Winter Forage Replacement Value Evaluation of a Blended Field Pea-Based Co-Product Supplement Fed to Cows Daily or on Alternate Days

D.G. Landblom[1], S. Senturklu[2], K. Koch[3], G.A. Perry[4]

[1]North Dakota State University, Dickinson Research Extension Center
[2]Canakkale Onsekiz Mart Universitesi, BMYO, 17200 Biga/Canakkale, Turkey
[3]North Dakota State University, Northern Crops Institute
[4]South Dakota State University, Department of Animal and Range Science

Abstract

One hundred-seven, 3-10 year old, third trimester-early lactation cows were randomized to treatment and weight blocks, in a 113 day study to evaluate a 25% hay reduction and a blended RDP-RUP supplement replacement for hay fed either daily (C) or on alternated days (Alt-D) as a drought management strategy. Control cows were fed an all mixed hay diet (Alfalfa-Bromegrass; 10.2% CP) (C) or a mixed hay and wheat straw (4.7% CP) diet in which the amount of hay fed per cow was reduced approximately 25% and replaced with a field pea/co-product supplement (22.8% CP) that was fed either daily (D) at 0.25% of initial BW or 0.50% of initial BW on alternate days (Alt-D). The pelleted supplement (0.25 in) contained a blend of RDP and RUP from field peas (70.0% RDP), distiller's dried grain with solubles (65.0% RUP), and barley malt sprouts (64.0% RDP). Data was analyzed using MIXED procedures of SAS. Unsupplemented C cows were fed an average 34.6 lb of mixed hay daily compared to supplemented cows that were fed 20.6 lb of hay, 3.35 lb wheat straw, and 3.29 or 6.64 lb of the pea-co-product supplement totaling 27.24 lb daily or 30.59 lb on alternated days (As-Fed). Using the blended RDP-RUP supplement as a replacement for hay, fed either D or on Alt-D, did not affect ending cow weight (P = 0.30), body condition score (P = 0.19), 12th rib fat depth (P = 0.19), or pre-breeding estrous cyclicity (P = 0.68). Subsequently, hay conserving strategies did not affect fall calf weaning weight (P = 0.63), gain (P = 0.62), or ADG (P = 0.64). Daily cost per cow was $1.13, $1.19 and $1.19 for the C, D and Alt-D methods, respectively. The data suggests that blending the selected RDP and RUP ingredient sources supplied sufficient ammonia nitrogen to the rumen on the non-supplementation day providing adequate protein and energy to the pre- and postpartum cows fed restricted hay diets. The supplementation strategies tested maintained an ending postpartum BCS 5 and the restricted hay intake diets were competitively priced.

Introduction

Distiller's dried grains with solubles (DDGS) are difficult to pellet (personal communication with CHS Nutrition production manager). Koch and Landblom (2010) documented that, when field pea and barley malt sprouts were blended with DDGS, electrical use declined and pellet quality improved.

Nutrient-dense co-products can replace a large amount of forage, but when used in alternate day feeding systems, the supplement must not induce a rapid decline in rumen pH postfeeding. The starch degradation rate of field pea (*Pisum sativum*) is similar to that of corn (Robinson and McQueen, 1989) and rumen protein degradation (RDP) is estimated to range from 78 to 94% (Aufrere et al., 1994; NRC 1989).

Distiller's dried grains with solubles are a source of rumen undegradable protein (RUP), energy, and minerals (Stock et al., 2000. As a percent of CP, DDGS contain approximately 65% RUP, which can be beneficial when balancing cattle diets for Metabolizable protein (Patterson et al., 2003). Barley malting co-products consist primarily of dried malt sprouts and some thin light test weight barley. Barley malt sprouts (BMS) possess medium CP (16%), moderate energy (74%), and a NEg of 1.15 Mcal/kg indicating that the fiber component is of moderate to high digestibility (Lardy and Anderson, 2009).

Supplementation, as infrequently as every 6th day, with ingredients high in rumen undegradable protein (RUP) have been utilized effectively by ruminants fed low-quality forage without adversely affecting DMI, N efficiency, bacterial CP synthesis, or animal performance (Bohnert et al., 2002a, b). Atkinson et al., (2009) evaluated ruminal protein degradation and supplementation frequency on intake, N retention and nutrient flux across visceral tissues of lambs fed a low-quality forage diet. This study evaluated diets containing either predominantly RDP or RUP, which were compared to a blended diet containing a 50:50 blend of RDP and RUP that was fed daily or on alternate days. Forage OM, NDF, ADF, and N were unaffected by treatment, and neither protein degradability or supplement frequency had any effect on N retention.

Moderate body condition score of 5 (1-9 scale) has been suggested as the most functional target condition for mature beef cows at calving (Houghton et al., 1990; Richards et al., 1986). Feeding pre- and postpartum beef cows a blended field pea-BMS-DDGS supplement, as a replacement for hay, may be a desirable drought management strategy, but has not been evaluated.

The objective of this research project was to evaluate a drought strategy in which a significant amount of daily forage is replaced with a blended RDP/RUP supplement fed either daily or on alternate days to determine the effect on ending cow body weight, ending BCS, ending fat depth, estrous activity at the start of the breeding season, and the subsequent effect on calf gain and weaning weight.

Materials and Methods

Animals and Treatments. All experimental protocols were approved by the North Dakota State University Animal Care and use Committee.

Multiparous (3-10 yr) range beef cows (n = 107) were randomly assigned in a 113 day study to three treatments: 1) all hay control diet (**C**), 2) 25% of forage DM replaced with blended RDP/RUP field pea/co-product supplement fed daily at the rate of 0.25% of BW (**D**), and 3) 25% of forage DM replaced with a blended RDP/RUP field pea/co-product supplement fed on alternate days at the rate of 0.50% of BW (**ALT-D**). There were four pen blocks per treatment (light, medium, medium-heavy, and heavy) and nine cows per pen.

Diets and Adjustment for Temperature. Nutrient analysis of the forages used in the study and experimental supplement composition and analysis are shown in Tables 1 and 2. The diets fed were formulated to contain a calculated balanced energy concentration (DM Basis) across treatments using medium-quality alfalfa-bromegrass hay (*Medicago sativa* and *Bromus inermis;* 10.2% CP), wheat straw (4.7% CP), and the experimental 22.8% CP pelleted field pea-co-product supplement. The forages were delivered to the cows daily using a Haybuster® forage processor equipped with a Digi-Star EZ 2000® electronic scale. Within a 7 day feeding period, alfalfa-bromegrass hay was fed 6 days and wheat straw was fed 1 day. Forages were fed on the ground and orts were not weighed back. The field pea-BMS-DDGS supplements were fed in portable bunks at the rate of 0.25% of trial starting BW for the D supplemented treatment and 0.50% of trial starting BW for the ALT-D treatment.

Winter temperature and wind speed in North Dakota can fluctuate widely from pleasant temperatures and light wind to strong wind, blizzards, and subzero temperatures. During the 16 week study, the amount of daily dry matter fed within each weight block was determined based on the estimated energy content of the supplement, alfalfa-bromegrass hay, and wheat straw. To arrive at the desired calculated NEm energy balance across treatments, the initial DMI for each weight block was determined using the NRC (1996) formula for DMI. The initial late gestation daily NEm/cow for each starting weight block was calculated to be 10.10, 10.80, 11.67, and 12.52 Mcal/day for the light, medium, medium-heavy, and heavy weight blocks, respectively. Since temperature fluctuations in western North Dakota can be extreme, the amount of hay DMI was adjusted at the beginning of each week for temperature based on the local weather forecast for the upcoming week. Dry matter increases used, due to declining temperature, were as follows: 12.2 ºC and above – no increase, 12.2 ºC to -15.0 ºC + 7% increase, -15.0 ºC to -17.8 ºC + 10% increase, -17.8 ºC to -23.3 ºC + 16% increase, and -23.3 ºC to -28.9 ºC + 20.0% increase. These dietary adjustments only affected the amount of hay delivered to each BW block. During the entire study, the RDP/RUP levels, which were established based on cow starting BW, did not change. Gestation diets were fed from the first week of January to the 3rd week of March, when the diets were reformulated for lactation by removing wheat straw and increasing hay DM. The daily lactation NEm balance for weight blocks was calculated to be 15.80, 18.19, 19.06, and 19.97 Mcal/day for the light, medium, medium-heavy, and heavy weight blocks, respectively. The lactation diets were fed until the last week of April, when the cow-calf pairs were moved to crested wheatgrass pastures.

Data Collection and Assay Procedures. Measurements of cow performance included changes in cow BW, BCS, 12th rib fat depth, number of cows in estrus at the start of the breeding season, and subsequent weaning weight. Visual BCS and ultrasound fat depth measurements were collected each time the cows are weighed.

The number of cows cycling at the start of a 45 d breeding season was based on the circulating progesterone concentration derived from two blood serum samples collected 10 days apart just prior to the start of the breeding season. Circulating concentrations of progesterone were analyzed in all serum samples using methodology described by

Engel et al. (2008). Intra- and interassay CV for progesterone assays were 2.47 and 5.9%.

Statistical Analysis. The data was analyzed using the generalized least squares MIXED analysis procedure of SAS (2002-2008). Main effects included dietary treatments and pen served as the experimental unit. Pretrial cow gestation interval days were used as a covariate to adjust cow starting and ending weight, and gain.

Results and Discussion

According to the project objective, a drought management strategy was evaluated in which the amount of forage fed daily was reduced and replace with a nutrient-dense field pea-BMS-DDGS supplement fed either daily at 0.25% of BW or on alternate days at 0.50% of BW. Hay, straw, and field pea-BMS-DDGS supplement intake are shown in Table 3. The diet cost/cow/day was 1.13, 1.19, and $1.19 for the C, D, and ALT-D treatments, respectively.

Cow performance was not negatively affected by forage reduction or supplementation frequency (Table 4). Using pretrial gestation interval as a covariate, cow starting weight, ending weight, and gain did not differ between treatments ($P > 0.10$). Cow BCS changed from a prepartum starting condition of approximately 6 across treatments ($P = 0.81$) to an ending postpartum BCS of 5.39, 5.47, and 5.14 for the C, D, and ALT-D treatments, respectively, that did not differ ($P = 0.624$). Ultrasound fat depth mimicked BCS and did not differ between treatments ($P = 0.415$).

Postpartum circulating progesterone concentrations did not differ ($P = 0.678$); however, there was a numerically greater number of cows in estrous at the start of the breeding season among supplemented cows compared to the control cows (Table 4).

Calf birth and weaning weights are shown in Table 5. Calf birth weight for calves whose dams received daily supplement were lighter ($P = 0.014$) than calves from either C or ALT-D supplemented cows. Calf weaning weight ($P = 0.634$) and preweaning gain ($P = 0.621$) did not differ.

Although hay is the most common feed fed to gestating and lactating beef cows, the cost per unit of energy is often considerably more expensive than high energy feedstuffs such as corn (Loerch 1996; Schoonmaker et al., 2003). Radunz et al. (2010) documented that energy source, i.e. grass hay, corn, or DDGS, fed during gestation did not affect pre- and postpartum cow performance, but energy partitioning associated with corn and DDGS shunted nutrients to the fetus and increased birth weight. In the present study, ending ultrasound fat depth did not differ; however, fat depth decline was numerically greater among the ALT-D and C hay groups, and calf birth weight among these two groups was greater ($P = 0.014$) compared to the daily supplemented group. Energy, CP, and amino acids are essential for late gestation fetal growth (Ferrell et al., 1976). Although the current data is not conclusive, it appears that there may have been greater lipid mobilization from fat stores among cows in the C and ALT-D groups combined with greater energy and N flow when the ALT-D supplemented cows received a double amount of supplement resulting in greater calf birth weight. This may also be associated with feeding excess protein on the days of supplementation, and the possible loss of nitrogen compared to daily supplemented cows through excretion of excess nitrogen in the urine.

Implications

These data are in agreement with others and suggest that nutrient-dense field pea-BMS-DDGS supplements formulated to contain blended RDP and RUP, and fed on alternate days, can be used to supply adequate protein and energy to pre- and postpartum cows fed restricted hay diets. The supplementation strategies tested maintained an ending postpartum BCS 5 and the restricted hay intake diets were competitively priced.

Literature Cited

Atkinson, R.L., C.D. Toone, T.J. Robinson, D.L. Harmon and P.A. Ludden. 2009. Effects of ruminal protein degradability and frequency of supplementatioin on nitrogen retention, apparent digestibility, and nutrient flux across visceral tissues in lambs fed low-quality forage. J. Anim. Sci. 87:2246 .

Aufrere, J.D., D. Graviou, J.P. Melcion, and C. Demarquilly. 2001. Degradation in the rumen of lupin (*Lupinus albus L.*) and pea (*Pisum sativum L.*) pea seed proteins. Anim. Feed Sci. Technol. 92:215.

Bohnert, B.W., C.S. Schauer, and T. DelCurto. 2002a. Influence of rumen protein degradability and supplementation frequency on performance and nitrogen use in ruminants consuming low-quality forage: Cow performance and efficiency of nitrogen use in wethers. J. Anim. Sci. 80:1629-1637.

Bohnert, B.W., C.S. Schauer, M.L. Bauer, and T. DelCurto. 2002b. Influence of rumen protein degradability and supplementation frequency on steers consuming low-quality forage: I. Site of digestion and microbial efficiency. J. Anim. Sci. 80:2967-2977.

Engel, C. L., H. H. Patterson, and G. A. Perry. 2008. Effect of dried corn distillers grains plus solubles compared with soybean hulls, in late gestation heifer diets, on animal and reproductive performance. J. Anim. Sci. 86:1697-1708.

Ferrell, C. L., W. N. Garrett, N. Hinman, and G. Gritching. 1976. Energy utilization by pregnant and non-pregnant heifers. J. Anim. Sci. 42:937-950.

Houghton, P. L., R. P. Lemenager, G. E. Moss, and K. S. Hendrix. 1990. Prediction of postpartum beef cow body composition using weight to height ratio and visual body condition score. J. Anim. Sci. 68:1428-1437.

Koch, K. and D. G. Landblom. 2010. Steam Pelleted Supplements for Beef Cows made using Field Peas, Barley Malt Sprouts (BMS), and Distiller's Dried Grains with Solubles (DDGS). http://www.ag.ndsu.edu/DickinsonREC/annual-reports-1/2010-annual-report/beef10d.pdf.

Lardy, G. P. and V. Anderson. 2003. Alternative feeds for ruminants. NDSU Extension Publication AS-1182. North Dakota State University, Fargo.

Loerch, S. C. 1996. Limit-feeding corn as an alternative to hay for gestating beef cows. J. Anim. Sci. 74:1211-1216.

NRC. 1989. Nutrient Requirements of Dairy Cattle. (6th Rev. Ed.) National Academy Press, Washington, DC.

NRC. 1996. Nutrient Requirements of Beef Cattle. (7th Rev. Ed.) National Academy Press, Washington, DC.

Richards, M. W., J. C. Spitzer, and M. B. Warner. 1986. Effect of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive performance in beef cattle. J. Anim. Sci. 62:300-306.

Robinson, P.H. and R.E. McQueen. 1989. Non-structural carbohydrates in rations for dairy cattle. Proc. 10th Western Nutrition Conference University of Saskatchewan, Saskatoon, Saskatchewan, Canada, p 153.

Radunz, A. E., F. L. Fluharty, M. L. Day, H. N. Zerby, and S. C. Loerch. 2010. Prepartum dietary energy source fed to beef cows: I. Effects on pre- and postpartum cow performance. J. Anim. Sci. 88:2717-2728.

Schoonmaker, J. P., S. C. Loerch, J. E. Rossi, and M. L. Borger. 2003. Stockpiled forage or limit-fed corn as alternatives to hay for gestating and lactating beef cows. J. Anim. Sci. 81:1099-1105.

Stock, R. A., J. M. Lewis, T. J. Klopfenstein, and C. T. Milton. 2002. Review of new information on the use of wet and dry milling feed by-products in feedlot diets. J. Anim. Sci. 77:1-12.

Table 1. Mixed Hay and Wheat Straw Nutrient Analysis

Nutrient	**Mixed Hay Dry Matter (%)**	**Wheat Straw Dry Matter (%)**
Dry Matter	84.90	84.40
Crude Protein	10.20	4.70
TDN	52.5	35.0
ADF	39.00	49.20
NDF	57.60	77.06
Calcium	0.93	0.27
Phosphorus	0.17	0.04

Table 2. Field Pea-Co-Product Based Supplement Composition and Nutrient Analysis

Composition		Nutrient Analysis		
Ingredient	**Dry Matter (%)**	**Nutrient**	**Dry Matter (%)**	**Mcal/lb**
Field Peas	49.80	Dry Matter	90.28	-
Barley Malt Sprouts	22.00	Crude Protein	22.80	-
Distillers Dried Grain (DDCS)	20.00	ADF	10.52	-
Beet Molasses	5.00	NDF	27.74	-
Dicalcium Phosphate (21%)	2.45	TDN	79.08	-
Salt	0.50	Crude Fat	3.35	-
Trace Mineral Pre-Mix[a]	0.15	Fiber	8.36	-
Vitamin Pre-Mix[b]	0.0250	Starch	29.62	-
		Calcium	0.63	-
		Phosphorus	0.11	-
		NEm	-	0.88
		NEg	-	0.59

[a] Trace Mineral Content: Potassium, % 0.96, Sodium, % 0.42, Chloride, % 0.47, Magnesium, % 0.19, Sulfur, % 0.43, Manganese, ppm 161.28, Iron, ppm 164.58, Copper, ppm, 105.27, Zinc, ppm 371.64, Cobalt, ppm 1.82, Iodine, ppm 8.84.
[b] Vitamin Content: Vitamin E, IU/Lb 22.15, Vitamin A, IU 22.1533, Vitamin D_3 2.2153, Thiamine, Mg/Lb 0.60.

Table 3. Hay, Straw and Field Pea-Based Supplement Consumption

	Control	**Supplemented Daily**	**Supplemented Alternate Daily**	**SE**	**P-Value**
Hay Intake:					
Total Hay Fed, lb [a-b]	35189.0[a]	20944.0[b]	20964.0[b]	0.74	0.001
Hay, lb/Cow [a-b]	3910.0[a]	2328.0[b]	2329.3[b]	84.68	0.001
Hay, lb/Cow/Day [a-b]	34.6[a]	20.6[b]	20.6[b]	0.74	0.001
Total Straw Fed, lb	-	3411.3	3411.3	7.14	-
Straw/Cow, lb	-	379.0	379.0	0.79	-
Straw/Cow/Day, lb	-	3.35	3.35	0.01	-
Total Hay & Straw/Cow, lb	3910.0	2707.0	2708.3		
Total Forage/Cow/Day, lb	34.6	23.95	23.95	-	-
Field Pea-Based Supplement Intake:					
Total Supplement Fed, lb	-	3342.8	3288.8	-	-
Supplement/Cow, lb	-	371.3	365.5	-	-
Supplement/Cow/Day, lb	-	3.29	6.64	-	-
Percent of Cow Body Wt., %	-	0.23	0.46	-	-
Total Feed Cost/Cow/Day, $	1.13	1.19	1.19		

[a-b] Rows with unlike superscripts differ ($P < 0.01$).

Table 4. Cow Performance Following Hay Replacement with a Field Pea-Based Supplement Fed Either Daily or on Alternate Days

	Control	Supplemented Daily	Supplemented Alternate Daily	SE	P-Value Covariate	Trt
Trial Length, Days	113	113	113			
Cow Body Weight Change:						
Gestation Interval, Days [a-b]	197.8[a]	198.7[a]	195.3[b]	1.23		0.061
Cow Start Wt., lb	1435.8	1443.8	1445.6		0.634	0.473
SE	(72.94)	(73.03)	(73.11)			
Cow End Wt., lb	1346.6	1312.9	1419.1		0.085	0.301
SE	(48.15)	(52.64)	(56.56)			
Cow Gain, lb	-74.29	-88.68	-83.67		0.963	0.900
SE	(22.52)	(23.98)	(25.29)			
Cow ADG	-0.66	-0.78	-0.74		0.963	0.900
SE	(0.1993)	(0.2122)	(0.2238)			
Cow Body Condition Score Change:						
Start BCS	6.10	6.00	5.95	0.23		0.810
End BCS	5.39	5.47	5.14	0.34		0.624
BCS Increase or (Loss)	(-0.71)	(-0.53)	(-0.81)	0.12		0.191
Percent BCS Decline	11.64	8.83	13.61	-		-
Cow Ultrasound Fat Depth Change:						
Start Rib Fat Depth, mm	6.42	6.31	6.53	0.67		0.973
End Rib Fat Depth, mm	3.97	4.92	4.67	0.74		0.415
Rib Fat Depth Inc. (Decline), mm	(-2.46)	(-1.39)	(-1.86)	0.47		0.190
Percent Rib Fat Depth Decline	38.16	22.03	28.48	-		-
Pre-Breeding Percent Cycling, %	70.35	79.06	75.06	6.85		0.678

[a-b] Rows with unlike superscripts differ ($P < 0.01$).

Table 5. Calf birth and Weaning Weight Following Hay Replacement with a Field Pea-Based Supplement Fed Either Daily or on Alternate Days

	Control	Supplemented Daily	Supplemented Alternate Daily	SE	P-Value
Calf Birth and Growth Performance:					
Calf Birth Wt., lb. [a-b]	91.83[a]	87.00[b]	95.35[a]	1.58	0.014
Calf Weaning Age, days [x-y]	213.9[x]	214.9[x]	211.6[y]	1.23	0.061
Calf Weaning Wt., lb.	660.7	671.1	672.2	13.96	0.634
Calf Wt. Gain, lb	568.9	584.1	576.9	13.9	0.621
Calf ADG, lb	2.66	2.72	2.73	0.060	0.644

[a-b] Rows with unlike superscripts differ ($P < 0.05$).
[x-y] Rows with unlike superscripts differ ($P < 0.10$).