Influencing Steer Performance Through Maternal Nutrition

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Summary

*Cows were fed a 28% CP cube at one of two supplement levels, high (**HN**) or low (**LN**), while grazing dormant winter range during late gestation to determine the effects of maternal supplementation level on male progeny performance and carcass characteristics. Steer initial BW did not differ between treatments; however, year 1 steers from cows fed higher supplement levels had greater final BW, HCW, marbling scores, and carcass value compared with steers from cows receiving lower supplement levels. Year 2 HN steers had greater proportions grading USDA quality grade modest or greater when compared to steers from both treatments in year 1, but only differed numerically from LN steers from year 2. Steer performance and carcass characteristics were improved in year 1 when dam protein supplementation levels were increased.*

Introduction

Providing protein supplementation through winter grazing has been a common practice in the Nebraska Sandhills (2006 *Nebraska Beef Cattle Report*, pp. 7-9; 2009 *Nebraska Beef Cattle Report,* pp. 5-8). Late gestation protein supplementation has increased progeny weaning BW (2006 *Nebraska Beef Cattle Report,* pp. 7-9; 2009 *Nebraska Beef Cattle Report,* pp. 5-8), improved post-weaning calf health, increased HCW, and increased the proportion of calves grading USDA Choice or greater (2009 *Nebraska Beef Report*, pp. 5-8). These results indicate maternal nutrition during gestation can influence postnatal growth and health, which is hypothesized as fetal programming. The objective of the current study was to evaluate the effects of two dam protein supplementation levels while grazing dormant Sandhills forage on subsequent steer progeny growth, feed efficiency, and carcass quality.

Procedure

Cow and Calf Management

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

A two-year study was conducted at two units of the Rex Ranch, Ashby, Neb. Spring calving multiparous composite beef cows comprised of 50% Red Angus, 25% Simmental, and 25% South Devon or other breeds were managed in a year-round grazing system. Cows were pasture exposed to bulls of similar breeding at each location for 70 days beginning mid-June through August. Forty-five days following the breeding season, pregnancy rates were determined via rectal palpation.

Cows grazed dormant forage pastures from November to late February with a protein supplement (28% CP cubes) delivered three times weekly. The supplement offered was 62.0% dried distillers grains plus solubles, 11.0% wheat middlings, 9.0% cottonseed meal, 5.0% dried corn gluten feed, 5.0% molasses, 2.0% urea, and 6.0% vitamin and trace mineral premix. The supplement was formulated to meet the vitamin and trace mineral requirements of the cows.

Cows were offered supplement and meadow hay at both locations at the discretion of the manager with cows at one location (year 1 = 754; year 2 = 700) receiving higher levels of supplement (**HN**; 2.62 lb/day year 1; 2.05 lb/day year 2) and cows at the second location (year 1 = 673; year 2 = 766) being fed lower levels of supplement (**LN**; 0.85 lb/day year 1; 0.94 lb/day year 2). During calving (March and April) cows received meadow hay in the form of large round bales with HN cows receiving 13.9 lb/day in year 1 and 12.0 lb/day in year 2, and LN cows receiving 10.2 and 14.4 lb/day in year 1 and year 2, respectively. After weaning (early to mid-September), calves grazed meadow pasture while receiving 3 lb/day of the CP supplement until shipping (year 1 = Nov. 12; year 2 = Nov. 18).

Steer Calf Management

A random sample of steers from each treatment group (year 1 = 50 HN, 50 LN; year 2 = 50 HN, 50 LN) were shipped approximately 132 miles to the West Central Research and Extension Center, North Platte, Neb. Steers were grouped together in one pen and fed a starter diet (20% CP, DM basis) for five days prior to being weighed on 2 consecutive days to determine initial BW. Implants providing 20 mg of estradiol benzoate and 200 mg progesterone (Synovex S, Fort Dodge Animal Health, Overland Park, Kan.) were administered at second initial weight collection. Steers were transitioned to a finishing diet (16% CP, DM basis) over a 21 day period. Approximately 100 days prior to slaughter, steers were implanted with 24 mg estradiol and 120 mg trenbolone acetate (Revalor S, Intervet, Millsboro, Del.). Steers were slaughtered at a commercial abattoir 218 days after entering the feedlot. Final BW was calculated from HCW using a common dressing percentage (63%), and carcass data were collected after a 24-hour chill.

To determine the effect of the two supplementation levels on profitability, a partial budget analysis was conducted. Supplementation costs included a delivery charge ($0.03/lb) and were valued similar to Larson et al. (2009, *Journal of Animal Science,* 87: 1147-1155). Meadow hay values were taken from Nebraska state average monthly price based on USDA Agricultural Marketing Service. Calf sale prices were the Nebraska weighted average feeder cattle price reported for the given year at the time of entry into the feedlot, as reported by the USDA Agricultural Marketing Service. Feedlot ration costs were valued at $0.064/lb and non-feed costs were charged at $0.50/day, including veterinary charges, trucking,

Table1. Effects of maternal protein supplementation level on progeny steer feedlot performance.

	Treatment[1]							
	HN		LN			Treatment *P*-value[2]		
Item	Year 1	Year 2	Year 1	Year 2	SEM	Trt	Yr	Trt×Yr
Initial BW, lb	525	476	519	468	5	0.17	< 0.01	0.82
Re-implant BW, lb	1010	902	975	906	9	0.09	< 0.01	0.03
Final BW[3], lb	1388	1253	1330	1263	13	0.07	< 0.01	0.01
Initial to reimplant, lb/day	4.26	3.73	4.00	3.85	0.056	0.20	< 0.01	< 0.01
Reimplant to harvest, lb/day	3.63	3.38	3.41	3.43	0.066	0.21	0.08	0.04
Overall lb/day	3.96	3.57	3.72	3.65	0.049	0.11	< 0.01	< 0.01
DMI[4], lb/day	18.52	17.74	18.04	17.90	0.103	0.12	< 0.01	< 0.01
G:F	0.213	0.200	0.206	0.203	0.001	0.15	< 0.01	< 0.01

[1]HN = dams supplemented with 2.62 and 2.05 lb/day 28% CP cube (DM basis) during late gestation and 12.98 and 12.0 lb/day meadow hay during calving, year 1 and 2, respectively; LN = dams supplemented with 0.85 and 0.94 lb/day protein supplement during late gestation and 10.2 and 14.4 lb/day meadow hay during calving, year 1 and 2 respectively.
[2]Trt = dam treatment; Yr = year; Trt×Yr = dam treatment by year interactions.
[3]Final BW calculated based on a common dressing percentage (63%).
[4]DMI calculated using a modified prediction formula from Tedeschi et al. (2006) where DMI = (4.18 + (0.898 x ADG) + (0.0006 x ($MBW^{0.75}$) + (0.019 x EBF)) ÷ 0.4536.

yardage, and implants. The value of the steer at harvest was based on the Nebraska dressed steer price for the day of harvest, with grid premium and discounts applied as reported by USDA Agricultural Marketing Service. Differences in partial budget net returns were summarized for the cow-calf and feedlot phases.

Statistical Analysis

Supplementation levels were applied to the dams on a location level (n = 1) during a two-year period; therefore, location was considered the experimental unit for steer performance and carcass data. Data were analyzed using PROC MIXED (SAS Inst. Inc., Cary, N.C.) with a $P \leq 0.10$. The statistical model included dam treatment, year, and the interaction. The proportion of steers grading USDA Choice and USDA quality grade of modest or higher were analyzed using χ^2 procedures in PROC FREQ of SAS.

Results

Steer Production

Steer feedlot performance data are presented in Table 1. Initial BW did not differ ($P = 0.17$) between HN and LN steers; however, steers in year 1 were 49 and 51 lb heavier ($P < 0.01$) for HN and LN steers compared with HN and LN steers from year 2, respectively. Re-implant BW and final BW were greatest ($P = 0.03$; 0.01, respectively) for steers from year 1 HN, and differed from year 1 LN steers; however, there were no differences in re-implant or final BW for steers from year 2. Data from Larson et al. (2009, *Journal of Animal Science,* 87: 1147-1155) and Stalker et al. (2006 *Nebraska Beef Cattle Report,* pp. 7-9) indicate steer calves from dams supplemented protein while grazing dormant winter range have greater BW at initial feedlot entry compared to calves from nonsupplemented cows. Calves from those studies were placed in the feedlot 14 days post-weaning; whereas calves in this study were not shipped to the feedlot until approximately eight weeks after weaning, and were allowed to graze subirrigated meadows and received 3.0 lb/day of 28% CP cube supplement. In the studies conducted by Stalker et al. (2006 *Nebraska Beef Cattle Report,* pp. 7-9) and Larson et al. (2009, *Journal of Animal Science,* 87: 1147-1155) pregnant cows were supplemented with either 1.0 lb/day supplement or no supplement. In the present study, cows were provided supplement at both locations with HN cows receiving approximately 2.5 times more supplement than LN cows, and LN cows receiving supplement levels similar to Stalker et al. (2006 *Nebraska Beef Cattle Report,* pp. 7-9) and Larson et al. (2009, *Journal of Animal Science,* 87: 1147-1155).

Average daily gain differed (< 0.01) due to the interaction of dam treatment and year. Steer average DMI was calculated using a modified DMI prediction equation from Tedeschi et al. (2006, *Journal of Animal Science*, 84: 767-777) where DMI = (4.18 + (0.898 x ADG) + (0.0006 x (**$MBW^{0.75}$**) + (0.019 x **EBF**)) ÷ 0.4536 and where $MBW^{0.75}$ EBF represents empty mean metabolic body weight and body fat percentage. Empty body fat percentage was calculated using a modified equation from Guiroy et al. (2001, *Journal of Animal Science*, 79: 1983-1995) where EBF = 17.76107 + (11.8908 x 12th rib fat depth) + (0.0088 X HCW) + (0.81855 x [(marbling score/100) + 1] – (0.4356 x LM area). These equations were developed to predict individual intake in a group environment, similar to the design utilized in this study. Dry matter intake was greatest ($P < 0.01$) for year 1 HN steers and lowest for year 1 LN steers, and efficiency calculated as gain: feed indicated HN steers from year 1 had greater ($P < 0.01$) G:F ratios than all other groups.

Steer carcass data are summarized in Table 2. Hot carcass weights were greater ($P = 0.01$) for steers from year 1 HN cows compared to steers from year 1 LN cows. There were no significant differences ($P = 0.95$) in HCW between steers from HN and LN cows in year 2. The proportion of steers grading USDA Choice was 32 and 33% greater ($P < 0.01$) for HN and LN steers from year 2 compared to year 1. Furthermore, steers from year 2 HN cows had a greater ($P = 0.03$) proportion grade USDA modest or greater compared to steers from year 1 HN and LN cows.

Steers from HN cows had greater ($P \leq 0.05$) marbling scores compared to steers from LN cows, and year 2 steers

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Table 2. Effects of maternal protein supplementation level on progeny steer carcass data.

	Treatment[1]							
	HN		LN			Treatment P-value[2]		
Item	Year 1	Year 2	Year 1	Year 2	SEM	Trt	Yr	Trt×Yr
HCW, lb	874	790	838	796	8	0.07	< 0.01	0.01
Marbling score[3]	410	458	388	441	10	0.05	< 0.01	0.79
12-th rib fat, in	0.48	0.46	0.50	0.44	0.02	0.93	0.08	0.44
LM area, in^2	14.63	12.61	14.43	12.39	0.19	0.26	<0.01	0.96
Yield grade	2.74	3.02	2.71	3.07	0.10	0.95	< 0.01	0.64
Quality grade, % Sm[4] or greater	46	78	48	81		0.78	<0.01	< 0.01
Quality grade, % Md[5] of greater	12	29	4	19		0.07	< 0.01	0.03

[1]HN = dams supplemented with 2.62 and 2.05 lb/day 28% CP cube (DM basis) during late gestation and 12.98 and 12.0 lb/day meadow hay during calving, year 1 and 2, respectively; LN = dams supplemented with 0.85 and 0.94 lb/day protein supplement during late gestation and 10.2 and 14.4 lb/day meadow hay during calving, year 1 and 2 respectively.
[2]Trt = dam treatment; Yr = year; Trt×Yr = dam treatment by year interactions.
[3]Where 400 = small^0.
[4]Sm = small quality grade, USDA low Choice.
[5]Md = modest quality grade, USDA average Choice.

had greater ($P < 0.01$) marbling scores compared to year 1 steers. In a review on fetal skeletal muscle development, Du et al. (2010, *Journal of Animal Science*, 88: E55-E60) reported the importance of maternal nutrition on muscle development and the ability to increase intramuscular fat deposits, which later lead to marbling. Greater marbling scores reported in HN steers compared to LN steers could result from fetal programming. Increased maternal supplementation can lead to recruitment of mesenchymal stem cells to adipogenesis rather than myogenesis, increasing intramuscular fat levels. There were no differences ($P \geq 0.26$) in 12th rib fat, LM area, or yield grade when comparing steers from HN to LN cows; however, differences were significant ($P < 0.08$) between year 1 and year 2.

Table 3. Partial budget analysis of maternal protein supplementation during last trimester of gestation to weaning and weaning to harvest.

	Treatment[1]			
	HN		LN	
Item	Year 1	Year 2	Year 1	Year 2
Cow-calf phase				
Costs, $/cow				
Protein Supplement	7.41	5.79	2.42	2.67
Meadow Hay	51.15	45.52	37.54	54.53
Returns, $/calf				
Calf sale price[2]	626.28	469.95	617.09	467.11
Net profit difference	567.72	418.64	577.13	409.91
Feedlot phase				
Costs, $/steer				
Purchase cost[3]	661.70	509.41	654.09	500.38
Feedlot feed cost[4]	365.67	354.69	358.96	357.13
Returns, $/steer				
Carcass Value	1302.63	1030.54	1247.68	1040.83
Net profit difference	275.26	166.44	234.63	183.32

[1]HN = dams supplemented with 2.62 and 2.05 lb/d 28% CP cube (DM basis) during late gestation and 12.98 and 12.0 lb/day meadow hay during calving, year 1 and 2, respectively; LN = dams supplemented with 0.85 and 0.94 lb/day protein supplement during late gestation and 10.2 and 14.4 lb/day meadow hay during calving, year 1 and 2 respectively.
[2]Value of steer and heifer calves after grazing meadow hay and receiving 3.0 lb/day 28% CP cube (DM basis) for approximately 8 weeks.
[3]Value of steer calves.
[4]Value based on $0.064/lb feed cost for 218 days and including yardage at $0.50/day.

Economic Analysis

Data for the economic analysis are summarized in Table 3. Data represent actual values for the years of the study (2007-2009). In year 1, if calves were sold in November, HN calves were valued at $9.19/calf greater than calves from LN cows; however, net returns for HN calves were $9.41/calf less than those for LN calves due to increased amounts of supplement and hay offered to HN cows. Year 2 calves also had greater sale values for HN calves; however, unlike year 1, HN calf value was $8.73/calf greater than LN calves due to increased hay amounts offered to LN cows during year 2. Carcass value was greater for year 1 steers compared to year 2 steers from both treatments. In year 1 net profit difference through the feedlot phase was $40.63/steer greater for steers born to HN cows compared to LN cows; however, in year 2, returns were $16.88/steer greater for LN steers compared to HN steers. Differences between returns are related to HCW. In year 1, HCW was significantly greater ($P < 0.01$) for HN steers compared to LN calves, whereas in year 2 difference in returns is due to numerical, not statistical, difference in HCW ($P = 0.95$). Fed cattle base prices were $20.81/cwt higher in year 1 compared to year 2, which along with the heavier HCW from year 1 added to the differences in carcass values from the two different years.

Providing increased late gestation supplementation to dams did not affect steer initial BW at feedlot entry; however, steers from HN cows in year 1 had greater final BW and HCW than steers from LN cows. Average marbling scores were greater for HN calves compared to LN calves suggesting a fetal programming effect with increased dam supplementation altering fetal development.

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