 (.10)
Weight change, lb	61.8^{b} (7.8)	66.6^{b} (8.7)	92.6^{c} (9.0)	62.0^{b} (7.9)	84.1^{c} (8.6)	108.0^{d} (8.5)
Condition score change	-.2^{b} (.08)	.0^{b} (.09)	.2^{c} (.09)	-.2^{b} (.08)	-.1^{b} (.09)	.2^{c} (.08)

[a] Least squares means followed by standard errors.
[b,c,d,e,f] Means in a row with uncommon superscripts differ ($P<.05$).