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Effects of Pre- and Postpartum Nutrition on Reproduction in Spring Calving Cows and Calf Feedlot Performance

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Effects of pre- and postpartum nutrition on reproduction in spring calving cows and calf feedlot performance[1]

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ABSTRACT: Crossbred, spring-calving cows (yr 1, n = 136; yr 2, n = 113; yr 3, n = 113) were used in a 3-yr experiment to evaluate the influence of supplemental protein prepartum and grazing subirrigated meadow postpartum on pregnancy rates and calf feedlot performance. A 2 × 2 factorial arrangement of treatments was used in a switchback design. From December 1 to February 28, cows grazed dormant upland range in 8 pastures (32 ± 2 ha each). The equivalent of 0.45 kg of supplement/cow per d (42% CP) was provided to half of the cows on a pasture basis 3 d/wk. For 30 d before the beginning of breeding (May 1 to May 31), half of the cows grazed a common subirrigated meadow (58 ha), and the remainder was fed grass hay in a drylot. Cow BW and BCS were monitored throughout the year, and steer calf performance was determined until slaughter. Feeding supplement prepartum improved ($P = 0.01$ to $P < 0.001$) BCS precalving (5.1 vs. 4.7) and prebreeding (5.1 vs. 4.9) and increased ($P = 0.02$) the percentage of live calves at weaning (98.5 vs. 93.6%) but did not affect ($P = 0.46$) pregnancy rate (93 vs. 90%). Calves born to dams fed supplement prepartum had similar ($P = 0.29$) birth weight (37 vs. 36 kg) but greater ($P = 0.02$) weaning weight (218 vs. 211 kg). However, steer feedlot DMI (8.53 vs. 8.48 kg), ADG (1.6 vs. 1.6 kg), and carcass weight (369 vs. 363 kg) were not affected ($P = 0.23$ to $P = 0.89$) by prepartum supplementation. Allowing cows to graze subirrigated meadow postpartum improved ($P < 0.001$) BCS prebreeding (5.2 vs. 4.9) but did not affect ($P = 0.88$) pregnancy rate (92 vs. 91%). Allowing cows to graze subirrigated meadow increased ($P = 0.01$) calf weaning weight (218 vs. 211 kg) but not ($P = 0.62$ to $P = 0.91$) feedlot DMI (8.4 vs. 8.3 kg), ADG (1.6 vs. 1.6 kg), or carcass weight (363 vs. 362 kg) of their steer calves. Increased percentage of live calves at weaning as a result of feeding supplemental protein increased net returns at weaning and after finishing in the feedlot. Net returns were increased by allowing cows to graze subirrigated meadow postpartum regardless of whether calves were marketed at weaning or after finishing in the feedlot.

Key words: beef cattle, feedlot performance, reproduction, supplementation, system

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INTRODUCTION

Previous studies have examined the relative importance of pre- and postpartum nutrition on reproduction (Richards et al., 1986; Perry et al., 1991; Spitzer et al., 1995). However, previous research has been somewhat segmented and the interactions between pre- and postpartum nutrition and their economic ramifications within the context of beef production systems in an applied production setting are not well established. In addition to influencing cow reproductive performance, nutritional plane both pre- and postpartum has been shown to affect calf growth to the point of weaning (Perry et al., 1991; Beaty et al., 1994; Spitzer et al., 1995). But the persistency of differences in growth rate of calves as a consequence of pre- and postpartum nutrition of the dam beyond weaning is not known.

Extending the grazing season through the winter reduces costs compared with feeding hay (Adams et al., 1994) but dormant forage may not meet cow nutrient requirements; thus, supplementation is commonly recommended to ensure acceptable pregnancy rates (DelCurto et al., 2000). However, feeding supplement can be expensive. In the Nebraska Sandhills, subirrigated meadows are a common resource and are dominated

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Table 1. Causes for cows being removed from the study

Treatment[1]	n	Injured/died during Prepartum Cow	Prepartum Calf	Parturition Cow	Parturition Calf	Lactation Cow	Lactation Calf	Late[2]	Total (all causes)
Supplement + meadow	90	0	0	0	0	1[3]	2[3,4]	1	4
Supplement + hay	91	0	0	0	0	0	0	1	1
No supplement + meadow	90	2[3,5]	2[6]	0	2[7]	1[8]	2[3]	1	10
No supplement + hay	91	0	1[6]	0	2[7]	0	2[3,8]	4	9

[1]Supplement = Cows fed the equivalent of 0.45kg of supplement (42% CP)/d prepartum; No Supplement = Cows not fed supplement prepartum; Meadow = Cows grazed meadow for 30 d postpartum; Hay = Cows fed grass hay for 30 d postpartum.
[2]Cows were removed from the study if calving did not occur by April 20.
[3]Cause of death unknown.
[4]Calf drowned in stock tank.
[5]Cow died of hardware disease.
[6]Positive confirmation of aborted fetus.
[7]Calves dead at birth, no dystocia observed.
[8]Crippling injury.

by cool-season grass species that provide high-quality forage, which is available postpartum in spring-calving operations. We hypothesized that production costs could be reduced without decreasing pregnancy rates by not feeding supplement and allowing loss of BCS while cows grazed dormant forage prepartum and then regain BCS prebreeding by beginning the grazing season earlier to incorporate high quality forage from subirrigated meadows into the production system. Objectives of this study were to determine the effects of pre- and postpartum nutrition and their interaction in an applied production setting on productivity of the entire system, cow reproductive performance, and calf growth through the feedlot and carcass characteristics.

MATERIALS AND METHODS

Animals, Treatments, and General Procedures

Animal use and management were in accordance with University of Nebraska Institutional Animal Care and Use Committee guidelines. In yr 1, 136 pregnant, MARC II (4-breed composite: ¼ Angus, ¼ Gelbvieh, ¼ Hereford, and ¼ Simmental), spring-calving cows, 3 to 5 yr of age were stratified by age and then weaning weight of their previous calf and assigned randomly to 1) supplement or no supplement prepartum, and 2) subirrigated meadow or grass hay postpartum in a 2 × 2 factorial arrangement. In yr 2, cows were switched to the opposite treatment, and in yr 3 were switched back to their original treatment. Cows remained in the experiment unless removed because of injury, reproductive failure, or if calving did not occur by April 20 (Table 1). In yr 2 and 3 only, 113 cows were used because of reduced forage availability caused by drought. Replacement cows added in yr 2 and 3 were selected randomly from available 3-yr-old cows and assigned to treatment as described for yr 1.

On December 1, cows were divided into 8 pastures (32 ± 2 ha) and grazed native upland range at the University of Nebraska, Gudmundsen Sandhills Laboratory (near Whitman, NE). A detailed description of the study site is available (Adams et al., 1998). Either 0 or the equivalent of 0.45 kg of supplement/cow per d was provided to cows on a pasture basis, 3 d/wk, from December 1 to February 28. On a DM basis, supplement ingredients were: 50.0% sunflower meal, 47.9% cottonseed meal, and 2.1% urea, and contained 66,139 IU of vitamin A/kg. Nutrient composition was: 42.0% CP and 73.3% TDN. Supplement CP content was determined using a Leco N analyzer (Leco Corp., Henderson, NV), and TDN was calculated from tabular values (NRC, 1996). Feeding the equivalent of 0.45 kg of 42% CP supplement was sufficient to maintain BCS of spring-calving cows grazing dormant upland range in previous research conducted at this site (Ciminski, 2002). All cows had access to salt.

At the beginning of the calving season (March 1 to April 20), cows were vaccinated against *Clostridium perfringens C*/*Escherichia coli*/Rotavirus/Coronavirus [Scour Bos 9, Novartis Animal Health, Bucyrus, KS, and Scour Guard 3 (K)/C, Pfizer Animal Health, Exton, PA]. Cows were managed in a common group during the calving season and fed grass hay in a drylot. The amount of hay fed was adjusted daily in an effort to satisfy appetite but minimize waste and averaged 14 kg/cow per d (DM basis). Hay quality was determined at a commercial laboratory (Ward Labs, Kearney, NE; Table 2) by near infrared reflectance spectroscopy using a NIRSystems 5000 scanning monochromator (NIRSystems, Silver Spring, MD) with software developed by Infrasoft International (Port Matilda, PA) and near infrared light from 1,100 to 2,498 nm. Average calving date was March 27. During the period between calving and the beginning of breeding (May 1 to 31), half of the cows were fed grass hay in a drylot and half were grazed on a common 58-ha subirrigated meadow.

At the beginning of breeding season (June 1) cows were given an infectious bovine rhinotracheitis/parainfluenza-3 virus/bovine respiratory syncytial virus/bo-

Table 2. Upland range diet and hay quality (mean ± SD)[1]

Item	Yr 1	Yr 2	Yr 3
Upland range diet			
CP, % of DM	6.4 ± 0.6	4.7 ± 1.4	5.1 ± 0.1
TDN, % of DM	50.8 ± 5.4	49.0 ± 0.8	50.6 ± 0.8
Hay			
CP, % of DM	8.6 ± 1.2	8.7 ± 0.7	6.3 ± 0.6
TDN, % of DM	56.0 ± 1.8	54.2 ± 2.1	57.9 ± 1.3

[1]SD are for the mean nutrient content of samples obtained from multiple esophageally fistulated cows or bale samples.

Table 3. Model inputs (NRC, 1996) and average nutrient balances of cows fed 0 (No Supp) or 0.45 kg (Supp) of supplement prepartum and allowed to graze subirrigated meadow or fed grass hay postpartum

Item	Supp	No Supp	Meadow	Hay
Animal inputs[1]				
Age, mo	60	60	60	60
BW, kg	476	476	476	476
BCS	5	5	5	5
Mature BW, kg	476	476	476	476
Days pregnant	214	214	—	—
Days in milk	—	—	53	53
Peak milk yield, kg/d	—	—	9.0	9.0
Calf birth weight, kg	36	36	36	36
Environmental inputs[1]				
Temperature, °C	4.4	4.4	20	20
Diet inputs				
Grazed forage CP, %	5.4	5.4	15.7	—
Grazed forage DIP,[2] % CP	88.0	88.0	82.0	—
Grazed forage TDN, %	50.1	50.1	66.0	—
Hay CP, %	—	—	—	7.9
Hay DIP,[2] % CP	—	—	—	85.0
Hay TDN, %	—	—	—	56.0
Microbial efficiency, % TDN	9.4	9.0	13	11.4
Output				
Forage DMI,[3] kg/d	9.9	10.5	12.1	11.1
Supplement DMI, kg/d	0.43	0.0	—	—
NE_m balance, Mcal/d	−0.34	−0.45	2.35	−2.76
MP balance, g/d	−30	−102	81	−295
DIP balance,[2] g/d	78	26	518	37
Days to lose (gain) 1 BCS	462	350	(98)	57

[1]Default values were used unless otherwise specified.
[2]Degradable intake protein.
[3]Intake estimated by the NRC (1996) model.

vine virus diarrhea (killed) Leptospirosis/Vibriosis vaccine (Vira Shield 5+VL5, Novartis Animal Health). Treatment groups were combined at the beginning of the breeding season, and cows grazed upland range in a common pasture for the remainder of the production year. The breeding season lasted 60 d, and a sufficient number of bulls was used to achieve at least a 1:20 bull:cow ratio.

Weight and BCS (Wagner et al., 1988) of all cows were recorded at the beginning (December 1) and end (February 28) of the prepartum supplementation period, at the beginning (May 1) and end (May 30) of the postpartum meadow-grazing period, and at weaning (first week of October). A veterinarian examined cows for pregnancy via rectal palpation in October.

Calves were weighed at birth and at weaning. In yr 2 and 3, a blood sample was collected from each calf via coccygeal venipuncture between 24 and 48 h after birth in serum separator tubes (Corvac, Sherwood Medical Co., St. Louis, MO). Serum was harvested by centrifugation at 1,500 × *g* for 15 min, and stored at −20°C until analyzed for immunoglobulin G (**IgG**) concentration by single radial immunodiffusion (Bovine IgG SRID kit; VMRD Inc., Pullman, WA). At branding (May), bull calves were castrated, and all calves were given a *Mannheimia* (*Pasteurella*) *haemolytica* type A1 vaccination (One Shot, Pfizer Animal Health) and a 7-way Clostridial vaccination (Vision 7, Intervet, Millsboro, DE). The percentage of live calves in each treatment was calculated at weaning. When the cause of death or injury of the calf could be definitively determined and was unrelated to treatment (e.g., the dam died of hardware disease, the calf drowned in stock tank, or a crippling accidental injury), the calves were excluded from the weaning rate calculation.

Diet Quality

Diet quality (Table 2) of winter range was estimated from masticate samples obtained from esophageally fistulated cows that were not part of the experiment. Surgeries had been performed on all cows at least 2 yr before the beginning of the experiment, and 3 animals were used for each diet collection. Feed was withheld from the cows for 12 h, and they were then fitted with screen-bottom bags after removal of the esophageal plug. The cows were allowed to graze for 30 min in a previously ungrazed, upland pasture immediately adjacent to those used in the experiment. Masticate samples were stored frozen at −20°C, freeze dried, and analyzed for N using a Leco FP 2000 N analyzer (Leco Corp.); TDN was calculated using a summative equation after wet chemistry analysis of components according to AOAC (1996) methods in a commercial laboratory (Ward Labs). Masticate samples were obtained from upland range at the beginning of the prepartum treatment period. Nutrient content of feedstuffs was entered into the NRC (1996) model to calculate cow nutrient balances during the pre- and postpartum treatment periods (Table 3). In this experiment, the quality of the subirrigated meadow diet was not measured during the month of May. Data reported in Table 3 are the average of values reported by Lardy et al. (2004) and Haugen et al. (2006), who quantified nutrient content of forage from the same meadow used in this experiment over multiple years.

Postweaning Management

At weaning, steers (yr 1, n = 61; yr 2, n = 65; yr 3, n = 45) received 2 doses of infectious bovine rhinotracheitis/parainfluenza-3 virus/bovine respiratory syncytial virus/bovine viral diarrhea vaccine (PRISM 4, Ft. Dodge

Animal Health, Overland Park, KS) 14 d apart and revaccinated with the same vaccines at branding. Steers were offered grass hay ad libitum in a drylot during a 2-wk preconditioning period before being shipped 167 km to a feedlot at the West Central Research and Extension Center in North Platte, NE.

Upon arrival at the feedlot, steers were fed grass hay at 2.5% of BW for 7 d. After the 7-d limit-feeding period, steers were weighed on 2 consecutive days and implanted with 20 mg of estradiol benzoate and 200 mg of progesterone (Synovex S, Ft. Dodge Animal Health) and administered moxidectin (Cydectin, Ft. Dodge Animal Health) on the second day. Steers were reimplanted with 24 mg of estradiol and 120 mg of trenbolone acetate (Revelor S, Intervet) approximately 100 d before slaughter. The beginning diet contained 35% alfalfa, and steers were adapted over 14 d to a finishing diet that contained 48% dry rolled corn, 40% wet corn gluten feed, 7% alfalfa, and 5% supplement (DM basis) by replacing alfalfa with corn. Steers were fed in 8 pens corresponding to the prepartum pasture of their dam until the average 12th rib backfat of all steers was visually estimated to be 1.3 cm.

Carcass data were obtained via the Cattlemen's Carcass Data Service, West Texas A&M University (Canyon, TX). Hot carcass weight was obtained at slaughter. Dressing percent was calculated using the unshrunk weight obtained at the feedlot before shipment to the abattoir. After a 24-h chill, marbling score, fat thickness at the 12th rib, percentage of KPH, LM area, yield grade, and quality grade were determined.

Economic Analysis

Partial budgets were employed to determine the economic ramifications of treatments. Actual purchase price, including delivery to the ranch, was used to assign a value to the supplement. Meadow forage was valued using the high figure ($31.65/animal unit month) reported by Johnson et al. (2005) for the agricultural statistics district in which the study was conducted. The high figure was used because of the superior quality of meadow forage in May. Hay was valued using the 10-yr average price ($0.068/kg, as fed) reported by Mark et al. (2005), and costs associated with feeding were included at $0.013/kg. Sale value of steers at weaning ($97.55/45 kg of BW) and slaughter ($109.54/45 kg of carcass) was the 10-yr average price during the month when weaning and slaughter occurred (Mark et al., 2005). Budgets evaluated difference in net returns from birth to weaning (cow-calf phase), from weaning to slaughter (feedlot phase), and from birth to slaughter (retain ownership).

Statistical Analysis

Data were analyzed using the MIXED procedure of SAS (SAS Inst., Inc., Cary, NC). The statistical model was appropriate for a 2 × 2 factorial arrangement of treatments in a switchback design and included prepartum treatment (supplement vs. no supplement), postpartum treatment (meadow vs. hay), and their interaction as fixed effects. Year was included in the model as a random variable, using the random statement. Prepartum by postpartum treatment interaction (P = 0.17 to P = 0.9) did not occur for any variable except steer calf weight upon entry into the feedlot. Because cows were fed supplement on a pasture basis, all dependent variables were analyzed using pasture or feedlot pen as the experimental unit. Initial analysis explored the utility of including initial cow BW and BCS as covariates, but neither influenced any dependent variable, and BW and BCS were therefore not used in the final analysis

RESULTS AND DISCUSSION

Cow Variables

Cows fed supplemental protein maintained BW during the prepartum treatment period (December 1 to February 28) but cows not fed supplement lost 29 kg (Table 4). Cows fed protein supplement prepartum had greater BCS at the end of the supplementation period (P < 0.001) than cows not fed supplement. Improved BCS as a result of prepartum supplementation still existed at the beginning of postpartum treatment period (May 1; P < 0.001) and at the beginning of the breeding season (June 1; P = 0.01). But increased BCS did not result in increased pregnancy rates in supplement-fed cows (P = 0.46). Even though cows fed supplement lost less BCS during the prepartum treatment period (P < 0.001), nonsupplemented cows gained more BCS during the postpartum treatment period (May 1 to 30; P = 0.05). This increased rate of BCS gain postpartum may have influenced pregnancy rates in nonsupplemented cows. Whereas the magnitude of difference in BCS between supplemented and nonsupplemented cows was not so great that similar pregnancy rates would be unexpected, the fact that nonsupplemented cows grazing dormant upland range could maintain BCS to the degree observed in this study was interesting.

Cows that grazed subirrigated meadow gained more weight (P < 0.001) and BCS (P < 0.001) during the postpartum treatment period (May 1 to 30) than did cows fed hay. Even though BCS at the beginning of breeding was greater (P < 0.001) in cows that grazed meadow, pregnancy rates were not affected (P = 0.88).

Body condition score at calving has been shown to influence pregnancy rates and interval from calving to pregnancy (DeRouen et al., 1994). Mature cows calving with BCS 5 or greater become pregnant in fewer days than do cows calving with BCS 4 or less; however, increased BCS above 5 at calving does not improve reproduction (Richards et al., 1986). In our study, nonsupplemented cows had a BCS of 4.7 at calving, which may be near the threshold at which increasing BCS no longer

Table 4. Body weight, BCS, and reproductive performance of cows fed 0 (No Supp) or 0.45 kg (Supp) supplement prepartum and allowed to graze subirrigated meadow or fed grass hay postpartum

	Supp		No Supp			*P*-value[2]		
Item	Meadow	Hay	Meadow	Hay	SEM[1]	Pre	Post	Pre × Post
Cow BW, kg								
December 1	490	487	493	496	4	0.16	0.95	0.52
February 28	489	491	457	475	6	0.001	0.13	0.20
May 1	447	449	433	447	5	0.14	0.13	0.22
May 30	466	453	457	451	5	0.24	0.06	0.52
October 8	486	476	478	481	5	0.81	0.55	0.23
BW change, kg								
Prepartum	–1	3	–37	–21	5	<0.001	0.06	0.25
Postpartum	19	4	24	3	3	0.52	<0.001	0.32
Cow BCS								
December 1	5.2	5.2	5.3	5.3	0.05	0.11	0.67	0.91
February 28	5.1	5.2	4.5	4.8	0.10	<0.001	0.16	0.35
May 1	4.8	4.9	4.5	4.7	0.05	<0.001	0.08	0.60
May 30	5.2	4.9	5.1	4.8	0.06	0.01	<0.001	0.97
October 8	5.2	5.1	5.1	5.1	0.05	0.21	0.39	0.96
BCS change								
Prepartum	–0.1	–0.1	–0.8	–0.5	0.1	<0.001	0.22	0.29
Postpartum	0.4	0.1	0.5	0.1	0.1	0.05	<0.001	0.62
Pregnancy rate, %	94.8	91.5	89.2	91.3	3.9	0.46	0.88	0.49
Calving d of yr	87	88	84	85	1	0.01	0.16	0.80
Calving to conception,[3] d	82	79	84	82	2	0.26	0.12	0.91
Conception first 21 d,[3] %	68.7	71.3	76.2	66.3	5.4	0.97	0.36	0.17

[1]Pooled standard error of treatment means, n = 12 pastures per treatment.

[2]Pre = prepartum treatment main effect; Post = postpartum treatment main effect; Pre × Post = prepartum × postpartum treatment interaction.

[3]Determined from subsequent calving date minus 285 d.

improves reproduction. Postpartum nutritional plane influences reproduction (Randel, 1990) but is most pronounced in cows calving in thin to moderate BCS (Wettemann et al., 2003). Increased postpartum nutritional plane improved reproductive performance of cows whose BCS at calving was 4 or less but did not improve reproduction if cows calved in BCS of 5 or greater (Richards et al., 1986). Even though cows fed hay in the current study gained less BCS postpartum, BCS at calving may have been sufficient to prevent improved reproduction in response to postpartum nutritional plane in cows that grazed meadow. We hypothesized it would be important for nonsupplemented cows to graze meadow postpartum to regain lost BCS and achieve acceptable pregnancy rates. A lack of interaction between pre- and postpartum treatments for pregnancy rates would indicate this was not the case. Whereas the practice of managing cows to calve at a BCS of 5 is commonly recommended (Richards et al., 1986; Morrison et al., 1999), results of this study suggest that allowing cows to calve with BCS slightly less than 5 could result in acceptable reproductive performance even under conditions encountered in applied production settings.

Date of conception was determined by subtracting 285 d from the subsequent calving date (DeRouen et al., 1994). On average, conception occurred on d 16 of the 60-d breeding season, resulting in an 82-d mean interval from calving to conception. Interval from calving to conception and percentage of cows conceiving within the first 21 d of the breeding season were not affected ($P = 0.12$ to $P = 0.97$) by either pre- or postpartum treatment (Table 4).

Calf Variables

Calves born to cows fed supplement were born 3 d later in the calving season ($P = 0.01$; Table 4) than calves born to cows not fed supplement but birth weight was not affected by treatment ($P = 0.29$; Table 5). Weaning weight ($P = 0.02$) and ADG from birth to weaning ($P = 0.002$) were greater for calves born to cows fed supplement. Likewise, weaning weight was greater ($P = 0.01$) for calves born to cows that grazed subirrigated meadow compared with cows fed hay postpartum. Other studies report increased weight of calves born to cows with greater nutrient plane pre- and postpartum. Beaty et al. (1994) demonstrated increased calf weaning weight as the amount of CP fed during gestation increased. Increased weaning weight of calves nursing heifers fed to gain 0.90 kg/d postpartum compared with calves nursing heifers fed to gain 0.45 kg/d was observed by Spitzer et al. (1995). Houghton et al. (1990) documented greater weight at 105 d postpartum in calves born to cows fed to maintain weight prepartum and of calves born to cows fed to gain weight postpartum compared with calves born to cows fed to lose weight

Table 5. Preweaning growth performance and serum immunoglobulin G concentration of calves born to cows fed 0 or 0.45 kg supplement prepartum and allowed to graze subirrigated meadow or fed grass hay postpartum

	Supp		No Supp			P-value[2]		
Item	Meadow	Hay	Meadow	Hay	SEM[1]	Pre	Post	Pre × Post
Birth BW, kg	36.3	36.9	35.7	36.4	0.5	0.29	0.20	0.95
Wean BW, kg	222	213	213	209	2	0.02	0.01	0.27
ADG to wean,[3] kg/d	0.97	0.93	0.92	0.90	0.01	0.002	0.04	0.32
Calves weaned,[4] %	97.2	100.0	92.1	95.0	1.9	0.02	0.15	0.97
IgG,[5] mg/100 mL	3,262	3,068	3,224	3,115	203	0.98	0.47	0.84

[1]Pooled standard error of treatment means, n = 12 pastures per treatment.
[2]Pre = prepartum treatment main effect; Post = postpartum treatment main effect; Pre × Post = prepartum × postpartum treatment interaction.
[3]Average daily gain from birth to weaning.
[4]Excludes death or debilitating injury of calf or dam unrelated to treatment.
[5]Immunoglobulin G concentration in calves between 24 to 48 h after birth measured by radial immunodiffusion.

during the same periods. Differences in calf weight still existed at weaning (205 d). Feeding energy-deficient diets, beginning at 100 d prepartum to heifers and 2-yr-old cows resulted in lighter weight at weaning (Corah et al., 1975). Similarly, Perry et al. (1991) reported decreased weight at 70 d of age for calves born to cows fed low levels of energy either pre- or postpartum.

The percentage of live calves at weaning was greater ($P = 0.03$; Table 5) for cows fed supplement prepartum but was not different ($P = 0.56$) between cows that grazed meadow or were fed hay. From the beginning of the experiment (December 1) through calving, 7 calves died when cows were not fed supplement prepartum but no calves were lost during the same period when cows were fed supplement. Differences in diet quality during gestation is a possible explanation for decreased percentage of calves weaned in nonsupplemented cows. This conclusion is supported by the results of Corah et al. (1975) who fed energy-deficient diets prepartum to heifers and 2-yr-old cows and observed decreased percentage of live calves at weaning. Because only pregnant cows were used in the current study, differences in percentage of live calves at weaning cannot be attributed to failure to conceive. Potentially, failure of passive transfer of immunity could explain differences in weaning rate and weaning weight (Wittum and Perino, 1995). In yr 2 and 3, IgG titers of calves between 24 and 48 h after birth were similar ($P = 0.98$; Table 5)

Table 6. Finishing performance and carcass characteristics of steer calves born to cows fed 0 or 0.45 kg of supplement prepartum and allowed to graze subirrigated meadow or fed grass hay postpartum

	Supp		No Supp			P-value[2]		
Item	Meadow	Hay	Meadow	Hay	SEM[1]	Pre	Post	Pre × Post
Finishing period (222 d)								
Beginning BW, kg	222[a]	209[b]	210[b]	209[b]	2	0.01	0.01	0.01
ADG, kg/d	1.56	1.56	1.55	1.58	0.02	0.89	0.45	0.45
DMI, kg/d	8.56	8.50	8.38	8.58	0.17	0.78	0.71	0.44
Gain:feed, kg:kg	0.182	0.184	0.185	0.185	0.002	0.39	0.71	0.73
Life ADG,[3] kg/d	1.23	1.21	1.19	1.21	0.02	0.32	0.94	0.23
Carcass data								
HCW, kg	373	365	361	365	4	0.23	0.67	0.23
Dressing, %	64.8	65.0	64.6	64.5	2	0.13	0.96	0.49
Marbling[4]	482	476	467	467	9	0.23	0.76	0.74
Fat,[5] cm	1.31	1.38	1.27	1.35	0.06	0.32	0.23	0.92
LM area,[2] cm	88.6	87.6	86.7	87.1	1.0	0.27	0.76	0.48
Choice, %	94.2	98.5	87.7	83.0	4.2	0.16	0.29	0.99
Yield grade	2.95	3.03	2.91	3.02	0.11	0.81	0.44	0.91

[a,b]Within a row, means lacking a common superscript letter differ, $P < 0.05$.
[1]Pooled standard error of treatment means, n = 12 pens per treatment.
[2]Pre = prepartum treatment main effect; Post = postpartum treatment main effect; Pre × Post = prepartum × postpartum treatment interaction.
[3]ADG from birth to shrunk live weight at slaughter.
[4]Marbling score: 400 = Small^{00}, 500 = Modest^{00}.
[5]Backfat thickness measured at the 12th rib.

Table 7. Costs and returns ($/animal) from birth to weaning (cow-calf phase), from weaning to slaughter (feedlot phase), and from birth to slaughter (retain ownership) associated with feeding supplement prepartum and allowing cows to graze subirrigated meadow postpartum

Item	Supp	No Supp	Meadow	Hay
Cow-calf phase				
Returns				
More calves weaned[1]	23.50	0.00	—	—
Weaned calf value	467.26	454.58	467.26	454.58
Costs				
Supplement	10.80	0.00	—	—
Hay	—	—	0.00	34.02
Meadow	—	—	31.65	0.00
Net returns	479.96	454.58	435.61	420.56
Difference	25.38		15.05	
Feedlot phase				
Returns				
Carcass value	890.56	877.19	886.29	881.58
Costs				
Purchase cost	467.26	454.58	467.26	454.58
Feedlot feed costs	250.42	249.08	248.82	250.68
Net returns	172.88	173.53	170.21	176.32
Difference		0.65		6.11
Retain ownership				
Returns				
More carcasses[1]	44.53	0.00	—	—
Carcass value	890.56	877.19	886.29	881.58
Costs				
Supplement	10.80	0.00	—	—
Hay	—	—	0.00	34.02
Meadow	—	—	31.65	0.00
Feedlot feed costs	250.42	249.08	248.82	250.68
Net returns	673.87	628.11	605.82	596.88
Difference	45.76		8.94	

[1]Increased returns resulting from increased percentage of live calves at weaning.

indicating passive transfer of immunity was not different between treatments. These results agree with the findings of Perino et al. (1995) who showed that BCS at calving, ranging from 4 to 7, does not influence IgG titers of calves.

Feedlot Performance

A prepartum by postpartum treatment interaction occurred for BW of steer calves upon entry into the feedlot (Table 6). Steers born to cows fed supplement prepartum that grazed subirrigated meadow were heavier ($P < 0.05$) than steers born to cows in the other treatment combinations. The observation of prepartum and postpartum treatment interaction for BW upon entry into the feedlot but not for weaning weight is likely due to the conditions under which calves were weighed. Weight at weaning was a single measurement without shrink whereas weight upon entry into the feedlot was a 2-d average BW after a limit-feeding period.

Feedlot ADG (P = 0.89), DMI (P = 0.78), and feed efficiency (P = 0.39) were similar for steers born to supplemented and nonsupplemented cows. Likewise, feedlot ADG (P = 0.45), DMI (P = 0.71) and feed efficiency (P = 0.71) were similar for steers born to cows that grazed meadow and cows that were fed hay. Carcass characteristics were not influenced by either prepartum or postpartum treatment (Table 6).

Studies examining the effects of supplement fed to the cow on calf feedlot performance are rare in the literature. Ciminski (2002) showed improved growth from birth to slaughter in steers born to cows fed supplemental protein during the last trimester of gestation while grazing dormant upland range in the Nebraska Sandhills. One major difference between the study by Ciminski (2002) and the current study is weaning date. In the Ciminski (2002) study, increased steer carcass weight was observed when cows weaned in November were fed supplemental protein during the last trimester, but increased carcass weight in response to supplemental protein was not observed when weaning occurred in August. The fetus can be buffered from deleterious effects of gestational undernutrition by mobilization of maternal nutrient reserves (Martin et al., 1997). In the current study, weaning in early October may have allowed the cow to accumulate sufficient body reserves that could be mobilized during late gestation to compensate for dietary deficiency. Delaying weaning until November in the Ciminski (2002) study may have depleted maternal nutrient reserves, thus eliminating them as a resource to support fetal growth. Body condition score in nonsupplemented cows at the beginning of the calving season was 4.4 in the Ciminski (2002) study and 4.7 in the current study.

Economic Analysis

If calves were sold at weaning, feeding supplemental protein prepartum increased net returns by $25.38/calf because of increased calf weaning weight and percentage of live calves weaned (Table 7). Similarly, net returns at weaning were increased by $15.05/calf when cows were allowed to graze subirrigated meadow because of increased weaning weight and because grazing subirrigated meadow is less expensive than feeding hay. Net return differences through the feedlot phase were negligible ($0.65/steer) between steers born to supplemented and nonsupplemented cows. Feedlot net returns were $6.11/steer greater for steers whose dams were fed hay during the postpartum treatment period compared with those whose dams grazed meadow. This switch in postpartum treatment with greater net returns for the weaned calf phase vs. the feedlot phase is a consequence of weaning a greater number of heavier, greater-value calves from the meadow treatment, but those greater-value calves finish with an equivalent carcass value to the lighter, lower-value calves from the hay-fed treatment. If the cow-calf operator retained ownership of the steer from birth to weaning, net returns were $45.76/steer greater if supplement was fed to the dam. This increase is almost entirely accounted for by a greater percentage of live calves at weaning and therefore greater percentage of finished steers. Retaining ownership of a steer born to a dam that grazed meadow increased net returns by $8.95.

IMPLICATIONS

Results of this study justify the common practice of feeding supplement to spring-calving cows grazing dormant forage even though the benefits may not include improved reproduction. Although feeding supplement may not improve pregnancy rates, an increase in percentage of live calves at weaning and weaning weight would improve net returns through the cow-calf phase. Feeding supplement to the dam has no benefit through the feedlot phase for steer calves; heavier calves from the meadow treatment are less profitable through the feedlot phase than are lighter calves from the hay-fed treatment. Allowing cows to graze high-quality forage in the early spring costs less than feeding hay and improves calf growth preweaning.

LITERATURE CITED

AOAC. 1996. Official Methods of Analysis. 16th ed. Association of Official Analytical Chemists, Arlington, VA.

Adams, D. C., R. T. Clark, S. A. Coady, J. B. Lamb, and M. K. Nielsen. 1994. Extended grazing systems for improving economic returns from Nebraska Sandhills cow/calf operations. J. Range Manage. 47:258–263.

Adams, D. C., R. T. Clark, P. E. Reece, and J. D. Volesky. 1998. Research and education for managing resources within the Nebraska Sandhills: The Gudmundsen Sandhills Laboratory. Rangelands 20:4–8.

Beaty, J. L., R. C. Cochran, B. A. Lintzenich, E. S. Vanzant, J. L. Morrill, R. T. Brandt, Jr., and D. E. Johnson. 1994. Effect of frequency of supplementation and protein concentration in supplements on performance and digestion characteristics of beef cattle consuming low-quality forages. J. Anim. Sci. 72:2475–2486.

Ciminski, L. A. 2002. Weaning date and protein supplementation effects on cow/calf productivity. MS Thesis, Univ. Nebraska, Lincoln.

Corah, L. R., T. G. Dunn, and C. C. Kaltenbach. 1975. Influence of prepartum nutrition on the reproductive performance of beef females and the performance of their progeny. J. Anim. Sci. 41:819–824.

DelCurto, T., B. W. Hess, J. E. Huston, and K. C. Olson. 2000. Optimum supplementation strategies for beef cattle consuming low-quality roughages in the western United States. Proc. Am. Soc. Anim. Sci Annu. Mtg 1999. Available: http:/www. asas.org/JAS/symposia/proceedings/0922.pdf. Accessed Apr. 20, 2005.

DeRouen, S. M., D. E. Franke, D. G. Morrison, W. E. Wyatt, D. F. Coombs, T. W. White, P. E. Humes, and B. B. Greene. 1994. Prepartum body condition and weight influences on reproductive performance of first-calf beef cows. J. Anim. Sci. 72:1119–1125.

Haugen, H. L., M. J. Lamothe, T. J. Klopfenstein, D. C. Adams, and M. D. Ullerich. 2006. Estimation of undegradable intake protein in forages using neutral detergent insoluble nitrogen at a single in situ incubation time point. J. Anim. Sci. 84:651–659.

Houghton, P. L., R. P. Lemanager, L. A. Horstman, K. S. Hendrix, and G. E. Moss. 1990. Effects of body composition, pre- and postpartum energy level and early weaning on reproductive performance of beef cows and preweaning calf gain. J. Anim. Sci. 68:1438–1446.

Johnson, B. B., R. J. Supalla, and A. Raymond. 2005. Nebraska Farm Real Estate Market Developments 2003-2004. Available: http://agecon.unl.edu/realestate/re2004.pdf Accessed May 20, 2005.

Lardy, G. P., D. C. Adams, T. J. Klopfenstein, and H. H. Patterson. 2004. Building beef cow nutritional programs with the 1996 NRC beef cattle requirements model. J. Anim. Sci. 82(E Suppl.):E83–E92.

Mark, D., D. Feuz, R. Selly, and T. Barrett. 2005. Crop and Livestock Prices for Nebraska Producers. Available: http://agecon.unl.edu/mark/Agprices/ Accessed May 20, 2005.

Martin, G. S., G. E. Carstens, T. L. Taylor, C. R. Sweatt, A. G. Eli, D. K. Lunt, and S. B. Smith. 1997. Prepartum protein restriction does not alter norepinephrine-induced thermogenesis or brown adipose tissue function in newborn calves. J. Nutr. 127:1929–1937.

Morrison, D. G., J. C. Spitzer, and J. L. Perkins. 1999. Influence of prepartum body condition score change on reproduction in multiparous beef cows calving in moderate body condition. J. Anim. Sci. 77:1048–1054.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th ed. National Academy Press, Washington, DC.

Perino, L. J., T. E. Wittum, and G. S. Ross. 1995. Effects of various risk factors on plasma protein and serum immunoglobulin concentrations of calves at postpartum hours 10 and 24. Am. J. Vet. Res. 56:1144–1148.

Perry, R. C., L. R. Corah, R. C. Cochran, W. E. Beal, J. S. Stevenson, J. E. Minton, D. D. Simms, and J. R. Brethour. 1991. Influence of dietary energy on follicular development, serum gonadotropins, and first postpartum ovulation in suckled beef cows. J. Anim. Sci. 69:3762–3773.

Randel, R. D. 1990. Nutrition and postpartum rebreeding in cattle. J. Anim. Sci. 68:853–862.

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.

Spitzer, J. C., D. G. Morrison, R. P. Wettemann, and L. C. Faulkner. 1995. Reproductive responses and calf birth and weaning weights as affected by body condition at parturition and postpartum weight gain in primiparous beef cows. J. Anim. Sci. 73:1251–1257.

Wagner, J. J., K. S. Lusby, J. W. Oltjen, J. Rakestraw, R. P. Wettemann, and L. E. Walters. 1988. Carcass composition in mature Hereford cows: Estimation and effect on daily metabolizable energy requirement during winter. J. Anim. Sci. 66:603–612.

Wettemann, R. P., C. A. Lents, N. H. Ciccioli, F. J. White, and I. Rubio. 2003. Nutritional- and suckling-mediated anovulation in beef cows. J. Anim. Sci. 81(E Suppl.):E48–E59.

Wittum, T. E., and L. J. Perino. 1995. Passive immune status at postpartum hour 24 and long-term heath and performance of calves. Am. J. Vet. Res. 56:1149–1154.