The following report was published in Clinical Theriogenology, Volume 4, Number 4 , December 2012. A portion of the data for this publication was collected at the Powell River Project.

Impact of body condition change post-breeding on reproductive performance of beef cows

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Abstract

Body condition score (BCS) is a commonly used tool for evaluating the nutritional status of beef cows. Good nutritional status of beef cows is one of the essential components for improved reproductive performance. The objective was to evaluate the impact of change in body condition during 2 months after breeding on ~~the~~ AI pregnancy success in beef cows. Angus cross beef cows (N = 2571) from 11 locations were included in this study. All cows were given a BCS (1-emaciated; 9-obese), by the same clinician in each location at the initiation of the synchronization (CO-Synch+CIDR) protocol and again at pregnancy diagnosis, 60 to 70 days later. Cows were fitted with Kamar heat detection patches at CIDR removal and observed three times daily for estrus expression until timed insemination. ~~Cow's~~ Cows' pregnancy status was determined by per-rectal palpation or using ultrasonography. Variables included in the model (PROC MIXED) were change in BCS (no change or gain vs. loss), cows - expression of estrus at or prior to AI (activated, partially activated, or lost Kamar) or not (intact Kamar), age of the dam (2, 3 to 6 and >6 years), days post calving at initiation of synchronization (30 to 60, 61 to 80 and > 81 days) and appropriate 2-way interactions. Season (location) and AI sires were considered as random effects. The results showed AI pregnancy rate was influenced by change in the BCS [No change or gain: 55.3%; (1034/1870) vs loss: 50.1% (352/703); P<0.05] and cows that showed estrus at or prior to AI [estrus: 57.8% (825/1423) vs no estrus: 48.9% (560/1148); P<0.0001]. In conclusion, cows that lost body condition - between breeding and pregnancy diagnosis had lower AI pregnancy rates compared to cows that maintained or gained body condition. It is essential to feed cows following breeding to maintain their BCS - in order to optimize their conception rates.

Keywords: body condition, pregnancy rate, timed artificial insemination, beef cows, fertility

Introduction

Variability in quantity and quality of pastures limits the energy intake in extensive grazing based cow-calf systems. ~~Poor~~ Lower quality pasture negatively impacts reproductive performance of beef cows. The nutritional program prior to calving reflects in body condition score (BCS) at calving and during post-calving. It is the most important factor determining the duration of the postpartum anestrus period beef cows.[1,2] However, post-calving nutrition may partially overcome the negative effects of a restriction in pre-partum nutrition in thin to moderate BCS beef cows.[1,2] The nutritional status of ~~a~~ pregnant beef cows throughout gestation is important for the development and health of fetus and nutritional status post calving is important for growth and health of calf. Studies have focused on BCS at calving, BCS change from calving to breeding and BCS change at breeding on reproductive performance. However, few studies have focused on the effect of BCS change immediately after breeding on reproductive performance. Increased energy intake for 3 to 4 weeks, before or during the mating period, in combination with temporary weaning (with or without separation of the calf) has shown to increase pregnancy rates during the first half of the mating period in cows with low-to-moderate BCS.[2]

Nutritional status is reflected in changes in body weight (BW) and BCS as well as in the levels of metabolites and hormones in blood. Blood concentrations of glucose, insulin and insulin- like growth factor-I (IGF-I) are indicative of the availability of energy, provide short- or long-term signals that mediate the effects of nutrition on reproduction.[3] The IGF-I plays a pivotal role in cattle fertility, acting as a monitoring signal that allows reproductive events to occur when nutritional conditions for successful reproduction are reached.[4] The objective of this study was to evaluate the impact of body condition change during 2 months after breeding on AI pregnancy rate in beef cows.

Materials and methods

Multiparous Angus cross beef cows (n=1054) from 11 locations were included in this study.

Cows were managed in forage based systems. Forages used for grazing and hay making include Kentucky-31 fescue, ladino clover, orchard grass and other native grasses. Spring-calving cows are wintered on grass hay based rations with occasional supplements of concentrates or by-product feeds when nutritional needs cannot be met with hay and grazing. Fall-calving cows that are lactating during winter are more frequently given concentrate or by-product feed supplements. In addition, attempts are made to stockpile fall grasses for early winter grazing. Hay is analyzed for protein and energy content prior to the winter to assist in winter feeding management.

All cows were given a BCS (1-emaciated; 9-obese), by the same clinician in each location at the initiation of synchronization (CO-Synch+CIDR; Figure 1) protocol and again at pregnancy diagnosis, 60 to 70 days later. Briefly, cows received 100 µg of GnRH, im, (Cystorelin®, Merial Ltd. Duluth, GA) and a controlled internal drug release insert (CIDR; Eazi-Breed™ CIDR® cattle insert, Pfizer Animal Health) on Day 0. The CIDR insert was removed and 25 mg PGF2α, im, (Dinoprost; 5mL Lutalyse® sterile solution; Pfizer Animal Health) was given on Day 7. On Day 10, starting at 8:00 AM, at 66 h (N=544) after CIDR removal cows were inseminated artificially and were given 100 µg of GnRH, im, concurrently.

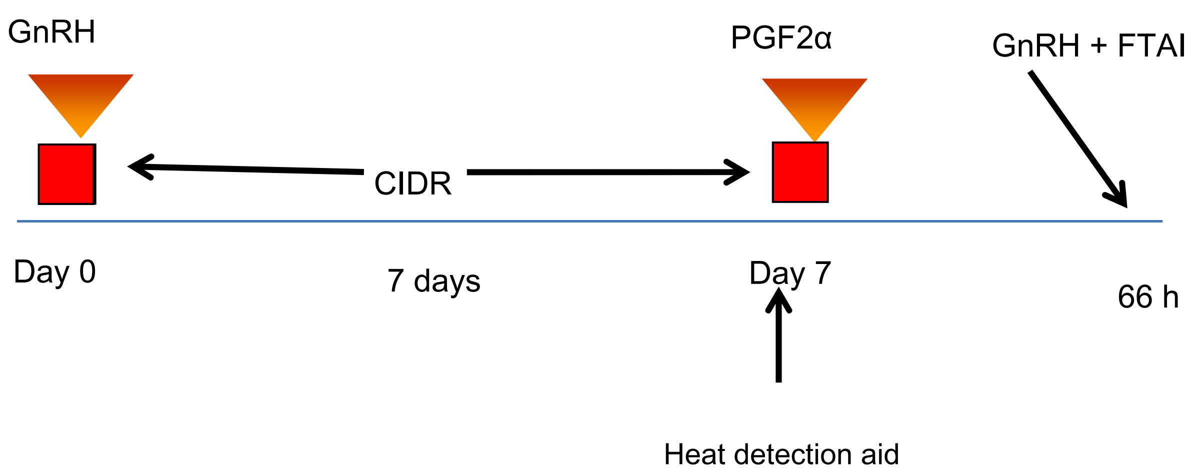

Fig 1. Diagrammatic representation of the CO-Synch+CIDR synchronization protocol

All cows received a Kamar® Heatmount detector (Kamar, Inc., Steamboat Springs, CO, USA) at the time of CIDR insert removal on Day 7. During the period from CIDR insert removal to insemination, cows were observed 3 times daily for estrus and heat detector aid status (activated, partially activated and lost vs. intact). A cow was determined to be in estrus if the cow was visually observed to stand for mounting or if the cow had an activated, lost (with mount marks) or partially-activated heat detector aids.

Two weeks later, intact Angus bulls were placed with cows (approximately1:40 bull: cow ratio), for the remainder of the 60 to70 d breeding season. Cows were examined for pregnancy status at 55 to 70 d after fixed-time AI, by ultrasonography (Aloka-500, Sysmed Lab Inc., Chicago, IL, USA) to identify time of conception. In all locations, cows were inseminated by AI technicians from stud companies and/or clinicians. The AI sires were selected and assigned to cows based on sire traits and to avoid inbreeding. The AI pregnancy rate was calculated as number of cows pregnant to AI divided by total number of cows inseminated.

Statistical analyses

The data were analyzed using SAS statistical software (SAS version 9.12, SAS Institute Inc., Cary, NC). Variables included in the model (PROC MIXED) were change in BCS (no change or gain vs. loss), cows expressed estrus at or prior to AI (activated, partially activated, or lost Kamar) or not (intact Kamar), age of the dam (2, 3 to 6 and >6 years), days post calving at initiation of synchronization (30 to 60, 61 to 80 and > 81 days) and appropriate 2-way interactions. Season (location) and AI sires were considered as random effects.

General linear model procedure was sued to determine the differences in the AI pregnancy among season (spring and Fall), locations (N=11), and AI sires (N=13).

Results

There were 1227 spring cows and 1346 fall ~~cows1346~~ cows. The mean body condition change was different between–season (Spring: 0.45 ± 0.03 vs. Fall -0.22 ± 0.03; $P<0.05$). The mean body condition score changes ~~were~~ among locations were significantly different (Fig 2). The range for BCS difference was -3 to + 3

The results showed AI pregnancy rate – to be influenced by change in the BCS [Table 1; No change or gain: 55.3%; (1034/1870) vs. loss: 50.1% (352/703); $P<0.05$] - Cows that showed estrus at or prior to AI were also different [Table 1; estrus: 57.8% (825/1423) vs. no estrus: 48.9% (560/1148); $P<0.0001$]. No interactions were observed ($P>0.1$). No differences in AI pregnancy (%) were observed for dam's age ($P>0.1$) and days post calving ($P>0.1$).

There was no difference in AI pregnancy between seasons (Fig 3; $P>0.1$). The AI pregnancy ranged from 50.4 to 66.7% for locations. Among locations, the AI pregnancy differed significantly (Fig 4; $P<0.05$). AI pregnancy for AI sires ranged from 49.0 to 71.3%. The AI pregnancy differed among AI sires (Fig 5; $P<0.05$).

Discussion

In this study, we observed that cows that lost body condition during the first 2 months after breeding had decreased odds of becoming pregnant to AI compared to cows that maintained or gained body condition. In spite of the facts that fertilization occurs in 90% of inseminated cows, only 60% of those diagnosed to be pregnant at 60 days post breeding indicating that there is estimated 30 % pregnancy wastage from fertilization to 60 days post breeding due to various reasons.[5] Several factors contribute to low AI pregnancy. The greatest of these risk factors is acute body condition loss.

Management of energy intake to maintain body condition in lactating cows that are being bred is a considerable challenge. Spring-calving cows that are grazing high quality pastures after breeding are more easily managed. However, even in these cows some individuals experience BCS loss, perhaps associated with higher energy demands for milk production. Summer drought conditions also influenced BCS in some locations. Fall-calving cows are dependent on stockpiled forages and supplemental feeds during the time from breeding to pregnancy diagnosis. An economical compromise was sought in these herds to maintain body condition with the least amount of supplementation.

Studies exist reporting body condition loss and reproductive performance~~s~~ influenced by the body condition loss from calving –to breeding.[6-8] These studies focused on the effect of nutrition on resumption ovarian cyclicity, duration of anestrus period post calving and/or proportion of anestrus cows at the beginning of breeding season. Duration of anestrus period post-calving is a key factor and is variable in the beef cows. Evidence suggests that cows that lose body condition have a longer postpartum interval to first ovulation. Follicular growth generally resumes within a week to two in the majority of cows associated with a transient follicle-stimulating hormone (FSH) rise that occurs within 3-5 days of parturition.[5] Beef cows with calf alongside in good body condition normally have 30 days to first ovulation whereas beef cows in poor body condition have 70 to 100 days to first ovulation.[5] The lack of ovulation of dominant follicles during the post-partum period is associated with infrequent luteinizing hormone (LH) pulses, with both suckling and low level of nutrition being implicated in the prolonged suppression of LH pulses in the absence of progesterone. The key to optimizing resumption of ovulation in beef cows is appropriate pre-calving nutrition and management so that cows calve in an optimal body condition (body condition score; BCS; 5 to 6) with post-partum body condition loss restricted to <0.5 BCS units.

In this study, we evaluated the effect of body condition loss during 2 months after breeding. There are several key factors regulating embryonic development during first 60 days of gestation. Leptin, originally described as a regulator of food intake and energy balance, was found to play a critical role in reproductive function.[9] Leptin promotes preimplantation embryo development.[10] This is supported by evidence that blastocysts cocultured with endometrial epithelial cells modulate leptin secretion.[9] Adiponectin is another cytokine that plays an important role in regulating energy homeostasis, specifically lipid and glucose metabolism.[11] Recent data suggest that adiponectin can also directly regulate reproductive and placental processes.[12] Adiponectin can play a complementary role in the regulation of several key female reproductive functions. It has been demonstrated that adiponectin is involved in the modulation of ovarian and endometrial functions, influencing periovulatory remodeling of the ovarian follicle, and steroid synthesis/secretion, as well as energy supply, and inflammatory response of endometrial cells.[13-15] Adiponectin has also been involved embryonic development and implantation supported by its expression in rat embryos and uterus and adiponectin receptors expression during the mid-secretory phase that corresponds to the embryo implantation window in human, mouse and pigs.[16-19] These findings strongly suggests that maintenance of body condition and energy status is critical during early gestation.

In this study, there was difference in AI pregnancy among locations. It should be noted that the number of cows lost or gained body condition differed among locations. The increase in BCS might have been associated with the increase in forage availability and quality during winter and spring months supported by the BCS difference was different between the fall and spring in this study. The BCS gains in cows could be explained by increased intake of energy and/or nutrients. In addition, increased forage availability and quality have been associated with reduced grazing energy cost by decreasing grazing time.[20] It should be noted that there was no difference in AI pregnancy between seasons. It is plausible that the gain or loss in body condition was associated with the individual cow needs.

Blood concentrations of glucose, insulin and insulin-like growth factor-I (IGF-I) are indicative of the availability of energy, and provide short- or long-term signals that mediate the effects of nutrition on reproduction.[3] In agreement with the BCS maintenance, recovery or gain, the total protein and albumin concentrations increased and urea and NEFA decreased which would indicate a better nutritional status[21] and decreased mobilization of reserves from muscle[22] and adipose tissue[23], respectively. Similarly, serum NEFA was reduced in beef cows as range forage quantity and quality improved.[24] It should be noted that adipose depot depletion and associated increase in adiponectin alter cytokine production. This alteration in cytokines may initiate neuroendocrine signals to interfere with feed intake.[21-24] So cows that loose body condition may not be interested in feed intake which may further prolong the decrease in essential metabolites involved and hence affect the reproductive performance. The economic benefit of a beef operation is directly related to pounds of beef produced per cow per year. In order to maximize the production not only the cow need to become pregnant but also it should become pregnant early in the breeding season. Cows that loose body condition take more time to become pregnant and thus incurring economic loss to beef producers. It is also conceivable that cow with poor body condition may lose its pregnancy and need to become pregnant again after early embryonic death during the breeding season.

There are several studies focus on alternative approach to address this by supplementing essential fatty acid and amino acids; however, further studies needed to focus on increasing key makers that are important for early pre- and peri-embryonic development, and placental development.

In conclusion, cows that lost body condition after breeding had lower AI pregnancy rates compared to cows that maintained or gained body condition. It is essential to feed cows following breeding to maintain their BCS and optimize their reproductive performance.

Appreciation

The authors express appreciation to the following for support of this work: Virginia Department of Corrections- Agribusiness, The Powell River Project, Nancy M Cummins Research Extension and Education Center in Caldwell, ID.

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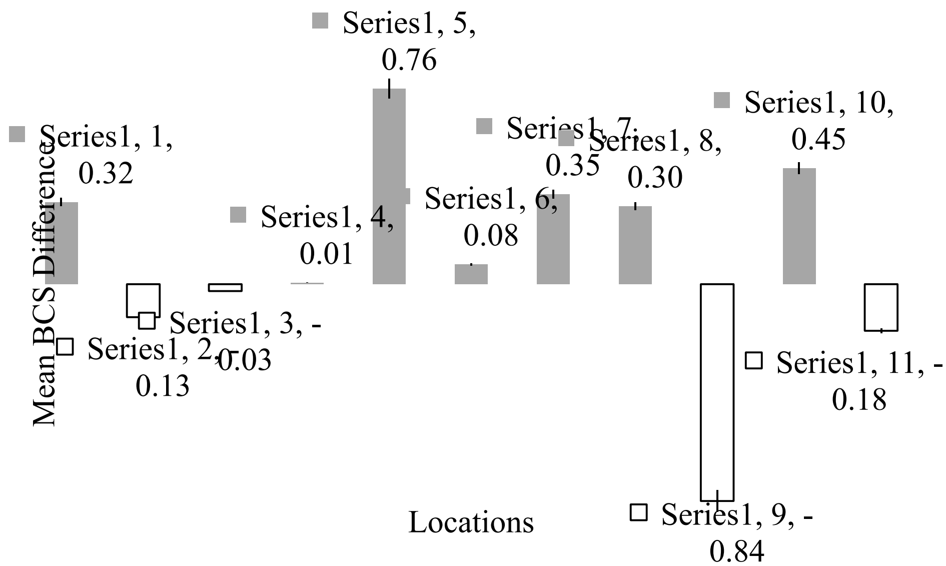
Table 1. Logistic regression for the effect of body condition change from breeding to pregnancy diagnosis at 2 months post AI and estrus status at or before the time of AI on the odds of pregnancy in beef cows

						95% CI	
Predictor	Coefficient	SE Coefficient	Z	*‘P’* value	Odds Ratio	Lower	Upper
Constant	-0.05555	0.059197	-0.94	0.348			
Estrus status	0.370487	0.079877	4.64	0	1.45	1.24	1.69
Body condition change	0.072708	0.037397	1.94	0.052	1.08	1	1.16

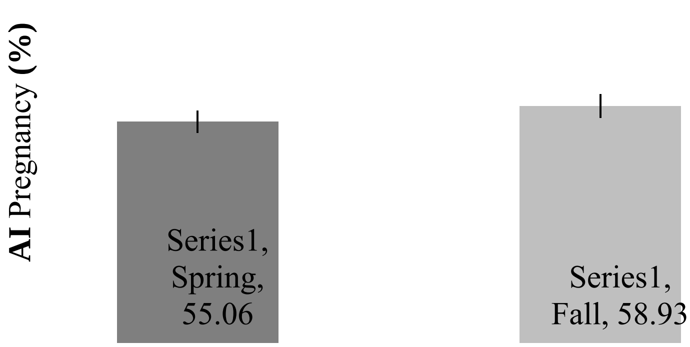
CI – Confidence Interval; SE – Standard error;
Accounted for season (location) and AI-sires;

Fig 2. Mean (± SEM) body condition difference for cows in different locations.



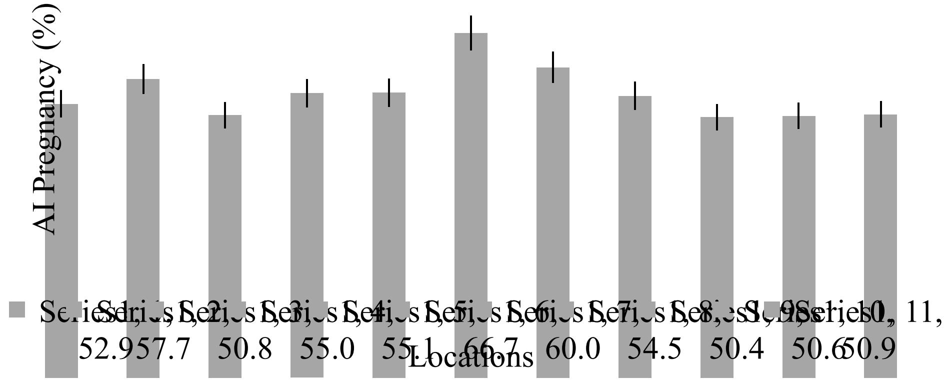
Mean BCS difference differed among locations (P<0.05).

Fig 3. Mean AI pregnancy (%) differences in Angus cross beef cows inseminated during fall and spring season.



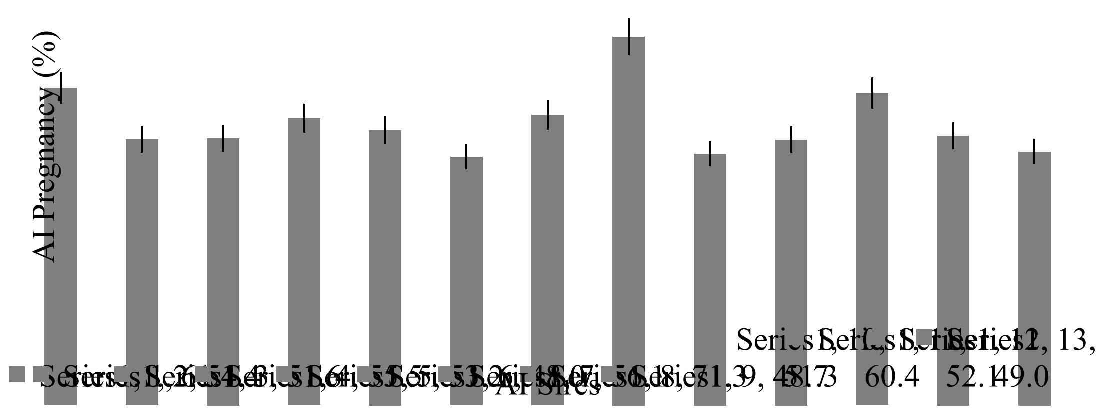
No differences in AI pregnancy (%) between seasons (P>0.1)

Fig 4: Mean AI pregnancy (%) differences in Angus cross beef cows inseminated in different ~~locations~~ locations



Differences in AI pregnancy (%) observed between different locations (P<0.05)

Fig 5: Mean AI pregnancy (%) differences in Angus cross beef cows inseminated using different AI sires



Differences in AI pregnancy (%) observed between different locations (P<0.05);
Locations 1, 2, 3, and 8 were both fall and spring locations.