January 2001

Forage Intake and Nutrient Balance of Heifers Grazing Sandhills Winter Range

Trey Patterson
University of Nebraska-Lincoln

Don C. Adams
University of Nebraska-Lincoln, dadams1@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Forage Intake and Nutrient Balance of Heifers Grazing Sandhills Winter Range

Trey Patterson
Don Adams
Terry Klopfenstein[1]

Metabolizable protein is deficient in pregnant heifers grazing winter range. Energy may be first limiting if grazed forage intake is less than 2.0% of body weight.

Summary

Two experiments with pregnant heifers grazing winter range investigated effects of supplementation to meet metabolizable protein versus CP requirements. Supplements were fed from October to February, and hay was fed in January and February of the second experiment. Supplementation to meet metabolizable protein requirements decreased weight loss in one experiment. Winter hay feeding reduced weight loss and body condition loss compared to no hay feeding. Forage intake declined from 2.1% of body weight in November to 1.3% in February. Metabolizable protein was deficient when animals were supplemented to meet CP requirements. Supplementation to meet metabolizable protein requirements may improve performance when energy intake is not deficient.

Introduction

Pregnant, spring-calving heifers have an elevated requirement for metabolizable protein (MP) during the winter, and this requirement increases exponentially as heifers approach calving. Due to low energy and undegradable intake protein (UIP) content, the MP value of winter sandhills range is low. The result is an MP deficiency in the heifer. Supplementation with protein sources high in UIP may alleviate this deficiency.

A study was conducted at a commercial operation to determine effects of supplements fed over the winter to meet MP or CP requirements of pregnant heifers. Metabolizable protein was balanced with a feather meal-based supplement. Supplementation to meet MP requirements improved subsequent 2-year-old pregnancy (2001 Nebraska Beef Report). However, it could not be determined from the experiment if MP requirements were met by the supplement strategy. In addition, a prediction of forage intake over the winter was difficult due to little published data on heifers grazing Nebraska Sandhills winter range. Therefore, two experiments were conducted to evaluate the effect of supplementing heifers to meet MP

(Continued on next page)

requirements versus CP requirements on weight and body condition score change, forage intake, and nutrient balance.

The performance results were published in the 2000 Nebraska Report pp. 7-10. Complete intake and nutrient analyses have now been conducted. These nutrient balance data, combined with the performance data, can be used to help define the supplemental requirements of the grazing heifer.

Procedure

Specific procedures are as described in the 2000 Nebraska Beef Report pp 7-10. Twelve pregnant heifers in 1997-98 (Exp. 1) and 18 heifers in 1998-99 (Exp. 2) were individually fed one of two protein supplements from mid-October to mid-February while grazing sandhills range. In Exp. 1, two treatments were: 1) a supplement designed to meet MP requirements (MPR) and 2) a conventional protein supplement fed to meet CP requirements (CPR). No hay was fed during the experiment. In Exp. 2, treatments were : 1) heifers supplemented to meet MP requirement and fed hay (approximately 5 lb/day) beginning in January (MPR/Hay) 2) heifers supplemented with conventional supplement and fed hay beginning in January (CPR/Hay), and 3) heifers supplemented to meet MP requirement and offered no hay during the experiment (MPR/No Hay). Hay was 8.4% CP and was determined to be 65% digestible in a 5-day in vivo trial with five steers.

The MPR supplement (Table 1) was composed of 53% CP and 28% UIP (DM basis). The CP supplement contained 51% CP and 14% UIP. The CPR supplement was fed at the rate of .89 lb/day (DM) throughout the trial, supplying 53 grams of UIP/day. The MPR supplement feeding rate increased gradually from .70 lb/day in October to 1.6 lb/day in February, supplying 86 grams UIP/day in October, 120 grams UIP/day in November, December, and January, 135 grams UIP/day in early February, and 203 g UIP/day after February 15.

Intake measurements were taken in six-day periods beginning Nov. 10, Jan. 5, and Febr. 9 in 1997-98 (Exp. 1). Intake measurements were taken beginning Dec. 15 and Febr. 18 in 1998-99 (Exp. 2). Time release chromium boluses were used for determination of fecal output in each animal, and predictions were validated with four steers using total fecal collection. Diets were collected with esophageally fistulated cows during each intake period and frozen for subsequent analyses. Diet samples were freeze dried and analyzed for DM, OM, CP, UIP, IVDMD, and in vitro organic matter digestibility (IVOMD). Forage UIP was determined by the amount of neutral detergent insoluble protein remaining after a 48-hour in situ incubation. Forage organic matter intake was calculated by dividing fecal output from forage by forage indigestibility (1-IVOMD).

Intake and nutrient data were used in the 1996 NRC model to determine nutrient balances at the time intakes were conducted during each experiment. Data were modeled assuming no effects of environmental conditions on nutrient requirements. Microbial crude protein production was assumed to be 9.5% of TDN intake. Forage intake, CP, and UIP were calculated on an OM basis and adjusted to a DM basis assuming 10% ash. In vitro dry matter digestibility was used for the forage TDN value.

Results

In Exp. 1, heifers supplemented to meet MP requirements lost less weight over the winter than those supplemented to meet CP requirements (Table 2; P = .04). All cattle lost substantial body condition over the course of the experiment (-1.5 BCS). As previously reported, cattle on the MPR treatment gained the weight advantage early in the fall, but both groups lost weight in January and February (2000 Nebraska Beef Report, pp. 7-10). Grazed forage intake declined linearly (P < .01) from an average of 21 lb (2.1% of body weight) in November

Table 1. Composition of supplements fed to heifers in Experiments 1 and 2 (% of DM).[a]

Ingredient	MPR	CPR
Cottonseed Meal	—	58.8
Feather Meal	40.2	—
Soybean Meal	—	17.8
Sunflower Meal	30.2	13.7
Wheat Middlings	26.2	—
Distillers Grains	—	3.4
Molasses (Cane)	2.1	2.1
Urea	—	2.8
Minerals/Vitamins	1.3	1.4

[a]Supplements were provided as range cubes fed 3 times weekly. MPR: designed to meet the metabolizable protein requirement; CPR: designed as conventional protein supplement.

Table 2. Weight, BCS, and forage intake (FI) of heifers grazing winter Sandhills range from October 1997 to February 1998 (Experiment 1).[a]

Item	MPR	CPR	SD[b]
Beginning wt, lb	955	948	54
Final wt, lb[c]	965	921	49
Wt change, lb[d]	10	-26	27
Beginning BCS	6.4	6.3	.5
Final BCS	4.9	4.8	.3
BCS change	-1.6	-1.7	.7
November FI,[e,f]			
lb	22.2	19.1	3.7
% BW	2.2	2.0	.3
January FI,[e,f]			
lb	15.5	14.8	4.1
% BW	1.6	1.5	.4
February FI,[e,f]			
lb	13.1	12.6	2.0
% BW	1.4	1.4	.2

[a]MPR: heifers supplemented to meet metabolizable protein requirement; CPR: heifers supplemented with conventional protein supplement. No hay fed during the experiment.
[b]Standard deviation, n = 12.
[c]Treatments differ, P = .16.
[d]Treatments differ, P = .04.
[e]Dry matter basis.
[f]Forage intake declined linearly over time (P = .0001).

Table 3. Weight and BCS of heifers grazing winter Sandhills range from October 1998 to February 1999 (Experiment 2).[a]

Item	MPR/Hay	CPR/Hay	MPR/No Hay	Stdev[b]
Beginning wt, lb	940	945	923	41
Final wt, lb[c]	914	921	808	69
Wt change, lb[d]	-26	-23	-114	48
Beginning BCS	6.1	6.0	6.1	.4
Final BCS[e]	5.7	5.4	5.0	.5
BCS change[f]	-.4	-.6	-1.0	.6
December FI,[g,h]				
lb	14.7	16.0	17.7	2.7
% BW	1.7	1.8	2.1	.3
February FI,[g,h]				
lb	11.3	12.4	11.6	1.8
% BW	1.3	1.4	1.4	.2
February FI + HI[g,i]				
lb	17.3	18.4	11.6	3.5
% BW	1.9	2.0	1.4	.3

[a]MPR/Hay: heifers supplemented to meet metabolizable protein requirements and fed hay (average 5 lb/day) in January and February; CPR/Hay: heifers supplemented with conventional protein supplement and fed hay in January and February; MPR/No Hay: heifers supplemented to meet metabolizable protein requirements and fed no hay.
[b]Standard deviation, n = 18.
[c]MPR/Hay and CPR/Hay versus MPR/No Hay, P = .001.
[d]MPR/Hay and CPR/Hay versus MPS/No Hay, P = .0001.
[e]MPR/Hay versus MPR/No Hay, P = .01; CPR/Hay versus MPR/No Hay, P = .10.
[f]MPR/Hay versus MPR/No Hay, P = .10.
[g]Dry matter basis..
[h]Forage intake declined linearly over time (P = .0001).
[i]Forage intake + hay intake.

Table 4. Nutrient composition of diets collected in the Nebraska Sandhills[a].

	1997-1998			1998-1999	
Nutrient	November	January	February	December	February
CP, % DM	5.25	5.19	5.13	6.13	5.60
UIP, % DM[b]	1.13	1.10	1.35	1.45	1.63
DIP, % CP[c]	78.48	78.81	73.68	76.35	70.89
IVDMD, %	51.99	48.91	49.43	51.20	47.39

[a]Diets collected from esophageally fistulated cows.
[b]Undegradable intake protein; calculated from neutral detergent insoluble CP remaining after 48 hour in situ incubation.
[c] Degradable intake protein.

to 13 lb (1.4% of body weight) in February. There were no differences between treatments in forage intake.

In Exp. 2, heifers on the MPR/No hay treatment lost significantly more weight than hay fed heifers (Table 3; P < .01) and more body condition than MPR/Hay heifers (P = .10). Body weight loss was greater than reported in Experiment 1, but body condition loss was not as severe. Grazed forage intake declined (P < .01) from 16 lb (1.8% of body weight) in December to 12 lb (1.3 % of body weight) in February. There were no differences in forage intake between treatments. Total intake (forage + hay) was greater for heifers fed hay than those not fed hay (P < .01).

The decline in intake over the winter was more severe than expected. Reduced digestibility, cold stress and reduced forage availability can cause a depression in forage intake over the winter. In Exp 1., IVDMD (Table 4) decreased from 52.0% in November to 48.9% in January, but then increased to 49.4% in February. Reduced forage digestibility does not explain the drop in intake from January to February. In Exp. 2, IVDMD dropped from 51.2% in December to 47.4% in February. The stocking rate in the pasture where heifers grazed was .70 AUM/acre during Exp. 1., with a cumulative grazing pressure (total AUM per ton of DM forage initially available) of .59 AUM/ton. This would be considered a moderate level of grazing for Nebraska Sandhills winter range. It is unlikely that forage was limiting to the heifers during Exp. 1, especially in January. In Exp. 2, the pasture was stocked at 1.06 AUM/acre (.83 AUM/ton cumulative grazing pressure). Forage potentially became limiting to the heifers in Exp. 2. However, the decline in grazed forage intake was consistent across years.

We hypothesize that advancing growth of the fetus and fluids reduces rumen volume before calving. Heifers are typically at 85% of their mature weight at calving, but the space acquired by the fetus and fluids is similar to a mature cow. Rumen fill limits intake of low quality diets, and reduced rumen volume reduces intake. This would be expected to have the greatest effect during the last month of gestation, when the size of the fetus increases markedly. A reduction in grazed intake occurs at a nutritionally stressful time for the heifer, as protein and energy requirements increase substantially in the last six weeks of gestation. Feeding hay that is more digestible and can exit the rumen faster will allow for a higher total intake.

The nutrient composition of diets collected by esophageally fistulated cows during both experiments is shown in Table 4. Protein did not change markedly across sampling time and year, but appeared to be higher in December of 1998 (6.1%) than November of 1997 (5.3%). The undegradable intake protein content of diets was lower in 1997-98 (1.2% of DM) than in 1998-99 (1.5% of DM). Less UIP in the forage can contribute to MP deficiencies. However, the biological implications of 0.3% UIP are small.

Due to both low UIP and digestibility, winter Sandhills range has a low MP value. Metabolizable protein comes from two sources: 1) microbes leaving the rumen (MCP), and 2) intake protein that escapes rumen degradation (UIP). Microbial crude protein is a function of TDN intake, and can range from 8.0% to 13.0% of TDN. When rate of passage is slow, MCP production is reduced, and may be around 9.5%. The reduced MCP

(Continued on next page)

efficiency, along with the lower TDN intake, creates a reduction in MP coming from microbes. This is why cattle with high protein requirements, such as the heifer, can experience an MP deficiency when grazing winter range.

The nutrient balances of the cattle during Experiments 1 and 2 are shown in Tables 5 and 6, respectively. Degradable intake protein was adequate in all diets during both experiments. However, energy (NEm) and MP were not adequate in all situations. Heifers receiving the MPR supplement had a more positive NEm balance than CPR heifers in November of Exp. 1. This was due to a numerical increase in intake associated with that treatment. MP was deficient (-19 grams) to the CPR heifers in November, but was 46 grams positive for MPR heifers. The energy and protein balance of the MPR heifers during November explains the increased body weight gain observed for that treatment during the fall. It appears that the MPR supplement was formulated correctly to meet the MP requirements of the heifers in the fall. Energy and MP were deficient in both groups of heifers in January and February of Exp. 1, explaining the decline in gain and body condition. Low energy intakes, combined with increasing animal requirements, caused an NEm deficiency reaching -5.5 Mcal per day in February. The low energy intakes reduced MP balance in January and February as well, and the MPR supplement did not supply enough UIP to meet the MP requirement. The MPR heifers were less deficient in MP than CPR heifers.

The MPR heifers were adequate in MP in December of Exp. 2 (Table 6), while CPR heifers were 26 grams deficient. Energy intake was slightly deficient in December for all heifers. Unlike Exp 1, where NEm balance was 1.0 to 2.0 Mcal positive in the fall, energy appeared to be limiting body weight gain. Dry matter intakes (forage + supplement) in December of Exp 2 were low compared to November intakes in Exp 1.

Table 5. Nutrient balance of heifers supplemented to meet metabolizable protein requirements (MPR) or crude protein requirements (CPR) in 1997-1998 (Experiment 1)[a].

	November		January		February	
Item	MPR	CPR	MPR	CPR	MPR	CPR
DM Intake[b]	23.2	20.0	16.5	15.7	14.2	13.5
NEm balance, Mcal	2.3	0.9	-2.9	-3.2	-5.4	-5.5
MP supplied, g	531	417	394	323	376	298
MP required, g	484	436	461	456	540	527
MP balance, g	46	-19	-67	-133	-163	-229
DIP supplied, g	527	508	401	425	348	367
DIP required, g	529	457	360	341	314	298
DIP balance, g	-2	50	41	84	34	69

[a]Calculated using 1996 NRC Model.
[b]Total intake.

Table 6. Nutrient balance of heifers supplemented to meet metabolizable protein or crude protein requirements with hay feeding in January and February (MPR/Hay and CPR/Hay, respectively) or supplemented to metabolizable protein requirements and not fed hay (MPR/No Hay) in 1998-99 (Experiment 2)[a].

	December			February		
Item	MPR Hay	CPR Hay	MPR No Hay	MPR Hay	CPR Hay	MPR No Hay
DM Intake[b]	15.7	16.9	18.7	18.9	19.3	13.2
NEm balance, Mcal	-1.2	-0.9	0.3	-1.7	-1.9	-5.1
MP supplied, g	408	374	465	552	441	415
MP required, g	395	400	404	523	525	497
MP balance, g	13	-26	61	29	-84	-82
DIP supplied, g	426	489	488	572	562	389
DIP required, g	358	381	423	453	452	288
DIP balance, g	68	108	66	120	110	101

[a]Calculated using 1996 NRC Model.
[b]Total intake.

The MPR/Hay heifers were adequate in MP in February, while the other treatment groups were negative. However, energy was deficient in all treatments. Feeding hay helped reduce the energy deficiency in February noted in heifers not fed hay.

When energy intake is adequate to meet the NEm requirement of pregnant heifers, the heifers appear to respond to UIP supplementation. Conventional supplements, such as the CPR supplement, do not supply adequate UIP to the pregnant heifer. This is true even when 5 lb of high quality hay are fed. However, the energy requirements of the spring calving heifer are high over the winter. Grazed forage intake needs to be over 2.0% of body weight for energy requirements to be met. In the Nebraska Sandhills, grazed forage intake will not supply adequate energy for March calving heifers in January and February. Balancing supplements to meet MP requirements can be an effective management strategy if energy requirements are met.

[1]Trey Patterson, research technician; Don Adams, professor, West Central Research and Extension Center, North Platte; Terry Klopfenstein, professor, Animal Science, Lincoln.