J. Range Manage.
50:351–356

Grass hay as a supplement for grazing cattle I. Animal performance

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Abstract

Regrowth grass hay produced on subirrigated meadows in the Nebraska Sandhills was evaluated as a supplement for gestating beef cows grazing winter range. Ninety-six crossbred spring calving, gestating beef cows were used in a winter supplementation study on upland Sandhills range from 5 November to 27 February in 1990 and again in 1991. Cows were divided into 4 treatments (24 cows/treatment): 1) control (range forage only, no supplement); 2) range forage and 2.2 kg cow^{-1} day^{-1} of meadow regrowth hay (15.5% crude protein); 3) range forage and 1.2 kg cow^{-1} day^{-1} of a 30% wheat grain and 70% soybean meal:30% wheat supplement (36.0% crude protein); and 4) range forage with supplements in treatments 2 and 3 fed on alternate days. Meadow hay and soybean meal:wheat supplements provided 0.32 kg of crude protein/cow daily. Supplemented cows gained 3 to 53 kg body weight/year and maintained body condition, while control cows lost an average of 24.5 kg body weight/year and lost body condition. Intake of range forage was less ($P < 0.05$) by cows fed meadow hay and soybean meal:wheat supplements on alternate days than by cows on other treatments. Digestibility of range forage was lower ($P < 0.05$) for supplemented cows than control cows, but differences were small (avg. = 2%). Calving date, birth and weaning weights, and pregnancy rate were similar ($P > 0.05$) for all treatments. We concluded that subirrigated meadow regrowth grass hay was an effective alternative to traditional soybean meal-based supplements for maintaining body weight and body condition of gestating beef cows grazing winter range.

Key Words: subirrigated meadow, intake, digestibility, body condition

Rasby (1990) reported that feed costs were the greatest and most variable costs in the production of a calf by Nebraska beef producers. Grazing rather than feeding hay during winter decreases feed costs and increases profitability of cow-calf operations (Adams et al. 1994). Cows should be in moderate body condition at calving if they are to breed early in a controlled breeding season (Richards et al. 1986). Body condition at spring calving of cows wintered on range is influenced by body condition of the cow the previous fall (Adams et al. 1987) and protein supplementation during winter grazing (Cochran et al. 1986a).

Protein supplements have traditionally been based on grain and protein concentrates. Alfalfa has been used effectively as an alternative to soybean meal-sorghum grain (DelCurto et al. 1990) or cottonseed meal-barley supplements (Cochran et al. 1986a) for maintaining body condition of cows grazing dormant forage. Little information is available on other forages as supplements for dormant forages on range. Nichols et al. (1990) demonstrated that high protein grass hay can be produced from subirrigated meadows in the Nebraska sandhills, and such hay might have potential as an alternative to traditional protein supplements. Hence, our objective was to evaluate the efficacy of grass hay produced from regrowth following hay harvest on subirrigated meadows as a supplement for gestating beef cows grazing sandhills winter range.

Materials and Methods

The study area was located on typical sandhills range at the University of Nebraska-Lincoln Gudmundsen Sandhills Laboratory near Whitman, Neb. The primary range site was sands, which was dominated by blue grama [*Bouteloua gracilis* (H.B.K.) Lag. ex Griffiths], little bluestem [*Andropogon scoparius* (Michx.) Nash], prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.], sand bluestem (*Andropogon hallii* Hack.), switchgrass (*Panicum virgatum* L.), and sand lovegrass [*Eragrostis trichodes* (Nutt.) Wood]. Common forbs and shrubs included western ragweed (*Ambrosia psilostachya* Dc.) and leadplant [*Amorpha canescens* (Nutt.) Pursh]. Standing forage on a similar nearby range site was 1,399 kg/ha and 1,419 kg/ha in August of 1990 and 1991, respectively (Northup 1993).

Ninety-six, 4-year-old crossbred gestating beef cows were used in a winter supplementation study from 5 November 1990 to 28 February 1991 and again from 5 November 1991 to 28 February 1992. Cows were 1/4 Hereford, 1/4 Angus, 1/4 Simmental and 1/4 Gelbvieh. In each year, cows were assigned randomly to 1 of 4 treatments (24 cows/treatment). Cows within each treatment were divided into 2 groups and each group was assigned randomly to graze in 1 of 8 different 36.5 ha paddocks (2 paddocks/treatment) that were similar in dimension and vegetation. Treatments were: 1) control (range forage only); 2) range forage plus 2.2 kg cow^{-1} day^{-1} in 1990 to 1991 and 2.0 kg cow^{-1} day^{-1} in 1991 to 1992 of meadow regrowth hay supplement (DM basis); 3) range forage plus 0.90 kg

Published with the approval of the director of the Univ. of Nebraska-Lincoln, Institute of Agr. and Natur. Resources, Agr. Res. Div. as Journal Ser. no. 10550.
Manuscript accepted 30 Sep. 1996.

cow^{-1} day^{-1} of a 70% soybean meal:30% wheat grain supplement (DM basis); and 4) range forage with supplements in treatments 2 and 3 fed on alternate days. Supplements provided 0.31 to 0.43 kg of crude protein/cow daily.

The hay was subirrigated meadow regrowth harvested during late August of both years following a hay harvest and fertilization in June. Fertilizer applied consisted of 14.7 kg/ha nitrogen, 7.4 kg/ha phosphate, and 3.7 kg/ha sulfur. The subirrigated meadow soils were classified as Gannett-Loup fine sandy loam (course-loamy mixed mesic Typic Haplaquoll). Dominant meadow vegetation was smooth bromegrass (*Bromus inermis* Leyss.), redtop (*Agrostis stolonifera* L.), timothy (*Phleum pratense* L.), slender wheatgrass [*Agropyron trachycaulum* (link) Malte], quackgrass [*Agropyron repens* (L.) Beauv.], Kentucky bluegrass (*Poa pratensis* L.), prairie cordgrass (*Spartina pectinata* Link), and several species of sedges (*Carex* spp.) and rushes (*Juncus* spp.). Less abundant grass species were big bluestem (*Andropogon gerardii* Vitman), indian grass [*Sorghastrum nutans* (L.) Nash], and switchgrass. Forbs and legumes were a minor component of the standing vegetation.

Fall pregnancy rate and calf weaning weight were determined. From calving to weaning, study cows were integrated into a larger herd. Cows were fed meadow hay (approximately 8.0% CP) ad libitum from 1 March to 15 May and grazed sandhills range until weaning on 5 October. The breeding season was 55 days in length beginning 1 June of each year.

Individual cow body weight was recorded after 16 hours without feed or water on 7 November, 5 December, 3 January, 31 January, and 28 February during winters of 1990 to 1991 and 1991 to 1992. Individual cows were scored for body condition on 7 November, 3 January, and 28 February. Body condition scores were based on a palpated determination of fleshing over the ribs and thoracic vertebrae. Body condition was scored from 1 (thinnest) to 9 (fattest) according to the system described by Richards et al. (1986). Calves were weighed at birth and at weaning on 7 October. Pregnancy was determined by rectal palpation at weaning.

Voluntary forage intake by cows was determined 10 through 15 December 1990 and 5 through 10 February 1991 and again 11 through 16 December 1991 and 28 through 31 January 1992. Forage intake and digestibility were determined for 6 cows/treatment, consisting of 3 cows from each of the 2 paddocks assigned/treatment. Six days before and during the 6-day intake trials, these cows were moved to a common paddock similar in dimension and vegetation to treatment paddocks and were individually fed their assigned supplements on a daily basis. Each cow on the intake trial was dosed orally with an intraruminal continuous chromium (Cr) releasing device[1] 5 days before the 6-day fecal collection period. Three to 500 g of feces were obtained daily at about 0800 hours from each cow.

Four steers (avg weight = 250 kg) were assigned to control, meadow hay supplement, and soybean meal:wheat supplement treatments during 1990 to 1991; and 5 steers were assigned to control and the meadow hay supplement treatment during 1991 to 1992. Steers were fitted with fecal collection bags for total collection and dosed with the same intraruminal continuous release Cr device as the cows to obtain a correction factor for fecal output (Adams et al. 1991a, Hollingsworth et al. 1995). Feces contained in collection bags were weighed, mixed, subsampled (150 to 300 g), and emptied once daily at 0800 hours during the 6-day collection period.

Six esophageally-fistulated cows (avg. body weight = 400 kg) were used to obtain diet samples. Diets were collected on 2 days within each 6-day fecal collection period, 10 and 14 December 1990, 6 and 8 February 1991, 11 and 15 December 1991, and 28 and 30 January 1992. After an overnight fast, cows were fitted with screen bottom canvas collection bags. Forage samples were collected from the esophagus during a 30- to 45-min grazing period and composited for the 2-day collections for each cow within each 6-day fecal collection period. All fecal and extrusa samples were frozen and stored for subsequent chemical analyses.

In vivo dry matter digestibility of the meadow hay supplement was determined for hay harvested in August 1990 and August 1991 in a replicated 2 × 2 Latin square with 4 steers (avg body weight = 411 kg) by standard methods (Schneider and Flatt 1975) in 1992. Steers were fitted with fecal collection bags and harnesses for a 7-day adaptation period followed by a 6-day measurement period. Fecal bags were weighed, mixed, subsampled, and emptied twice daily at 0800 and 2000 hours. Digestibility of soybean meal:wheat supplement was estimated by in vitro digestibility (Tilley and Terry 1963).

Extrusa and fecal samples were freeze dried and ground to pass a 1-mm screen in a Wiley mill. Dry matter and crude protein (CP) of extrusa and supplements were determined by standard methods (AOAC 1990), neutral detergent fiber (NDF) was determined according to Van Soest et al. (1991), and acid detergent fiber (ADF) was determined by the method of Van Soest (1963). Diet indigestible ADF was determined on meadow hay supplement, soybean meal:wheat supplement, esophageal extrusa, and fecal samples as described by Cochran et al. (1986b). Fecal samples were analyzed for Cr concentration by atomic absorption spectrophotometry using an air-plus-acetylene flame (Williams et al. 1962).

Fecal output, forage intake, and total intake (e.g., range forage + supplement) were calculated according to Kartchner (1980) using indigestible ADF as the internal marker and Cr as the external marker. For the December 1990 and February 1991 intake trials, fecal output of cows was corrected using a 0.77 adjustment factor, obtained from the Cr recovery estimates derived by total collection from steers. During December 1991 and January 1992 intake trials, fecal outputs estimated from the Cr-continuous release device and total fecal collections in the steers did not differ ($P > 0.05$); hence, no correction was made on cow fecal output estimates. Digestibility of supplements and amount of supplement fed were used to determine supplement contribution to fecal output. Fecal output attributed to supplements was subtracted from total fecal output so that intake and digestibility of the range forage could be estimated.

Chemical composition of diets was analyzed with a one-way analysis of variance (SAS 1990). In vivo dry matter digestibility of the meadow hay supplement for both years was analyzed as a 2 × 2 replicated Latin square with steer, period, and treatment in the model (Steel and Torrie 1980).

Range forage and total dry matter intake (range forage + supplement), and range forage and total dry matter digestibility were analyzed with the GLM procedure of SAS (1990). The model included treatment, year, collection period, treatment × year, treatment × year × collection period, and paddock (treatment ×

[1]Captec Chrome manufactured by Captec Pty. Ltd., Australia, distributed internationally by Nufarm Limited, Manu Street, P.O. Box 22-407, Otahunu, Auckland 6, New Zealand.

Table 1. Chemical composition of range diets, protein supplements, meadow hay in vivo digestibility, and in vitro digestibility of the soybean meal:wheat supplement.

Item[1]	Native range Collection period Dec. 1990	Feb. 1991	Dec. 1991	Jan. 1992	Meadow hay 1990	1991	Soybean meal:wheat supplement 1990	1991
CP, %	4.3[b]	6.4[a]	5.0[b]	4.8[b]	15.1	15.5	36.0	36.0
NDF, %	76.3[c]	74.1[c]	78.9[a]	81.2[a]	73.5	69.1	----	----
ADF, %	53.8[a]	54.3[a]	51.1[b]	51.4[b]	37.4	35.9	----	----
Digestibility[2], %	----	----	----	----	61.8	59.8	84.6	83.0

[1]Percent of dry matter, CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber.
[2]Meadow hay in vivo DM digestibility and soybean meal:wheat supplement in vitro DM digestibility.
[a,b,c]Means within a row with different superscripts are different (P<0.05).

year). Cow was the experimental unit and cow (paddock treatment × collection period × year) was used as the error term. Body weight, body condition score, calving date, and birth and weaning weights were analyzed using a model including treatment, year, treatment × year, paddock (treatment × year). Paddock was the experimental unit and cow (paddock × year × treatment) was used as the error term. Treatment sums of squares were partitioned by orthogonal contrasts. Orthogonal contrasts were: 1) control vs all supplement treatments; 2) hay + soybean meal:wheat supplements vs hay and soybean meal:wheat supplements on alternating days; and 3) soybean meal:wheat supplement vs hay supplement (Steel and Torrie 1980). Pregnancy rates were transformed to a logit (Cox 1970) before analysis.

Results and Discussion

A year × collection period interaction occurred ($P < 0.05$) for crude protein, ADF, and NDF; therefore, means are reported on a within-year basis. Chemical composition of esophageal extrusa varied between collection dates ($P < 0.05$) in crude protein, NDF, and ADF (Table 1); but values were within the range reported by Powell et al. (1982) and Yates et al. (1982) for dormant range in Nebraska. In vivo digestibility of meadow hay supplement averaged 61.8% in 1990 to 1991 and 59.8% in 1991 to 1992 and in vitro digestibility of the soybean meal:wheat supplement averaged 84.6% for 1990 to 1991 and 83.0% for 1991 to 1992.

Body weight. Cows on all supplement treatments maintained or gained body weight, and control cows lost body weight during both winters (Table 2). A year effect ($P < 0.05$) was observed only for the beginning body weight (7 November). Body weight on 7 November and 5 December were similar ($P > 0.05$) for all treatments. A year × treatment interaction was detected for the 3 January body weight ($P < 0.05$). Body weight on 3 January was lowest for the meadow hay treatment in 1990 to 1991 and greatest in 1991 to 1992 compared with the other supplement treatments. On 3 January and 31 January, supplemented cows were heavier ($P < 0.05$) than control cows. Final body weight on 28 February was greater for the 3 supplement treatments in both years. Cows fed the meadow hay supplement were heavier than cows fed soybean meal:wheat at the final body weight on 28 February 1991 to 1992. In both winters, body weight gains over

Table 2. Body weight (kg) and body weight gain of gestating beef cows grazing native range without supplement, supplemented with meadow hay, soybean meal:wheat supplement, or meadow hay and soybean meal:wheat supplement fed on alternate days during winters of 1990 to 1991 and 1991 to 1992.

Item	1990 to 1991 C	H	S	SH	SE	Contrast[2]	1991 to 1992 C	H	S	SH	SE	Contrast[2]
	kg						kg					
7 Nov., beginning weight	506	503	492	502	9.08	NS[3]	520	531	521	525	9.08	NS
5 Dec., 28 day	524	529	525	535	9.03	NS	506	543	531	535	9.03	NS
3 Jan., 56 day[4]	519	533	535	545	8.91	NS	480	559	539	554	8.91	1
31 Jan., 84 day	504	540	537	554	9.02	1	492	566	543	556	9.02	1
28 Feb., 112 day, final weight	495	544	542	555	8.93	1	482	564	524	554	8.93	1,3
Body weight gain over 112 days	-11	41	50	53		1,3	-38	33	3	29		1,2,3

[1]C = control, H = meadow hay supplement, S = soybean meal:wheat supplement, and SH = soybean meal:wheat supplement + meadow hay supplement fed on alternate days.
[2]Orthogonal contrast ($P < 0.05$), Contrast 1 = C vs [(S + H + SH)/3]; 2 = [(H + S)/2] vs SH, 3 = H vs S.
[3]NS = not significant ($P > 0.05$).
[4]A treatment × year interaction occurred (P<0.05) for 3 Jan. body weight.

Table 3. Body condition score and change in body condition score of gestating beef cows grazing native range without supplement, supplemented with meadow hay, soybean meal:wheat supplement, or meadow hay and soybean meal:wheat supplement fed on alternate days during winters of 1990 to 1991 and 1991 to 1992.

	1990 to 1991						1991 to 1992					
Item	C[1]	H	S	SH	SE	Contrast[2]	C	H	S	SH	SE	Contrast[2]
7 Nov., beginning body condition score	5.9	5.7	5.9	5.6	.12	NS[3]	5.4	5.5	5.4	5.4	.12	NS
3 Jan. 56 day[4]	5.5	5.6	5.9	5.6	.12	NS	4.7	5.7	5.5	5.5	.12	1
28 Feb., Final body condition score[4]	4.7	5.7	6.1	5.7	.13	1,3	4.2	5.7	5.3	5.5	.13	1
Change in - body condition score over 112-day trial	-1.2	.0	.2	.1	.09	1	-1.2	.2	-.1	-.1	.09	1

[1]C = control, H = meadow hay supplement, S = soybean meal:wheat supplement, and SH = soybean meal:wheat supplement + meadow hay supplement fed on alternate days, SE = standard error.
[2] Significant orthogonal contrast P < 0.05, Contrast 1 = C vs [(S + H + SH)/3]; 2 = [(H + S)/2] vs SH; 3 = H vs S.
[3]NS = Nonsignificant (P > 0.05).
[4]Significant year × treatment interaction, P<0.05.

the 112-day grazing period were greater (P < 0.05) for supplemented cows vs control cows and for cows receiving meadow hay and soybean meal:wheat supplements on alternate days vs the average of cows receiving meadow hay or soybean meal:wheat supplements. In 1991 to 1992, gains over the 112-day period were greater (P < 0.05) for cows on the meadow hay treatment vs the soybean meal:wheat treatment.

Studies on the use of forages as supplements for cattle grazing dormant winter range forage have been mostly limited to alfalfa hay. Response of cow weight gain has been similar for alfalfa hay compared to cottonseed meal—or soybean meal—based supplements in other winter range grazing studies (Cochran et al. 1986a, DelCurto et al. 1990).

Body condition score. Cows on all supplement treatments maintained body condition; whereas, control cows lost body condition during both winters. Body condition scores at the beginning of the trial varied between 1990 and 1991 (P < 0.05) but were similar (P > 0.05) for cows in all treatments (Table 3). A year × treatment interaction occurred for the 3 January (day 56) body condition score. The 3 January body condition score was not different (P > 0.05) for control vs supplement treatments in 1990 to 1991, but in 1991 to 1992 body condition of control cows was lower (P < 0.05) than the average of supplemented cows. The 3 January body condition score was similar (P > 0.05) for all supplement treatments in both winters.

A year × treatment interaction occurred for 28 February final body condition score. During 1990 to 1991, cows receiving the meadow hay supplement were 0.37 body condition score lower (P < 0.05) than cows receiving the soybean meal:wheat supplement. In 1991 to 1992, no differences (P > 0.05) occurred between supplement treatments. Final body condition score on 28 February was 1.14 and 1.30 units less (P < 0.05) for control cows than the average of cows receiving the 3 supplement treatments in 1990 to 1991 and 1991 to 1992, respectively.

Body condition score is more closely related to reproduction than body weight in beef cattle (Dziuk and Bellows 1983). Cows in low body condition score (e.g., < 4) at calving may breed later or fewer will breed during a controlled breeding season than cows in higher body condition (e.g., > 5), especially if the cow loses body condition score between calving and the beginning of the breeding season (Richards et al. 1986).

Protein supplement helped the cows maintain body condition during winter grazing, but it did not increase body condition scores above those recorded at the beginning of the trial. This is in agreement with studies by Adams et al. (1991b). Body condition scores of cows in the fall or at the beginning of winter grazing should be taken into consideration when determining if a protein supplement should be fed during winter grazing. With or without protein supplement, thin cows or cows with a low body condition score are likely to stay thin during winter grazing (Adams et al. 1991b, Adams et al. 1987).

Dry matter intake and digestibility. Intake (kg/100 kg of body weight) was affected (P < 0.05) by treatment, year, and collection period within year (Table 4) but all interactions were nonsignificant (P > 0.05). Intake of range forage and total intake (i.e., range forage + supplement) were similar (P > 0.05) for the control vs all

Table 4. Forage and total dry matter intake and digestibility by gestating beef cows grazing native range without supplement, supplemented with meadow hay, soybean meal:wheat supplement, or meadow hay and soybean meal:wheat supplement fed on alternate days.

	Treatment[1]					
Intake	C	H	S	SH	SE[2]	Contrast[3]
	Intake, kg/100 kg of body weight					
Range forage	2.07	1.82	2.09	1.64	.11	2
Total	2.07	2.19	2.29	1.91	.11	2
-	Digestibility, % of dry matter					
Range forage	60.48	58.8	59.1	59.7	.39	1
Total	60.48	59.2	61.5	61.1	.37	3

[1]C = control, H = meadow hay supplement, S = soybean meal:wheat supplement, and SH = soybean meal:wheat supplement + meadow hay supplement fed on alternate days. All year and year × treatment effects were not significant (P > 0.05).
[2]SE = Standard error.
[3]Significant orthogonal contrasts (P < 0.05); 1 = C vs [(S + H + SH)/3]; 2 = [(H + S)/2] vs SH; 3 = H vs S.

Table 5. Reproductive performance of cows and birth and weaning weight of calves.

	Year (winter)								
	1990 to 1991				1991 to 1992				
	Treatment[1]								
Item	C	H	S	SH	C	H	S	SH	Contrast
Pregnancy rate, %	96	94	96	98	95	93	95	97	NS
Calving date, Julian	91	91	87	92	91	84	86	90	NS
Birth weight, kg	42	43	41	43	40	42	43	39	NS
Weaning weight, kg	250	252	242	260	251	260	261	248	NS

[1]C = control, H = meadow hay, S = protein supplement, and SH = protein supplement + meadow hay fed on alternate days.
[2]NS = Nonsignificant P>0.05.

supplement treatments and for meadow hay supplement vs soybean meal:wheat supplement. Intake of range forage and total intake were greater ($P < 0.05$) by the average of cows supplemented with meadow hay or soybean meal:wheat than by cows fed meadow hay and soybean meal:wheat supplements on alternate days.

Digestibility of range forage was greater ($P < 0.05$) for the control vs the average of all supplements. Total digestibility was greater ($P < 0.05$) for the soybean meal:wheat supplement vs meadow hay supplement, reflecting the difference in digestibility between the forage and concentrate supplement (Table 1). Digestibility of the range forage was relatively high compared to values reported for sandhills range forage (Rittenhouse et al. 1970), but was similar to other values reported for winter range (Powell et al. 1982, Ward et al. 1990).

Results of research evaluating effects of protein supplement on intake and digestibility of winter range forage have been inconsistent. Digestibility and(or) intake has increased in response to some supplementation studies but not in others (Rittenhouse et al. 1970, Kartchner 1980, Caton et al. 1988, Ward et al. 1990). Inconsistency of associative effects of protein supplementation on intake and digestibility is related to crude protein content in the diet, forage availability (Hafley 1990), and harsh weather (Adams et al. 1986).

Control cows lost body weight and body condition score during both years despite similarity in total intake and digestibility compared with supplemented cows. This difference is best explained by the additional protein consumed in the supplements meeting protein requirements of the cow that were not met by the range forage (Judkins et al. 1987). Villalobos (1993) fed steers a basal diet of prairie hay at 1.5% of body weight and replaced the prairie hay with increasing amounts of meadow hay supplement (same meadow hay as used in this study) from 0 to 40% of the dry matter consumed. Dry matter intake was constant for all levels of prairie hay and meadow hay supplement, but nitrogen intake and nitrogen flowing to the duodenum increased linearly with additions of meadow hay supplement. Improved livestock performance in response to increased duodenal protein supply may occur as a result of correction of a protein/energy imbalance in absorbed nutrients (Egan 1977), correction of an amino acid deficiency, increased availability of glycogenic substrates (Egan 1965, Annison and Armstrong 1970), and improved efficiency of metabolizable energy utilization (McCollum and Horn 1990).

Reproduction, birth, and weaning weight. Fall pregnancy rate following the winter supplement trials was 95.5% with all treatment, year, and interactions nonsignificant ($P > 0.05$; Table 5). Seemingly, loss of cow body condition score during winter grazing was not great enough to affect pregnancy rate. During more severe winter weather, loss of body condition might be greater and thereby negatively impact pregnancy rate.

In our study, there were no differences ($P > 0.05$) in calving date (avg Julian day = 89), birth weight (avg = 41.6 kg), or weaning weight (avg = 253 kg), and all treatment, year, and interaction effects were nonsignificant ($P > 0.05$). Bolze and Corah (1988) and Sanson et al. (1990) reported similar responses.

Implications

Regrowth grass hay from a subirrigated meadow hay was an effective alternative to traditional soybean meal-based protein supplements for maintaining body weight and body condition score of gestating beef cows grazing native winter range. Supplements did not affect pregnancy rate or weaning weight. If cows begin winter grazing with a body condition score > 5.5, protein supplementation may not affect economic traits such as weaning weight and pregnancy rate in years with mild winters. During harsh winters (snow and cold temperatures) or if cows begin winter in a body condition score < 5.5, the effects of protein supplementation on economic traits may be different than in mild winters.

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