Effects of Prepartum Nutrition on May-Calving Cows and Progeny

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Summary with Implications

May-calving dams grazed either sub-irrigated meadow or upland range from Jan. 5 to May 1 each year for 6 years. Within grazing system, dams received either no supplement or 1 lb/d of a 33% CP supplement from Jan. 5 to April 1. Dams grazing meadow in the prepartum period weighed more and had a greater body condition score prior to calving. They also tended to have greater pregnancy rates in the subsequent breeding season and tended to wean heavier calves than dams grazing upland range. Allowing May-calving dams to graze meadow in late gestation may increase herd profitability through increased dam pregnancy rates and weaned calf value. Furthermore, supplemented dams weaned heavier calves, independent of grazing system. Supplementation of May-calving dams in late gestation may be economical if the income from additional pounds of calf weaned is greater than the supplementation cost.

Introduction

Previous research (*2006 Nebraska Beef Cattle Report*, pp. 7–9; *2009 Nebraska Beef Cattle Report*, pp. 5–8) examined increasing dietary CP and TDN for March-calving cows in late gestation and determined no difference in rebreed pregnancy rates. Late gestation for a March-calving herd occurs when forage is dormant, low in crude protein (CP) and *in vitro* dry matter digestibility (IVDMD), and supplementation may not have been enough to meet cow nutrient requirements. Alternately, late gestation for a May-calving herd occurs during early forage growth, where forage can meet or exceed the dam's nutrient requirements. Furthermore, differences in forage species composition between upland range and subirrigated meadow (cool vs. warm season) result in different growth patterns and forage quality. The increased forage availability and quality during the prepartum period of a May-calving herd can affect maternal productivity, as well as progeny postnatal growth and performance. The objective of this study was to evaluate the effect of grazing system with and without supplementation on May-calving dam reproductive performance and progeny growth through weaning.

Table 1. Nutrient analysis and composition on a DM basis of supplement provided to May-calving cows in late gestation[1]

Item	
Nutrient	
CP, %	32.9
RUP, % CP	39.7
TDN, %	78.4
Ingredient, % DM	
Dried distillers grains meal	52.5
Soybean meal (46.5% CP)	14.7
Vitamin and mineral package[3]	13.3
Wheat middlings	6.3
Sunflower meal (35% CP)	6.3
Molasses, liquid	3.7
Urea	1.6
Cull beans	1.5

[1]May-calving dams were assigned to 1 of 2 supplementation groups for 85 d: 1 lb/d of supplement (S) or no supplement (NS) beginning at weaning in January.

[2]Calculated using the equations proposed by the NRC, 2000.

[3]Formulated to provide 0.7 g/lb monensin (Rumensin, Elanco Animal Health).

Procedure

Dam Management

Multiparous, May-calving cows (n = 652, 928 ± 4 lb) were blocked by BW and arranged in a 2 × 2 factorial treatment at weaning in January. Dams grazed either upland range (R) or sub-irrigated meadow (M). Within grazing treatment, cows were randomly assigned to receive either no supplement (NS) or 1 lb/d of a 33% CP supplement (S, Table 1). Grazing treatment continued for 116 ± 2 d (mean ± SD) while supplementation treatment continued for 85 ± 2 d (mean ± SD). Range sites were stocked at 0.6 AUM, whereas sub-irrigated meadow was stocked at 3 AUM.

Dietary CP and TDN as a percentage of dam requirements for each treatment combination are presented in Table 2. Dam BW and body condition score (BCS, 1 = emaciated to 9 = obese) were recorded at initiation and conclusion of grazing treatment. After the treatment period, dams were managed as a single herd grazing upland range the remainder of the year. At parturition, progeny birth BW, sex, and birth date were recorded. Dams were assigned a calving ease (CE) score (1 = no assistance, 2 = easy assist, 3 = difficult assist, and 4 = caesarian section) at parturition, with scores of 2 or greater considered dystocia.

In July, dams were placed with fertile bulls at a ratio of 1:20 (bull:dam) for a 45 d breeding season. Five d after bull placement, dams were synchronized with a single $PGF_{2\alpha}$ injection (5 mL i.m. Lutalyse, Zoetis, Parsippany, New Jersey). In early January, dams were diagnosed for pregnancy via rectal palpation or transrectal ultrasonography and calves weaned. Calf BW was recorded at pre-breeding and weaning.

Statistical Analysis

All data were analyzed using the PROC GLIMMIX procedure of SAS (SAS Inst. Inc., Cary, NC, version 9.4). The model statement included the fixed effects of dam grazing treatment, supplementation treatment, and the resulting interaction. The experimental unit was considered grazing system × supplementation treatment × yr. Dam age and yr were included as a covariate in all analyses and were removed when $P > 0.05$. Data were considered significant

Table 2. Predicted[1] nutrient composition as a percentage of requirements in diets offered to May-calving dams in late gestation[2]

	Meadow		Range	
	NS	S	NS	S
January				
CP, % mid-gestation req.[3]	85.9	95.8	70.4	80.3
NEm, % mid-gestation req.[4]	96.9	99.0	118.4	120.4
February				
CP, % late gestation req.[5]	139.2	146.8	73.8	82.3
NEm, % late gestation req.[6]	76.4	79.1	104.5	106.4
March				
CP, % late gestation req.	251.9	255.7	153.2	159.5
NEm, % late gestation req.	143.6	143.6	143.6	143.6
April				
CP, % late gestation req.	320.7	322.8	160.3	167.1
NEm, % late gestation req.	144.5	144.5	156.4	156.4

[1]Diet composition predicted using a computer model based on NRC, 2000 equations.

[2]May-calving dams were arranged in a 2 × 2 factorial at weaning in January and were assigned to 1 of 2 grazing treatments: sub-irrigated meadow (M) or upland range (R) for 116 d and then to 1 of 2 supplementation treatments: 1 lb/d of 33% CP (DM) supplement (S) or no supplement (NS) for 85 d.

[3]CP expressed as a percentage of requirement for mid-gestation multiparous dams (7.1% CP, DM; NRC, 2000).

[4]NEm expressed as a percentage of the requirement for mid-gestation multiparous dams (0.45 Mcal/lb; NRC, 2000).

[5]CP expressed as a percentage of requirement for late gestation multiparous dams (7.9% CP, DM; NRC, 2000).

[6]NEm expressed as a percentage of the requirement for late gestation multiparous dams (0.50 Mcal/lb; NRC, 2000).

at $P \leq 0.05$ and a tendency if $P \leq 0.10$ and $P > 0.05$.

Results

Over the treatment period, there was a grazing system × supplement interaction ($P = 0.02$, Table 3) for dam BW change. Dams allotted to the MS treatment had the greatest BW gain, MNS intermediate, followed by RS dams, and RNS dams. This resulted in differences in prepartum BW between grazing treatments and supplementation treatments. Dams grazing meadow had a greater ($P < 0.01$) prepartum BW when compared with R dams (1,036 vs. 1,005 ± 7 lb, M vs. R). Likewise, S dams had a greater ($P < 0.01$) prepartum BW than NS dams (1,034 vs. 1,005 ± 7 lb, S vs. NS). Increased dam BW is likely a result of increased diet quality (Table 2).

Grazing treatment did not affect ($P \geq 0.78$) prepartum BCS or BCS change during treatment. Conversely, dam supplementation increased ($P < 0.01$) prepartum BCS (4.7 vs. 4.6 ± 0.03, S vs. NS). Change in BCS during the prepartum period is an indicator of pregnancy success in the upcoming breeding season, with dams who increase or maintain BCS having greater pregnancy rates than dams who lose BCS. It is important to note supplemented dams in this study gained ($P < 0.01$) BCS over the treatment period, but NS dams did maintain condition (0.2 vs. 0.0 ± 0.03, S vs. NS).

Prepartum supplementation did not affect ($P = 0.48$) dam rebreed pregnancy rates. Prepartum meadow grazing tended ($P = 0.08$) to increase subsequent pregnancy rates (89 vs. 85 ± 2%, M vs. R), despite no difference in prepartum BCS. Recent research has shown feeding dams a high energy diet prepartum increased activation of metabolic pathways involved in triglyceride synthesis in the postpartum period (Shahzad et al., 2014, https://doi.org/10.1371/journal.pone.0099757). It is possible dams grazing meadow prepartum had an altered metabolic response and may have been primed to better utilize nutrients in the subsequent breeding season.

At parturition, dystocia rate was not affected ($P \geq 0.14$) by treatment, although both grazing treatment and supplementation affected calf birth BW. Calves born to dams who grazed meadow tended ($P = 0.07$) to have an increased birth BW (74 vs. 72 ± 0.4 lb, M vs. R). Additionally, calves born to supplemented dams had increased ($P = 0.04$) birth BW (74 vs. 72 ± 0.4 lb, S vs. NS). At pre-breeding, there was a tendency for a grazing system × supplement interaction ($P = 0.09$) in calf BW, with RS calves having the greatest BW, MS and MNS intermediate, and RNS having the lowest BW. At weaning, calves born to dams grazing meadow in the prepartum period tended ($P = 0.09$) to have increased BW (443 vs. 436 ± 2 lb, M vs. R). Similarly, prepartum supplemented dams weaned heavier calves ($P = 0.02$; 443 vs. 434 ± 2 lb, S vs. NS). Larson et al. (*2009 Nebraska Beef Cattle Report*, pp. 5–8) observed an increase in milk production for March-calving cows grazing corn residue in late gestation when compared with cows grazing winter range. It is possible increased dietary nutritive value in late gestation is responsible for increased milk production and consequent calf BW.

Conclusions

May-calving dams grazing sub-irrigated meadow had increased prepartum BW and BCS. Furthermore, they tended to have increased pregnancy rates in the following breeding season and wean heavier calves. Allowing May-calving dams to graze meadow during late gestation may increase total herd profitability through increased stayability of dams and increased weaned calf value. Independent of grazing system, supplemented dams had increased prepartum BW and BCS. Progeny birth and wean BW were also increased by prepartum supplementation, with no effect on dystocia rate. The cost of supplementation provided to May-calving dams in late gestation should be balanced against that additional 9 lb of calf weaned observed in the current study. This research indicates management decisions made in one segment of the beef production system may have unrealized impacts on herd profitability.

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Table 3. Effects of late gestation nutrition[1] on May-calving dam BW, BCS, and reproductive and calf performance

	M		R			P-value[2]		
	NS	S	NS	S	SEM	Graze	Supp	G × S
n	181	163	148	159				
Cow BW, lb								
Initial	926	928	935	930	9	0.62	0.87	0.75
Prepartum	1,027	1,045	983	1,021	9	< 0.01	< 0.01	0.25
BW change, lb	99[ab]	115[a]	51[c]	93[b]	6	< 0.01	< 0.01	0.02
Cow BCS[3]								
Initial	4.6	4.5	4.6	4.6	0.04	0.61	0.10	0.35
Prepartum	4.6	4.7	4.6	4.8	0.05	0.78	< 0.01	0.45
BCS change	0.0	0.2	0.0	0.2	0.04	0.58	< 0.01	0.94
Dystocia, %[4]	0	1	1	0	1	0.96	0.95	0.15
Pregnancy rate, %	90	89	82	87	3	0.08	0.48	0.37
Calf BW, lb								
Birth	73	75	71	73	1	0.07	0.04	0.84
Pre-breed	216[ab]	216[ab]	207[b]	234[a]	9	0.58	0.11	0.09
Weaning	439	445	430	443	4	0.09	0.02	0.33

[a,b,c]Means within a row lacking a common superscript differ ($P \leq 0.05$).

[1]May-calving dams were arranged in a 2 × 2 factorial at weaning in January and were assigned to 1 of 2 forage types: sub-irrigated meadow (M) or upland range (R) for 116 d and then to 1 of 2 supplementation groups: 1 lb/d of 33% CP (DM) supplement (S) or no supplement (NS) for 85 d.

[2]Graze = grazing treatment, Supp = supplementation treatment, and G × S = grazing and supplement assignment interaction.

[3]BCS = Body condition score (1 = emaciated to 9 = obese).

[4]At parturition a calving ease (CE) score was assigned (1 = no assistance to 4 = caesarian section). A score of 2 or greater was considered dystocia.

Table 2. Effect of late gestation nutrition on May-born heifer progeny BW, BCS, and reproductive performance

	M		R			P-value[2]		
	NS	S	NS	S	SEM	Graze	Supp	G × S
n	81	76	74	79				
Heifer BW, lb								
Prebreeding (14 mo)	701	701	694	694	4	0.20	0.92	0.94
Pregnancy diagnosis (17 mo)	791	789	785	785	4	0.37	0.85	0.75
Prepartum (23 mo)	842	851	858	869	11	0.13	0.41	0.94
Prebreeding (26 mo)	873	882	884	875	9	0.78	0.96	0.31
Pregnancy diagnosis (30 mo)	864	895	891	904	13	0.13	0.06	0.42
Heifer BCS[3]								
Pregnancy diagnosis (17 mo)	5.9	5.9	5.8	5.8	0.03	0.13	0.40	0.74
Prepartum (23 mo)	5.2	5.1	5.1	5.0	0.06	0.24	0.19	0.66
Prebreeding (26 mo)	5.4[ab]	5.5[a]	5.4[ab]	5.2[b]	0.07	0.02	0.38	0.04
Pregnancy diagnosis (30 mo)	5.2[b]	5.5[a]	5.3[ab]	5.3[ab]	0.08	0.76	0.08	0.01
Pubertal, %[4]	71	79	76	68	5	0.62	0.97	0.12
Percent mature BW, %[5]	60	61	58	59	0.7	0.01	0.06	0.59
Heifer pregnancy rate, %	78	79	72	74	5	0.29	0.81	0.88
Dystocia, %[6]	10	17	8	28	7	0.54	0.02	0.35
PPI, d[7]	89	89	96	95	3	0.03	0.99	0.83
Primiparous cow pregnancy rate, %	84	93	74	74	8	0.02	0.35	0.36

[1]May-calving dams were arranged in a 2 × 2 factorial at weaning in January and were assigned to 1 of 2 forage types: sub-irrigated meadow (M) or upland range (R) for 116 d and then to 1 of 2 supplementation groups: 1 lb/d of 33% CP (DM) supplement (S) or no supplement (NS) for 85 d.

[2]Graze = grazing treatment, Supp = supplementation treatment, and G × S = grazing and supplement interaction.

[3]BCS = Body condition score (1 = emaciated to 9 = obese).

[4]Considered pubertal if blood serum progesterone concentration > 1 ng/ml.

[5]Percent of mature BW at 14 mo of age. Calculated using a May-herd mature cow BW of 1,172 lb.

[6]At parturition a calving ease (CE) score was assigned (1 = no assistance to 4 = caesarian section). A score of 2 or greater was considered as dystocia.

[7]PPI = postpartum interval. Conception date was calculated by subtracting 285 d from subsequent calving date.

were collected from heifers via coccygeal venipuncture to determine plasma progesterone concentrations. Heifers were considered pubertal if plasma progesterone concentrations were ≥ 1.0 ng/mL at one or both time points. Heifer BW was recorded at blood collection and prebreeding BW was considered the average of these 2 time points. Heifer progeny were placed with fertile bulls at a 1:20 bull to heifer ratio for a 45 d breeding season. Heifers were synchronized using a single $PGF_{2\alpha}$ (5 mL i.m., Lutalyse; Zoetis Animal Health, Parisippany, NJ) 5 d after bull placement. Body weight and BCS were recorded and pregnancy diagnosed via transrectal ultrasonography in mid-October. Two weeks prior to calving, heifer BW and BCS was recorded. A calving ease (CE) score (1 = no assistance, 2 = easy assist, 3 = difficult assist, and 4 = caesarian section) was assigned at parturition, with scores of 2 or greater considered dystocia. Body weight and BCS were recorded at the start of the subsequent breeding season. Pregnancy status was diagnosed in November via transrectal ultrasonography, and BW and BCS recorded. Calves were weaned from heifers at this time.

Heifer Progeny First Calf Management

The BW of the first calf born to heifer progeny was analyzed based on granddam pasture and supplement treatment. At parturition, calf birth BW, sex, and birth date were recorded. Calves were vaccinated and male calves castrated at prebreeding. Calf BW was recorded at prebreeding in July and weaning in November.

Statistical Analysis

All data were analyzed using the PROC GLIMMIX procedure of SAS (SAS Inst. Inc., Cary, NC, version 9.4). The model statement included the fixed effects of dam grazing treatment, supplementation treatment, and the resulting interaction. The experimental unit was considered dam treatment × year, where dam treatment consisted of the grazing system, supplementation treatment, and the interaction. Dam age and year were included as a covariate in all analyses. The sex of the heifer progeny's first calf was included as a covariate when analyzing heifer parturition data and their calf BW. Covariates were removed from the model statement when $P > 0.05$. Data were considered significant at $P \leq 0.05$ and a tendency if $P \leq 0.10$ and $P > 0.05$.

Results

Heifer Progeny Performance

Heifer progeny BW, BCS, and reproductive performance are presented in Table 2. Neither prebreeding BW nor percentage of heifers pubertal at the start of the breeding