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LATE GESTATION SUPPLEMENTATION OF BEEF COWS: EFFECTS ON COW AND CALF PERFORMANCE

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ABSTRACT: We conducted a 2-yr study to evaluate the influence of cow BCS and dried distillers grains (DDGS) supplementation during late gestation on cow and calf productivity. The experimental design was a 2 X 2 factorial; 2 BCS (4 or 6) and supplemented or not supplemented. Approximately 12.7 kg/cow of low quality meadow hay (6.4% CP) was provided each day and supplemented cows received 1.81 kg/hd of DDGS every Monday and Wednesday and 2.72 kg/hd on Friday. On each supplementation day, supplemented cows were gathered and sorted into pens based on their respective blocking structure. After completing consumption of their allocated supplement, cows were returned to a common pasture. Performance data and binomial data were analyzed as a Randomized Complete Block using PROC MIXED and PROC GLIMMIX in SAS, respectively. Calf birth weight was greater with BCS 6 cows compared with BCS 4 ($P = 0.002$) and for supplemented compared with unsupplemented cows ($P = 0.05$). In addition, weaning weight was greater for BCS 6 compared with BCS 4 ($P = 0.05$) and calf weaning weight and ADG to weaning were greater for the offspring of supplemented compared with unsupplemented cows ($P \leq 0.02$). We noted no differences in post-weaning calf performance or carcass characteristics ($P > 0.10$). However, BCS 6 cows had approximately 10% more live calves at birth and at weaning ($P < 0.001$) compared with BCS 4 cows. Also, pregnancy rate was 91% for BCS 6 compared with 79% for BCS 4 cows ($P = 0.005$). Supplementation during late gestation resulted in an estimated net return of $7/cow if calves were sold at weaning compared with not supplementing. More importantly, because of additional weaned calves, the estimated net return for BCS 6 cows at weaning was $71/head more than BCS 4. Likewise, with retained ownership, BCS 6 cows yielded a net return of $130/head more than BCS 4 cows. This research demonstrates the potential consequences of not maintaining cows in good BCS (> 5) at calving; greater calf losses, less weaned calves, decreased pregnancy rate, and lower economic return.

Introduction

Protein supplementation of late-gestation beef cows consuming low-quality forages has been shown to increase cow body weight and BCS at calving (Sanson et al., 1990; Bohnert et al., 2002). Also, cows with a BCS less than 4 may breed late or not at all in a controlled breeding season. As a result, it is recommended to have cows in good body condition prior to calving to maximize reproductive performance. Recent research has suggested that providing supplemental protein to mature cows during the last 90 d of gestation improves calf survivability and yields greater economic return with retained ownership (Stalker et al., 2006) and improved weaning weight and fertility in heifers (Martin et al., 2007). This is novel work that demonstrates supplementation of the cow during the last third of gestation can affect the productivity of the offspring which was in utero during supplementation. The aforementioned cows began protein supplementation with an average BCS of 5 or greater. Based on this information, we hypothesize that cows in poor body condition (BCS ≤ 4) will respond more favorably to supplementation than cows in good condition (BCS ≥ 5).

The objectives of the current study were to determine the influence of cow BCS and dried distillers grains (DDGS) supplementation during the last third of gestation on cow reproductive performance, calf growth and performance through the feedlot, and steer calf carcass characteristics. Also, if supplementation is to be profitable it must improve net returns; therefore, we estimated the economic impact of treatments.

Materials and Methods

A 2-yr project, in accordance with an approved Oregon State University Animal Care and Use Protocol, was conducted to evaluate the effects of BCS and late-gestation DDGS supplementation of cows consuming low-quality forage. Each year, 120 cows were used in a 2 × 2 factorial design. The factors were cow BCS (4 or 6; 1 to 9 scale) and supplementation (with or without supplementation). Each year during a pre-study period (approximately 60 d prior to study initiation) 120 cows that had been palpated pregnant were stratified by BCS, blocked by age and weight (6 blocks; 20 cows per block), and randomly allocated to 1 of 4 treatments: BCS 4 with no supplementation (BCS4 NS), BCS 4 with supplementation (BCS4 S); BCS 6 with no supplementation (BCS6 NCP); BCS 6 with supplementation (BCS6 CP). The cows were then managed as two separate groups based on BCS treatment (BCS 4 or BCS 6). The 2 BCS groups were placed in separate pastures and nutritionally managed to reach their respective target BCS by the study start date (approximately January 1). During the pre-trial period all cows received meadow hay (approximately 6% CP; DM basis) and the BCS 6 cows were supplemented with alfalfa (approximately 20% CP) as needed to help reach the target BCS by study start date. Initial cow pre-trial weight for all cows was 501 ± 45 kg (BCS 4 = 501 ± 43 kg; BCS 6 = 501 ± 48 kg) and average pre-trial cow BCS was 4.30 ± 0.32 (BCS 4 = 4.28 ± 0.26; BCS 6 = 4.31 ± 0.36).

In early January each year, all 120 cows were placed into a 26 ha flood meadow pasture that had been harvested for hay the previous summer. All cows received approximately 13 kg/d of low-quality (6.4 % CP; DM basis) meadow hay through calving. Supplemented cows received DDGS (31% CP; DM basis) every Monday (1.8 kg/hd), Wednesday (1.8 kg/hd), and Friday (2.7 kg/hd) so that the total amount of DDGS provided daily over the week averaged 0.91 kg/hd. On each supplementation day, cows were gathered at 0700 h and cows not receiving supplement were turned back out to pasture while supplemented cows were sorted into supplement pens based on their respective treatments and blocking structure (12 total pens; 6 pens each for BCS 4 and BCS 6 supplemented treatments; 5 cows/pen; 60 total supplemented cows). The amount of supplement provided was adjusted as cows calved.

Approximately 1 mo prior to calving, all cows were vaccinated with Vira Shield 5 and Clostri Shield 7 (Novartis Animal Health US, Inc.). Approximately 30 d after calving, all cows were treated for internal and external parasites using Dectomax injectable (Pfizer Animal Health). Additionally, all cows were vaccinated with Vira Shield 5 + VL5 (Novartis Animal Health US, Inc.) at weaning.

At branding (approximately 30 d of age), all calves were vaccinated with Clostrishield 7 and Virashield 6 + Somnus (Novartis Animal Health US, Inc.). At weaning, calves were vaccinated with One Shot Ultra 7, Bovi-Shield Gold 5, and TSV-2 (Pfizer Animal Health). In addition, they received Dectomax injectable for treatment of internal and external parasites. Four weeks later, all calves received a booster of Bovi-Shield Gold 5 + Somnus, Ultra Choice 7, and TSV-2 (Pfizer Animal Health).

Upon calving, cows were weighed and body condition scored. Calves were weighed and a sample of blood collected for determination of serum IgG level within 24 to 48 h of birth. In addition, all bull calves were castrated at this time. After being weighed, all cow/calf pairs were placed into an adjacent 26 ha pasture and provided approximately 14 kg/hd of meadow hay until all cows had calved and calves were approximately 30 d of age. At that time, all of the cow-calf pairs were transported to the Northern Great Basin Experimental Range (NGBER) and managed as a single herd until weaning when calves averaged approximately 140 d of age. Angus and Hereford bulls were used during a 60-d breeding season. All cows and bulls were managed in a single pasture of approximately 810 ha during the breeding season. The cow to bull ratio was 20:1 and the breeding season began June 1 each year.

At weaning, all cows were weighed and body condition scored and all calves were weighed. All weaned calves were transported from the NGBER and placed on a pasture that had been rake-bunched (approximately 7% CP; Turner and DelCurto, 1991) the previous summer. In addition, DDGS were provided to the weaned calves on Monday (0.91 kg/hd), Wednesday (0.91kg/hd), and Friday (1.4 kg/hd). After approximately 45 d, the weaned steer calves were placed in a commercial growing lot for approximately 60 d and then finished in a commercial feedlot in Northeast Oregon. In addition, cows were rectally palpated in mid-October each year for determination of pregnancy. The response variables that were analyzed included: 1) cow weight and BCS change, 2) cow pregnancy rate, 3) calf birth weight, 4) calf serum IgG level within 24 to 48 h of birth, 5) calf performance to weaning, 6) steer performance in the growing lot and feedlot, 7) steer carcass quality, and 8) net returns based on cow BCS and CP Supplementation.

The values used for determination of partial budgets to evaluate the economic ramifications of treatments were \$93.70/t for meadow hay and \$220.46/t for DDGS. Growing lot feed costs were \$1.20/(hd·d) and \$0.88/(hd·d) for 2007 and 2008, respectively. In addition, feedlot feed costs were \$2.89/(hd·d) and \$2.74/(hd·d) for 2007 and 2008, respectively. The sale value of steers at weaning (\$117.88/45 kg of BW) and upon leaving the growing lot (\$102.52/45 kg of BW) was based on the 5-yr average (2004 to 2008) October price for 181 and 272 kg feeder steers, respectively, as reported in the Washington Weekly Combined Cattle Report accessed through the Livestock Marketing Information Center (Denver, CO). The carcass value of steers was determined similarly with the exception of using the 5-yr average (2004-2008) price for June from the National Weekly Direct Slaughter Cattle Report (\$139.84/45 kg of hot carcass wt).

Cow and calf performance data were analyzed as a Randomized Complete Block using the PROC MIXED option in SAS (SAS Inst., Inc., Cary NC). The model included treatment, block, year, treatment × block, treatment × year, and block × year. Data were analyzed using pen (treatment × year) as random variable. Treatment differences were evaluated using the following contrasts: BCS 4 vs BCS 6; Supplemented vs Not Supplemented; and the interaction of BCS and Supplementation.

Binomial data (cow pregnancy rate, live calves at birth and weaning, and proportion of carcasses grading choice) were analyzed as a Randomized Complete Block using the PROC GLIMMIX procedure of SAS. The model, random variable, and contrasts used were the same used previously for the cow and calf performance data.

Results & Discussion

The total number of cows that were removed from the study because of death, loss of a calf, or palpated not pregnant was 19, 15, 4, and 6 for BCS4 S, BCS4 NS, BCS6 S, and BCS6 NS, respectively (Table 1). In addition, the number of calves lost through slaughter was 9, 8, 2, and 3 for BCS4 S, BCS4 NS, BCS 6S, and BCS6 NS, respectively.

Cow Performance

The initial weight of BCS 6 cows was approximately 62 kg heavier than the BCS 4 cows ($P < 0.001$; Table 2). Likewise, the initial BCS of treatments came close to meeting our targeted values of 6 and 4 for

BCS 6 and BCS 4 cows, respectively; the BCS 6 cows averaged 5.7 while BCS 4 cows averaged 4.3 ($P < 0.001$). At calving, the difference in weight and BCS between BCS 6 and BCS 4 cows remained ($P < 0.001$). However, we did note a supplementation effect with both cow weight and BCS at calving. The supplemented cows weighed more ($P < 0.001$) and carried more BCS ($P < 0.001$) than unsupplemented cows. At weaning, the BCS 6 cows were still heavier (30 kg; $P < 0.001$) and had a greater BCS (0.6; $P < 0.001$) than BCS 4 cows. In addition, the supplemented cows had a greater BCS than unsupplemented cows ($P = 0.02$).

Table 1. Losses of cows and calves

Item	BCS 4 Supplement	BCS 4 No Supplement	BCS 6 Supplement	BCS 6 No Supplement
Cows				
n	60	60	60	60
Prepartum	1[c]	0	0	0
Parturition	0	0	0	0
Cow Lost fetus during study	2	1	0	0
Lost calf prior to turnout	5[d]	3[d]	0	0
Palpated not pregnant	11	11	4	6
Total (all causes)	***19***	***15***	***4***	***6***
Calves				
Prepartum	2	1	0	0
Parturition	5[d]	3[d]	0	0
Weaning	1[e]	1[e]	1[e]	0
Growing lot[a]	1[f]	0	1[g]	1[h]
Finishing lot[b]	0	3[f,f,g]	0	2[f]
Total (all causes)	***9***	***8***	***2***	***3***

[a] = Only remaining steer calves were placed in growing lot; n = 27, 26, 35, and 25 for supplemented and unsupplemented BCS 4 and supplemented and unsupplemented BCS 6, respectively
[b] = Only remaining steer calves were placed in finishing lot; n = 26, 27, 34, and 24 for supplemented and unsupplemented BCS 4 and supplemented and unsupplemented BCS 6, respectively
[c] = Cow got on back and suffocated; [d] = Calves born dead, no dystocia observed; [e] = Cause of death unknown; [f] = Calves died of pneumonia; [g] = Calf died of bloat; [h] = Crippling injury

Table 2. Cow performance relating to cow BCS and supplementation (Supp) during late gestation[a]

Item	BCS 4 Supp	BCS 4 No Supp	BCS 6 Supp	BCS 6 No Supp	SEM	P-value BCS 4 vs BCS 6	P-value Supp vs UnSupp	P-value BCS X Supp
Initial wt., kg[b]	503	502	562	567	4.5	<0.001	0.65	0.46
Calving wt., kg	531	495	570	538	5.0	<0.001	<0.001	0.63
Wt. at Weaning, kg	522	512	551	543	5.4	<0.001	0.10	0.81
Initial BCS[c]	4.32	4.39	5.67	5.75	0.05	<0.001	0.14	0.83
Calving BCS	4.57	4.33	5.51	5.18	0.05	<0.001	<0.001	0.36
Weaning BCS	4.74	4.61	5.30	5.19	0.05	<0.001	0.02	0.84
Days to calving	76	79	76	76	2.5	0.58	0.55	0.43
Live calf at birth, %	86.7	93.3	100.0	100.0	2.7	<0.001	0.22	0.22
Live Calf at Weaning, %	85.0	91.7	98.3	100.0	3.0	<0.001	0.16	0.40
Pregnancy rate, %	77.2	80.7	92.8	90.0	4.6	0.005	0.93	0.48

[a] Pretrial period was 11/1/06 to 1/4/07 in yr 1 and 11/8/07 to 1/3/08 in yr 2; During pretrial, BCS 4 and BCS 6 cows were managed as 2 separate groups and fed to reach target BCS by study start date
[b] Initial pretrial wt. Averages: Overall = 501 ± 45 kg; BCS 4 = 501 ± 43 kg; BCS 6 = 501 ± 48 kg
[c] Initial Pretrial BCS Averages: Overall = 4.30 ± 0.32; BCS 4 = 4.28 ± 0.26; BCS 6 = 4.31 ± 0.36

No difference in the proportion of live calves at birth and weaning were observed due to supplementation ($P > 0.15$); however, a difference was noted because of BCS treatment. The percentage of live calves at birth for the BCS 6 cows averaged 100% compared with 90% for the BCS 4 cows ($P < 0.001$). Also, the percentage of live calves at weaning averaged 99% and 88% for BCS 6 and BCS 4 cows, respectively. Therefore, if we extrapolate our data to a couple of theoretical cow herds entering the last third of gestation with an average BCS of 6 or 4, we could expect to have almost 11% more calves at weaning with the BCS 6 herd; an extra 11 calves per hundred cows.

Cow pregnancy rate was not affected by supplementation treatment ($P = 0.93$); however, there was a difference between the BCS 6 and BCS 4 treatments. The average pregnancy rate for BCS 4 cows was 79% compared with 91% for the BCS 6 cows ($P = 0.005$). Our breeding season was 60 d, so it is possible that a longer breeding season may have resulted in a greater overall pregnancy rate but the calving interval would be longer, cows would not have a calf within a 365-d interval, and the consistency and weight of the calves at weaning would be less.

Calf Performance

Calf birth weight increased with cow BCS (41 vs 38 kg for BCS 6 and 4, respectively; $P = 0.002$; Table 3) and with supplementation (41 vs 39 kg for supplemented and not supplemented, respectively; $P = 0.05$). However, no incidents of dystocia were noted during the study. There was no treatment effect on calf serum IgG level at birth ($P \geq 0.10$).

Calf weaning weight was greater for BCS 6 compared with BCS 4 cows ($P = 0.05$) and for supplemented cows compared with those cows not receiving supplement ($P = 0.01$). In addition, calf ADG to weaning was greater for calves from dams that received supplement during the last third of gestation ($P = 0.02$). This agrees with previous work indicating that supplementation of cows pre-calving increases weaning performance of calves (Stalker et al., 2006).

Table 3. Calf performance relating to cow BCS and supplementation (Supp) during late gestation

Item	BCS 4 Supp	BCS 4 No Supp	BCS 6 Supp	BCS 6 No Supp	SEM	P-value BCS 4 vs BCS 6	P-value Supp vs UnSupp	P-value BCS X Supp
Birth wt., kg	39.0	38.5	42.6	40.2	0.72	0.002	0.05	0.21
IgG, mg/dL[a]	5,880	6,348	5,836	6,088	231	0.49	0.10	0.62
Weaning wt., kg	188	179	192	186	3.2	0.05	0.01	0.58
Weaning age, d	140	137	140	141	2.8	0.46	0.65	0.53
ADG to weaning, kg	1.07	1.03	1.07	1.04	0.014	0.81	0.02	0.70
Growing lot initial wt., kg	207	199	214	208	5.5	0.11	0.18	0.86
Growing lot final wt., kg	256	247	264	256	6.1	0.14	0.16	0.94
Growing lot ADG, kg	0.63	0.60	0.64	0.59	0.036	0.97	0.26	0.74
Feedlot initial wt., kg	256	247	264	256	6.1	0.14	0.16	0.94
Feedlot final wt., kg[b]	587	580	593	579	11	0.79	0.32	0.74
Feedlot ADG, kg	1.83	1.91	1.90	1.88	0.09	0.84	0.71	0.54
Feedlot days on feed	178	166	177	166	7	0.84	0.10	0.86
Hot carcass wt., kg	370	365	374	365	7.2	0.79	0.32	0.74
Backfat, cm[c]	1.78	1.68	1.62	1.68	0.10	0.32	0.83	0.36
LM area, cm^2	87.1	84.5	87.1	86.4	1.81	0.65	0.37	0.66
KPH, %	2.07	1.99	1.93	2.24	0.11	0.62	0.25	0.05
Marbling[d]	423	403	434	420	14	0.33	0.24	0.84
Yield grade	3.4	3.4	3.3	3.4	0.15	0.49	0.86	0.70
Choice, %	57.6	38.6	65.7	62.4	11	0.13	0.28	0.42
Retail product, %[e]	48.7	48.8	49.0	48.9	0.36	0.50	0.88	0.66

[a] Immunoglobulin G concentration in calves between 24 to 48 h after birth measured by radial immunodiffusion
[b] Calculated from hot carcass weight assuming a 63% dressing percentage
[c] Thickness measured at the 12th rib
[d] Marbling score: 400 = $small^{00}$, 500 = $Modest^{00}$
[e] USDA Retail Yield Equation: 51.34 – (5.78*inches backfat) – (0.0093*pounds hot carcass weight) – (0.462*percentage kidney, pelvic, and heart fat) + (0.74*ribeye area in square inches)

No notable treatment effects were observed in steer calf performance in the growing lot or feedlot ($P \geq 0.10$). The only carcass characteristic affected by treatment was KPH which decreased with supplementation for BCS 4 cows and increased with supplementation for BCS 6 cows ($P = 0.05$). The reason for this observation is not readily apparent. None of the other carcass characteristics were affected by treatment ($P \geq 0.13$).

Economics

Table 4 lists the estimated net returns of treatments broken down in 4 production phases; cow-calf, growing lot, feedlot, and retained ownership. The most notable affect on net returns was because of cow BCS. The BCS 6 cows returned approximately $71/cow more than the BCS 4 cows if calves were sold at weaning and approximately $130/cow more if we retained ownership of the calves through the feedlot. The primary reason for the disparity in net returns is due to more live calves at weaning. Supplementation had minimal effects on net returns with the greatest benefit noted in the cow-calf phase where supplemented cows had a $7/cow greater net return than unsupplemented. Nevertheless, it is interesting to note the approximately 500% greater health costs in the feedlot for calves from unsupplemented compared with supplemented cows ($8.28 vs.$1.65/head).

Table 4. Economics relating to cow BCS and supplementation (Supp) during late gestation

	BCS 4		BCS 6		BCS	Supp.
Item	Supp.	No Supp.	Supp.	No Supp.	Difference[a]	Difference[b]
Cow-Calf Phase						
Returns						
More Calves Weaned[c]	0.00	0.00	54.14	52.50		
Weaned Calf Value	488.98	465.32	499.87	484.78		
Costs						
Supplement	15.25	0.00	15.25	0.00		
Hay	90.73	96.10	90.80	90.10		
Net Returns	*383.00*	*369.22*	*447.96*	*447.18*	*71.46*	*7.28*
Growing Lot Phase						
Returns						
Calf Value	577.91	558.23	596.96	578.97		
Costs						
Purchase Cost	488.98	465.32	499.87	484.78		
Growing Lot Feed Costs	82.90	82.90	82.90	82.90		
Growing Lot Health Costs	1.95	0.93	1.80	2.14		
Net Returns	*4.08*	*9.08*	*12.39*	*9.15*	*4.19*	*(0.88)*
Feedlot Phase						
Returns						
Carcass Value	1140.04	1125.78	1152.11	1124.73		
Costs						
Purchase Cost	577.91	558.23	596.96	578.97		
Feedlot Feed Costs	501.48	468.35	495.10	468.36		
Feedlot Health Costs	0.58	4.59	2.72	11.98		
Net Returns	*60.07*	*94.61*	*57.33*	*65.42*	*(15.97)*	*(21.32)*
Retained Ownership						
Returns						
More Carcasses[c]	0.00	0.00	124.77	121.81		
Carcass Value	1140.04	1125.78	1152.11	1124.73		
Costs						
Supplement	15.25	0.00	15.25	0.00		
Hay	90.73	96.10	90.80	90.10		
Growing Lot Feed Costs	82.90	82.90	82.90	82.90		
Growing Lot Health Costs	1.95	0.93	1.80	2.14		
Feedlot Feed Costs	501.48	468.35	495.10	468.36		
Feedlot Health Costs	0.58	4.59	2.72	11.98		
Net Returns	*447.15*	*472.91*	*588.31*	*591.06*	*129.66*	*(14.26)*

[a] Difference in net returns between the average of BCS 6 and BCS 4 treatments

[b] Difference in net returns between the average of supplemented and non-supplemented treatments

[c] Increased returns resulting from increased percentage of live calves at weaning (10.83%) for the average of BCS 6 treatments compared with the BCS 4 treatments

Implications

Supplementation of beef cows during the last third of gestation resulted in cows with greater BCS at birth and weaning compared with not supplementing. In addition, calves from cows that received supplement were heavier at weaning and had greater ADG from birth to weaning. However, the greatest effect of cow productivity was because of cow BCS entering the last third of gestation. The BCS 6 cows were in better condition at calving and weaning, they had approximately 10% more live calves at birth and weaning, and they had an 11% greater pregnancy rate than BCS 4 cows. As a result, estimated net returns for BCS 6 cows were approximately $71/cow greater than BCS 4 if calves were sold at weaning and $130/cow if ownership of calves was retained through the feedlot. These data demonstrate the potential economic importance of managing cows to achieve a good BCS (≥ 5) prior to entering the last third of gestation.

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