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Impacts of cow body condition score during gestation on weaning performance of the offspring

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ABSTRACT

This experiment evaluated the impacts of cow body condition score (**BCS**) during gestation on productive parameters of the offspring. Three hundred multiparous, lactating, non-pregnant Angus × Hereford cows were assigned to a fixed-time artificial insemination (**AI**) protocol using semen from a single sire (d 0). Forty days after AI, cows were evaluated for pregnancy status via transrectal ultrasonography and BCS, and 100 pregnant cows (543 ± 6 kg of BW, 6.6 ± 0.3 yr of age, 4.83 ± 0.06 of BCS, and 115 ± 2 d postpartum) were selected for the experiment. Within these 100 cows, 20 cows had BCS ≥ 5.50 but ≤ 6.50 and were classified as adequate BCS (5.85 ± 0.06; **HBCS**). The remaining cows had BCS ≤ 4.75 (4.52 ± 0.03), and were divided into 4 groups (20 cows/group): **LBCS** (4.60 ± 0.07), **BCSG1** (4.43 ± 0.07), **BCSG2** (4.63 ± 0.07), and **BCSG3** (4.63 ± 0.07). The HBCS and LBCS cows were managed to maintain their initial BCS throughout gestation. The BCSG1, BCSG2, and BCSG3 cows were managed to gain 1.50 BCS during the first, second, and third trimester of gestation, respectively, and maintain the resultant BCS until calving. Cow BCS was assessed again on d 102, 182, and 265. During the calving season (d 272-291), calf body weight (**BW**) was recorded within 3 h after birth. Only cows that met the BCS maintenance (within 0.50 of BCS change) and change (≥ 1.25 and ≤ 1.75 of BCS increase within the trimester) criteria were maintained in the experiment (HBCS, n = 14; LBCS, n = 14; BCSG1, n = 14; BCSG2, n = 15, BCSG3, n = 15). On d 344, cow milk production was estimated by the weigh-suckle-weigh method, and calves were weaned on d 475. No differences were detected ($P \geq 0.42$) for calving rate, calf birth BW, and cow milk production. Weaning rate and calf age at weaning were also similar among BCS groups ($P \geq 0.15$). However, calf weaning BW was greater ($P \leq 0.05$) for BCSG2 and BCSG3 cows (265 and 262 kg, respectively; SEM = 4) compared with HBCS and LBCS cows (248 and 249 kg, respectively; SEM = 4), and similar ($P \geq 0.20$) among all other comparisons. These results suggest that offspring weaning BW is directly influenced by BCS gain of beef cows during the second and third trimesters of gestation.

1. Introduction

Research has established that cow nutritional status during gestation directly impacts long-term offspring productivity via fetal programming effects (Funston et al., 2010; Reynolds et al., 2010). Body condition score (**BCS**) is widely used to assess cattle nutritional status (Wagner et al., 1988), whereas BCS during gestation is known to influence productive responses of beef cows such as reproductive performance (Richards et al., 1986; Cooke et al., 2009). Recent research from our group also demonstrated that cow BCS during late gestation has fetal programming implications (Bohnert et al., 2013). In that study, cows managed to sustain BCS ≈ 5.5 during the last trimester of gestation had greater calving rate, weaning rate, and tended to wean heavier calves compared with cohorts managed to sustain a BCS ≈ 4.5.

Dietary supplementation and subsequent increase in BCS has been widely used to stimulate and investigate fetal programing effects in beef cattle (Funston et al., 2012). In fact, cows with BCS ≈ 5.5 evaluated by Bohnert et al. (2013) were supplemented during mid-gestation to achieve the desired BCS during the last trimester of gestation. Re-alimentation and consequent BCS gain during late gestation can offset the negative consequences of inadequate nutrition during early and mid-gestation on fetal development and offspring productivity (Long et al., 2009, 2010). More importantly, BCS gain reflects a positive nutritional balance due to nutrient flushing, which is known to enhance reproductive function in livestock (Dunn and Moss, 1992) and likely has fetal programming effects by increasing nutrient delivery to the

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developing fetus (Wu et al., 2006). Therefore, it is unknown if the outcomes reported by Bohnert et al. (2013) were due to cow BCS sustained during late gestation, BCS gain during mid-gestation, or a combination of both. Based on this information, we hypothesized that cow BCS gain during gestation has a greater impact on offspring productivity compared with sustained BCS. Hence, this experiment compared cow-calf productivity parameters from beef cows that sustained BCS during gestation, or that gained BCS within each trimester of gestation.

2. Materials and methods

This experiment was conducted at the Oregon State University – Eastern Oregon Agricultural Research Center (Burns station). The animals utilized were cared for in accordance with acceptable practices and experimental protocols reviewed and approved by the Oregon State University, Institutional Animal Care and Use Committee (#4521).

2.1. Animals and treatments

Three hundred multiparous, non-lactating, pregnant Angus × Hereford cows were assigned to a fixed-time artificial insemination (**AI**) protocol (Cooke et al., 2014) using semen from a single sire (d 0 of the experiment), and exposed to mature Angus bulls for 50 d beginning on d 18. On d 40, cows were evaluated for pregnancy status via transrectal ultrasonography, BW, and BCS, and 100 cows pregnant to AI (mean ± SE here and throughout; 543 ± 6 kg of BW, 6.6 ± 0.27 yr of age, 4.83 ± 0.06 of BCS, and 115 ± 2 d postpartum) were selected for the experiment. Within these 100 cows, 20 cows had BCS ≥ 5.50 but ≤ 6.50 and were classified as adequate BCS (5.85 ± 0.06; **HBCS**). The remaining cows had BCS ≤ 4.75 (4.52 ± 0.03), and were divided into 4 groups of 20 cows each: **LBCS** (4.60 ± 0.07), **BCSG1** (4.43 ± 0.07), **BCSG2** (4.63 ± 0.07), and **BCSG3** (4.63 ± 0.07).

The LBCS and HBCS cows were managed to maintain their initial BCS throughout gestation at levels classically considered to be, respectively, inadequate or adequate for beef cow performance (Richards et al., 1986; Wagner et al., 1988; Kunkle et al., 1994). The BCSG1, BCSG2, and BCSG3 cows were managed to gain 1.50 BCS during the first, second, and third trimester of gestation, which was the BCS gain during mid-gestation reported by Bohnert et al. (2013), and maintain the resultant BCS until calving. Immediately after calving, all cow-calf pairs were assigned to the general management of the research herd (Cooke et al., 2012, 2014). Cattle management details are reported in Table 1 and are similar to the research approach employed by Bohnert et al. (2013). Calves were administered Clostrishield 7 and Virashield 6+ Somnus (Novartis Animal Health, Bucyrus, KS, USA) on d 320 and were weaned on d 475 of the experiment. Throughout the experiment, cattle had ad libitum access to water and a commercial mineral and vitamin mix (Cattleman's Choice; Performix Nutrition Systems, Nampa, ID) containing 14% Ca, 10% P, 16% NaCl, 1.5% Mg, 6000 ppm Zn, 3200 ppm Cu, 65 ppm I, 900 ppm Mn, 140 ppm Se, 136 IU/g of vitamin A, 13 IU/g of vitamin D_3, and 0.05 IU/g of vitamin E.

2.2. Sampling

Feed and forage samples (Ganskopp and Bohnert, 2009) were collected monthly during the experiment, and analyzed for nutrient content. Each sample was analyzed in triplicate by wet chemistry procedures for concentrations of CP (method 984.13; AOAC, 2006), ADF (method 973.18 modified for use in an Ankom 200 fiber analyzer, Ankom Technology Corp., Fairport, NY; AOAC, 2006), and NDF (Van Soest et al., 1991; modified for Ankom 200 fiber analyzer, Ankom Technology Corp.). Calculations for TDN used the equation proposed by Weiss et al. (1992).

Table 1
Management to cows to maintain inadequate (**LBCS**; n = 14) or adequate (**HBCS**; n = 14) body condition score throughout gestation, or to gain body condition score during the first (**BCSG1**; n = 14), second (**BCSG2**; n = 15), and third (**BCSG3**; n = 15) trimester of gestation and maintain the resultant body condition score until calving.[a,b]

BCS Group	Gestation management			Post-calving management	
	1st trimester (d 40 to 102)	2nd trimester (d 103 to 182)	3rd trimester (d 183 to calving)	Calving until d 344	d 340 until d 475
LBCS	A	A	C + E + F	C + F + H	D
HBCS	B	C + F + G	C + F + H	C + F + H	D
BCSG1	B + F	C + F + G	C + F + H	C + F + H	D
BCSG2	A	C + F + G + I	C + F + H	C + F + H	D
BCSG3	A	A	C + F + H + I	C + F + H	D

[a] A = Range pasture with ad libitum access to forage (49.4% TDN and 4.1% CP; DM basis), B = Meadow foxtail (*Alopecurus pratensis* L.) pasture with ad libitum access to forage (58.7% TDN and 7.5% CP; DM basis), C = Meadow foxtail pasture previously harvested for hay and with negligible forage availability, D = Range pasture with ad libitum access to forage (55.5% TDN and 10.2% CP; DM basis according to Ganskopp and Bohnert, 2009).
[b] E = Grass straw (53% TDN and 4.6% CP; DM basis), F = Alfalfa hay (63.1% TDN and 20.0% CP; DM basis); G = Meadow foxtail hay (56.0% TDN and 8.2% CP; DM basis), H = ground corn (90% TDN and 8.9% CP; DM basis), I = dried distillers grain with solubles (87% TDN and 30.9% CP; DM basis).

Individual cow full body weight (**BW**) and BCS (Wagner et al., 1988) were recorded on d 40, 102, 182, 265, 344 (BCS only), and 475. Further, BCS was evaluated by the same 3 evaluators, which were blinded to which BCS group the assessed cow was assigned to. Only cows that met the BCS maintenance (within 0.50 of BCS change) and change (≥ 1.25 and ≤ 1.75 of BCS increase within the trimester) criteria were used in the experiment (HBCS, n = 14; LBCS, n = 14; BCSG1, n = 14; BCSG2, n = 15, BCSG3, n = 15). The maintenance criterion was based on the expected variation in BCS scoring across evaluators and sampling events, whereas the BCS gain criterion was based on Bohnert et al. (2013). Overall BCS and BCS change during the experiment of cows that met requirements are reported in Table 2.

During the calving season (d 272–291), calf full BW was recorded within 3 h after birth. No incidences of dystocia were observed in the present experiment. On d 344, cow milk production was estimated by the weigh-suckle-weigh method (Aguiar et al., 2015). More specifically, calves were separated from their dams for 8 h and allowed to suckle for 30 min. Milk yield was calculated as the difference between pre- and post-suckling calf BW. Milk yield was adjusted to 24 h by multiplying the observed difference in pre- and post-suckling calf BW by 3. Calf full BW was determined on d 475 (weaning) and 476, and values averaged to represent calf weaning BW and calculate average daily gain (**ADG**) from birth to weaning.

2.3. Statistical analysis

All data were analyzed using cow(BCS group) as random variable, with SAS (SAS Inst. Inc., Cary, NC, USA; version 9.3) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. Cow BCS was assessed individually and only cows that met the BCS criteria adopted herein were used in the experiment; therefore, cow was considered the experimental