Effect of body condition at initiation of synchronization on estrus expression, pregnancy rates to AI and breeding season in beef cows

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Abstract

The objective was to examine the influence of body condition score (BCS) at synchronization initiation on estrus and pregnancy rates. Data were retrospectively collected from beef cattle breedings that occurred between fall 2003 and spring 2008 on 12 beef farms. The cows (N=5510) included in the analysis were synchronized with progesterone based CO-Synch or Ovsynch protocols. The BCS (1-emaciated; 9-obese) of all cows were recorded on Day 0 of synchronization at the time of insertion of a controlled internal drug release device (CIDR; Eazi-Breed™ CIDR®, Pfizer Animal Health, New York, NY). At the time of CIDR removal, pressure sensitive mount detectors (Kamar Heatmount® detector, Kamar Products, Inc., Zionsville, IN) were placed on all cows to aid in identification of cows displaying estrus until artificial insemination (AI). Cows were inseminated at observed estrus or at a fixed time and bulls (approximately 1:40 bull:cow ratio) were introduced 14 days after AI and maintained for a 45 to 50 d breeding period to impregnate cows that failed to conceive to AI. Cows were examined for pregnancy at 55 to 70 days and again at 120 days after AI. The BCS ranged from 3 to 8. The expression of estrus, AI and breeding season pregnancy rates were influenced by BCS ($P<0.05$). The estrus expression rates were 41.8%, 40.5%, 50.5%, 53.0%, 56.4% and 40.4% for BCS 3 to 8, respectively. The fixed-time AI pregnancy rates were 36.7%, 47.4%, 51.8%, 52.9%, 50.9% and 44.9% for BCS from 3 to 8, respectively. Breeding season pregnancy rates were 74.7%, 78.2%, 86.4%, 90.2%, 89.9%, and 87.9% for BCS from 3 to 8, respectively. In conclusion, a minimum BCS of 5 should be achieved prior to the breeding season to ensure acceptable reproductive performance in beef cows managed on forage.

Keywords: Beef cows, body condition score, synchronization, estrus expression, pregnancy

Introduction

In a beef cattle operation, failure of cows to become pregnant during a breeding season of 85 days is the most important factor reducing net calf crop.[1] Optimum reproduction in beef cows is often limited by prolonged postpartum anestrous intervals. Suckling and nutrition are major regulators of the duration of the postpartum anestrous interval. Reduced nutrient intake prepartum results in thin cows at calving, a prolonged postpartum anestrous interval, and fewer cows in estrus during the breeding season.[2,3] Greater postpartum nutrient intake can enhance the secretion of luteinizing hormone (LH) and follicular growth. Metabolites and metabolic hormones could mediate the effects of nutrient intake on reproductive function.[4,5]

Effects of nutrition on reproduction may be more pronounced in thin and fat cows than in cows with moderate body condition. Sufficient body energy reserve is necessary for acceptable reproductive performance. Body condition score has been shown to be a good practical and applicable indicator of body energy reserves when compared to body weight.[6,7] Body condition score at calving and nutrient supply during the early postpartum period affect the return to ovarian cyclic activity and subsequent pregnancy rates.[8,9] The BCS of 5 at calving is critical to ensure acceptable postpartum reproduction in mature cows. However the change in BCS after calving may influence the reproductive outcome.

The objective of this study was to determine the influence of body condition score at initiation of synchronization (30 to 90 d postpartum) on estrus expression rate and pregnancy rates for the AI and natural breeding seasons.

Materials and methods

Cattle and synchronization protocols

Data used in this study were retrospectively collected from fall 2003 to spring 2008 beef cattle breedings that occurred on 12 Virginia Correctional Center beef farms. Angus crossbred beef cows (N=5510) from 12 locations (six spring and six fall breeding locations) were synchronized with Ovsynch-CIDR or CO-Synch-CIDR protocols (Figure 1). Cows (N=2176) synchronized with the Ovsynch-CIDR protocols received 100 µg of gonadotropin-releasing hormone (GnRH; Cystorelin®, Merial, Athens, GA) and a CIDR on Day 0, 25 mg prostaglandin F2α (PGF, Lutalyse®, Pfizer Animal Health, New York, NY) and CIDR removal on Day 7, 100 µg GnRH 48 h after PGF on Day 9, and fixed-time AI 16 h after GnRH on Day 10. Cows (N=3334) synchronized with the CO-Synch-CIDR protocol received 100 µg GnRH and a CIDR device on Day 0, 25 mg PGF and CIDR removal on Day 5 (5-d CO-Synch-CIDR; N=830) or 7 (7-d CO-Synch-CIDR; N=2504), and 100 µg GnRH on Day 10 at the time of AI, 72 h (5-d CO-Synch-CIDR) or 66 h (7-d CO-Synch-CIDR) after CIDR removal. Cow BCS were recorded on Day 0 of synchronization.

Estrus detection

At the time of CIDR removal, all cows received a pressure sensitive mount detector to aid in identification of cows displaying estrus. Cows were observed for at least 30 minutes in the morning, at noon and late afternoon on Day 8, 9 and 10. A cow was determined to be in estrus if it was observed to stand for mounting or had an activated (color change from white to red), lost (with mount marks) or partially activated pressure sensitive mount detector. Bulls (approximately 1:40 bull:cow ratio) were introduced 14 days after AI and maintained for a 45 to 50 d breeding period.

Pregnancy determination

The pregnancy status of each cow was determined 55 to 70 d after fixed time AI either by per-rectal palpation or by trans-rectal ultrasonography (Sonosite® 180 Plus™, Sonosite Inc., Bothell, WA)

Reproductive parameters

Estrus expression rate was calculated by dividing the number of cows that expressed estrus by number of cows that received a pressure sensitive mount detector; AI pregnancy rate (PR) was calculated by dividing the number of cows that become pregnant to AI by number of cows inseminated; breeding season PR was calculated by dividing the number of cows pregnant following AI and natural service exposure by total number of cows exposed to breeding.

Data management

Cows were excluded from the analysis if they failed to calve during the season or if they received the synchronization treatment within 30 days of calving or 90 days after calving. Cows inseminated at observed estrus in 2004-05 were included in the analysis to account for AI pregnancy. Five-d CO-Synch CIDR and 7-d Co-Synch CIDR were pooled as CO-Synch-CIDR [5-d CO-Synch-CIDR AI-PR = 53.1% (291/548) vs. 7-d Co-Synch-CIDR AI-PR=50.5% (1406/2786); P=0.26. Note that data for two doses of PGF were excluded from 5-d CO-Synch-CIDR data from 2006 fall breeding[10]]. Cows were inseminated by experienced (with previous experience of a minimum of 1000 inseminations) technicians and clinicians. Inseminators randomly inseminated cows at each location. Since most inseminations occurred on the same day across several locations, different groups of inseminators inseminated cows at different locations, AI technicians were not included in the model. Sires were selected to avoid inbreeding and assigned randomly within locations. During a single breeding season, all AI sires were not utilized in all farms. Also, the number of cows inseminated was low for some sires; hence, AI sires was offered as a random effect.

Statistical analyses

The data were analyzed using a statistical software program (SAS Version 9.1 for Windows, SAS Institute, Cary, NC). The mixed procedure was used to evaluate differences in estrus expression rates, AI and breeding season pregnancy rates among the body condition scores. The data were managed to provide appropriate contemporaries for comparisons. The independent variables included in the estrus expression rate model were location (12), breeding season-year nested within location, BCS (3 to 8), days post-calving at protocol initiation (31 to 40; 41 to 50; 51 to 60; 61 to 70; 71 to 80; 81 to 90), dam age groups (2, 3 to 6 and ≥7 years) synchronization protocol × BCS, breeding season × BCS and breeding season × dam age groups. The independent variables included in the AI pregnancy rate model were location, breeding season-year nested within location, BCS, days post-calving at protocol initiation, dam age groups, synchronization protocol (Ovsynch-CIDR and CO-Synch-CIDR), synchronization protocol × BCS, synchronization protocol × age groups, breeding season × BCS and breeding season × dam age groups. The independent variables included in the breeding season pregnancy rate model were location, breeding season-year nested within location, BCS, dam age groups, breeding season × BCS and breeding season × dam age groups.

Results

Mean ± SE values of BCS and age of cows from different locations are shown in Table 1. Body condition scores ranged from 3 to 8. The estrus expression rate for all cows was 51.8% (2854/5510). The AI pregnancy for all cows was 51.5% (2835/5510) and the breeding season pregnancy for all cows was 87.9% (4843/5510).

Estrus expression

Accounting for location, breeding season-year location, age groups and days post-calving, estrus expression was influenced by BCS (Table 2; P<0.05). Estrus expression rates were 41.8%, 40.5%, 50.5%, 53.0%, 56.4% and 40.4% for BCS 3 to 8, respectively (Figure 2). Estrus expression rates were ranged from 37.2% to 54.8% for days post-calving (Figure 3) and were significantly different among age groups (Table 5). Decreased number of two-year-old cows expressed estrus compared to older groups. No interactions of breeding season × body condition score and breeding season × dam age groups were observed (P>0.1).

AI pregnancy rate

The AI pregnancy rate ranged from 48.3 to 56.4%. Accounting for location, breeding season-year location, synchronization protocol and days post-calving, pregnancy to AI was influenced by BCS (Table 3; P<0.05). Pregnancy rates to AI were 36.7%, 47.4%, 51.8%, 52.9%, 50.9% and 44.9% for BCS 3 to 8, respectively (Figure 2). Pregnancy rates to AI ranged from 42.1% to 54.5% for days post-calving (Figure 3) but did not differ among age groups (Table 5; P>0.1). The AI pregnancy rates were not different between the Ovsynch-CIDR (52.3%) and CO-Synch-CIDR (50.9%) protocols (Table 6; P<0.05). However, AI and breeding season pregnancy rates between the fall breeding season (52.9%) and the spring breeding season (50.1) were significantly different (Table 6; P<0.05). In addition, AI pregnancy rates varied among locations (Figure 4; P<0.05). No interactions of synchronization protocol × body condition score, breeding season × body condition score and breeding season × dam age groups (P>0.1) were observed.

Breeding season pregnancy

Breeding season pregnancy rates ranged from 78.7% to 95.4% and were influenced by BCS (P<0.05; Table 5). The breeding season pregnancy rates were 74.7%, 78.2%, 86.4%, 90.2%, 89.9%, and 87.9% for BCS from 3 to 8, respectively. No differences between breeding season pregnancy rates were detected among age groups (Table 5). However, breeding season pregnancy rates between the fall breeding season (92.9%) and the spring breeding season (86.8%) were significantly different (Table 6;

P<0.05). The breeding season pregnancy varied among locations (Figure 4; P<0.05). No interactions of breeding season × body condition score were observed (P>0.1).

Discussion

The results of this study indicate that the BCS at breeding influenced estrus expression, and AI and breeding season pregnancy rates. Reduced nutrient intake during the prepartum period increases the interval from parturition to first estrus in beef cows.[8,11,12] Restricted energy suppresses the hypothalamic secretion of luteinizing hormone releasing hormone (LHRH). However the mechanisms through which restricted energy intake suppresses LHRH may be through alterations in the growth hormone (GH), insulin like growth factor (IGF)-1, and IGF binding protein (IGFBP) axis in response to nutritional stress.[13] The IGF-1 was greater between two and ten weeks post-calving in cows that resumed ovarian cyclicity than in cows that remained anestrus.

Days post-calving and age of dam significantly affected estrus expression. Estrus expression rates increased as the days post-calving increased. Decreased number of two-year-old cows expressed estrus compared to older cows. Primiparous cows utilize energy for growth after parturition which results in a low LH pulse frequency and longer postpartum anestrous interval, one to four weeks longer than in multiparous cows.[14]

In the current study, cows with BCS 5, 6 and 7 achieved greater than 50% AI pregnancy rates (Figure 2). Lake, et al., showed that first service conception rates were 36.1% for cows with BCS 4 and 50.0% for cows with BCS 6.[15] The authors of that study suggested that the cows should be managed to achieve a BCS of >4 before parturition to improve reproductive success. They also showed that cows with BCS 4 at parturition are capable of maintaining this body condition score during lactation.

Dietary energy restriction has a negative impact on reproduction. Among cows that lost body condition during the mid-trimester of gestation, those that increased their nutrient intake one to three months before calving had substantially improved pregnancy rates compared to cows that continued to lose body condition until parturition.[6] However, cows that maintained body condition from mid-gestation until calving had a greater pregnancy rate than cows that lost and regained body condition.

Reproductive performance is decreased in primiparous compared to mature cows. The stress of calving, lower intakes of high forage diets and the requirements for growth and lactation impose nutritional demands that are often not met. Inadequate nutrient intake before or after calving has a greater detrimental effect on reproduction in heifers than in cows. Heifers bred to calve at two years of age resume ovarian cyclicity 20 to 40 days later than mature cows. Doornbos, et al., reported that multiparous cows have greater pregnancy rates than heifers.[16] Kress, et al., evaluated calving rates among young multiparous cows and found that cows ≥ 5 years old had a greater calving rate than young cows.[17] Renquist, et al., demonstrated a quadratic relationship between age and pregnancy rate and concluded that reproductive performance of ten-year-old cows decreased.[18] However, they suggested that age was not a significant determinant when BCS was included in the model and concluded that the effect of age is associated with the decreasing BCS of older cows at breeding. In the current study, the AI pregnancy rates were not different among age groups (P>0.1). This may be attributed to a good heifer management and nutritional program in these locations. It is interesting to note that the estrus expression rate was lower for the two-year-old cows compared to older cows.

Breeding season pregnancy rates were influenced by BCS (P<0.05; Figure 4). The breeding season pregnancy rates were 76.4%, 84.7%, 88.0%, 90.2%, 89.2%, and 87.0% for BCS 3 to 8, respectively; and AI and breeding season pregnancy rate between fall and spring were significantly different. More cows were pregnant during the fall compared to the spring season. In Virginia the primary grasses during spring are fescue (*Festuca arundinacea*), bluegrass (*Poa pratensis*) and clover (*Trifolium pratense*). Fescue toxicity and heat stress may play a role in reduced pregnancy during the spring season compared to fall. In females, the fescue endophyte may affect ovarian gamete maturation, ovulation, gamete transport and fertilization, conceptus transport, and/or embryo attachment and the effects on the postpartum anestrous interval are possibly caused by neurohormonal imbalances that lead to improper ovarian function.[19-21] The possible effects endophyte-infected fescue in the male include sperm production, sperm motility, libido, and testicular development.[22] These effects may be reflected in this study by reduced AI and breeding season pregnancy rates in spring compared to fall.

Days post-calving at protocol initiation significantly influenced the AI pregnancy rate. It is interesting to note that the days post-calving also affected estrus expression rates indicating that the late calving cows are still under the influence of postpartum anestrus. However if the cows were in moderate body condition they become pregnant. Lents, et al., showed that BCS at calving influenced the size of the dominant follicle at the first postpartum estrus in mature suckled cows and suggested that cows be managed to calve in moderate BCS.[23] There were no differences in the AI and breeding season pregnancy between Ovsynch-CIDR and CO-Synch-CIDR synchronization protocols. No interactions between synchronization protocols by BCS and between synchronization protocols by days post-calving were observed.

A progesterone-supplemented protocol is recommended for improving fertility by inducing cyclicity in anestrous postpartum beef cows. If anestrus is the problem, then all cows should benefit from progesterone-supplemented synchronization protocols. The results indicated that cows with BCS 5 to 7 achieved > 50% AI pregnancy. Ciccioli, et al., concluded neither BCS at calving nor postpartum nutrition influenced estrous behavior at the first postpartum estrus.[24] They suggested that the lack of effect of BCS at calving on reproductive performance in that study could be related to the minimal differences in BCS of the thin and moderate condition cows at calving, or that all cows had less than optimal BCS at calving for adequate performance. Spitzer, et al., demonstrated that BCS 4 to 6 at calving influences the duration from parturition to estrus.[25] They also found greater pregnancy rates for cows with a BCS of 6 at parturition compared with cows with a BCS of 4 or 5. Greater nutrient intake postpartum can have a positive effect[26-28] or no effect[29-32] on duration of the postpartum anovulatory interval. Results of other experiments indicate that postpartum energy intake may influence pregnancy rate at the first postpartum estrus,[11,33] however, the effect of energy intake on pregnancy rate was not significant. Reduced nutrient intake during estrous cycles did not affect fertilization rate[3] but did reduce conception rate.[34] Lack of consistency among studies may involve the amount of energy intake, duration of the feeding period, BCS at calving, BCS change during postpartum period, and age of cows. Fuel sensors, such as glucose, insulin or leptin, are known to be directly involved in the regulation of fertility at each level of the hypothalamus-pituitary-gonadal axis. Ciccioli, et al., suggested that the concentrations of IGF-1, leptin, insulin, glucose, nonesterified fatty acid, or thyroxin in blood may not individually signal the onset of postpartum ovarian function, but they may act in concert with other factors to indicate the adequacy of nutrients.[24] So it is plausible that differences in endocrine function or metabolic signals during the postpartum period could influence ovarian activity and fertility.

In summary, the BCS of beef cows at the time of initiation of synchronization protocol influenced estrus expression, AI and breeding season pregnancy rates. A minimum BCS of 5 should be achieved prior to the breeding season to ensure acceptable reproductive performance. Further research is needed to elucidate the mechanism(s) that control postpartum ovarian activity and estrous behavior to maximize reproductive efficiency in beef cattle. Lipid biomarkers play a key role in reproduction. It would be of interest to investigate the impact of different types of lipid biomarkers, perhaps integrated into feed, on ovulation capacity and embryonic development.

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Table 1. Mean ± SE values of body condition score and age of beef cows in different locations.

Season	Location	Body Condition Score	Age (y)
Fall	1	5.27 ± 0.05	4.79 ± 0.11
	2	6.31 ± 0.09	5.47 ± 0.38
	3	5.53 ± 0.04	5.62 ± 0.13
	4	5.43 ± 0.05	4.23 ± 0.06
	5	5.64 ± 0.03	4.02 ± 0.08
	6	5.55 ± 0.06	4.18 ± 0.16
Spring	7	5.54 ± 0.12	5.38 ± 0.25
	8	5.28 ± 0.05	5.23 ± 0.25
	9	5.79 ± 0.40	4.24 ± 0.62
	10	5.21 ± 0.04	4.44 ± 0.34
	11	5.65 ± 0.08	4.36 ± 0.29
	12	5.17 ± 0.10	5.19 ± 0.22

Table 2. The General Linear Model for the effects on estrus expression rate of Angus-cross beef cows (N=5510).

Source	d.f.	Sum of Squares	*F* ratio	Prob > *F*
Location	11	82.4517	4.1268	<0.0001
Breeding Season-year within location	44	63.4232	6.6214	<0.0001
Body Condition Score*	5	2.2319	4.1246	<0.0338
Days post-calving at protocol initiation†	5	5.8309	18.3948	<0.0015
Age group‡	2	2.9817	5.9985	<0.03238

d.f – degrees of freedom;
*1-emaciated and 9-obese;
†Days post-calving groups: 31-40; 41-50; 51-60; 61-70; 71-80 and 81-90;
‡Age groups: 2; 3-6 and >6

Table 3. The General Linear Model for the effects on AI pregnancy rate of Angus-cross beef cows (N=5510).

Source	d.f.	Sum of Squares	*F* ratio	Prob > *F*
Location	11	16.6242	4.1253	<0.0001
Breeding Season-year within location	44	58.5227	23.2381	<0.0001
Body Condition Score[§]	5	2.0121	3.6128	<0.0313
Days post-calving at protocol initiation[¶]	5	11.1174	3.9213	<0.0001
Age group[**]	2	1.2158	1.5781	<0.3316
Synchronization protocol[††]	1	5.2459	24.5168	<0.0123
Synchronization protocol by body condition score	5	0.0216	0.6921	<0.4571
Breeding season by body condition score	11	0.04328	0.7081	<0.6570
Synchronization protocol by days post-calving at protocol initiation	5	0.0721	0.7218	<0.8212

d.f – degrees of freedom;
[§]1-emaciated and 9-obese;
[¶]Days post-calving groups: 31-40; 41-50; 51-60; 61-70; 71-80 and 81-90;
[**]Age groups: 2; 3-6 and >6;
[††]Refer to Figure 1 for treatment;

Table 4. The General Linear Model for the effects on breeding season pregnancy rate of Angus-cross beef cows (N=5510).

Source	d.f.	Sum of Squares	*F* ratio	Prob > *F*
Location	11	14.4218	22.1246	<0.0001
Breeding Season-year within location	44	87.2445	7.8351	<0.0001
Body Condition Score[‡‡]	5	2.4513	4.7862	<0.0211
Age group[§§]	2	3.2193	0.5781	<0.2714
Breeding season by body condition score	11	1.6739	0.8463	<0.5438

d.f – degrees of freedom;
[‡‡]1-emaciated and 9-obese;
[§§]Age groups: 2; 3-6 and >6;

Table 5. Effect of age of the dam (in years) on the AI and breeding season pregnancy* in Angus cross beef cows (N=5510)

Age groups	N	Estrus Expression Rate (95% CI)	AI-PR (95% CI)	Breeding season PR (95% CI)
2	1317	47.9 (43.1, 50.9)[a]	53.5 (48.2-57.6)[a]	86.8 (81.1, 90.8)[a]
3 to 6	2920	54.0 (49.7, 57.8)[b]	52.7 (48.2-56.7)[a]	87.7 (80.9, 94.1)[a]
> 6	1273	50.8 (47.1, 53.1)[b]	50.3 (41.4-53.3)[a]	88.7 (84.3, 91.4)[a]

[ab] different superscripts within column are statistically significant, P<0.05;
CI – Confidence Interval
PR – Pregnancy rate

Table 6. Effect of synchronization protocol, breeding season on the AI and breeding season pregnancy* in Angus cross beef cows (N=5510).

Source	Level	N	AI-PR (95% CI)	Breeding season PR (95% CI)
Synchronization¶¶	Ovsynch-CIDR	2176	52.3 (48.9, 57.4)[a]	87.4 (83.4, 91.7)[a]
	CO-Synch-CIDR	3334	50.9 (48.2, 53.7)[a]	88.2 (81.8, 93.6)[a]
Breeding season	Spring	2816	50.1 (48.9, 52.4)[a]	86.8 (83.8, 89.6)[a]
	Fall	2694	52.9 (49.6, 55.4)[b]	89.0 (85.6, 93.3)[b]

[ab] Different superscripts within source and between level are different ($P<0.01$)

¶¶Refer to Figure 1 for treatment

CI – Confidence Interval

PR – Pregnancy rate

CIDR – Controlled internal drug release device

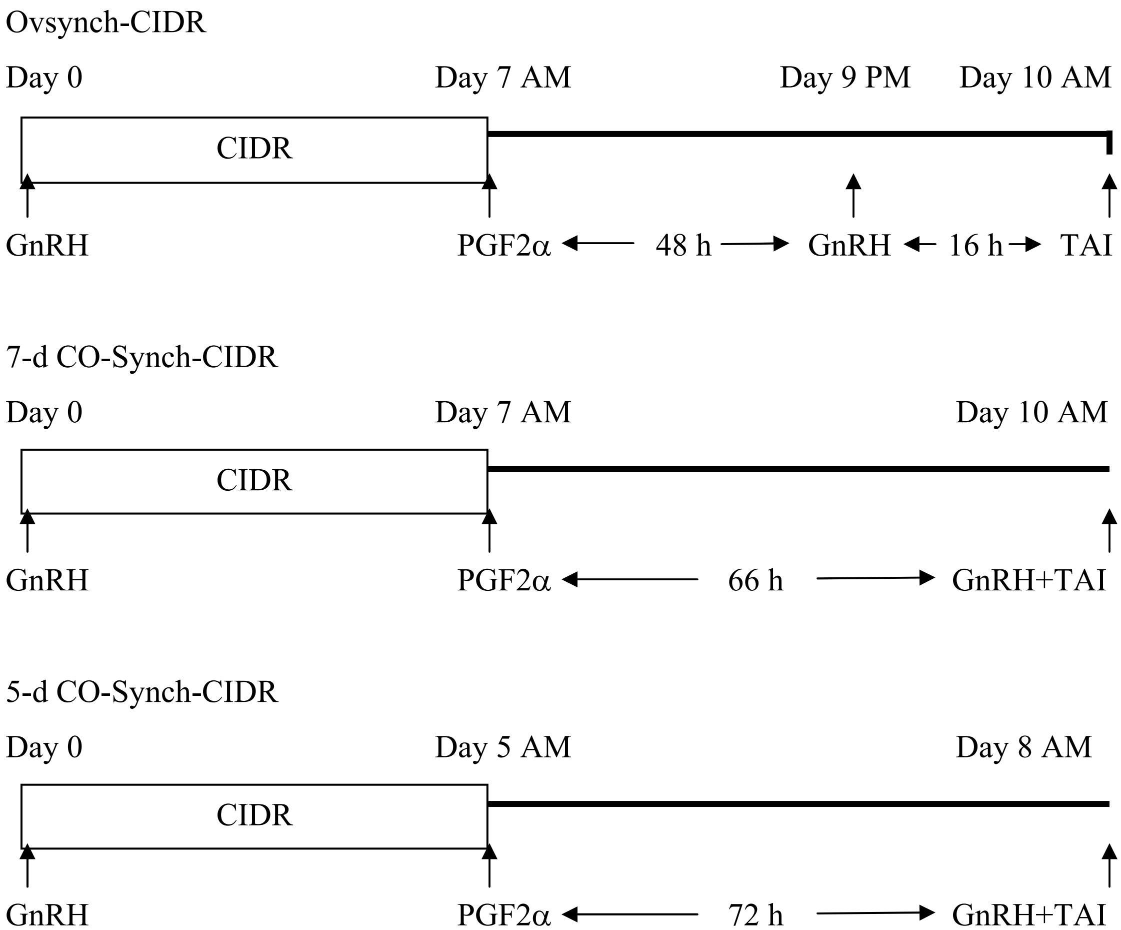
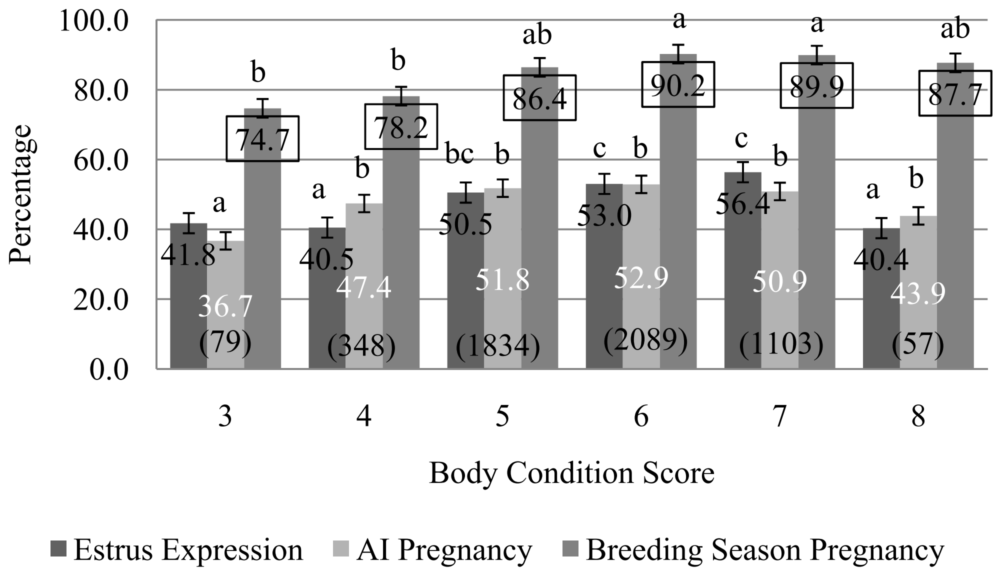
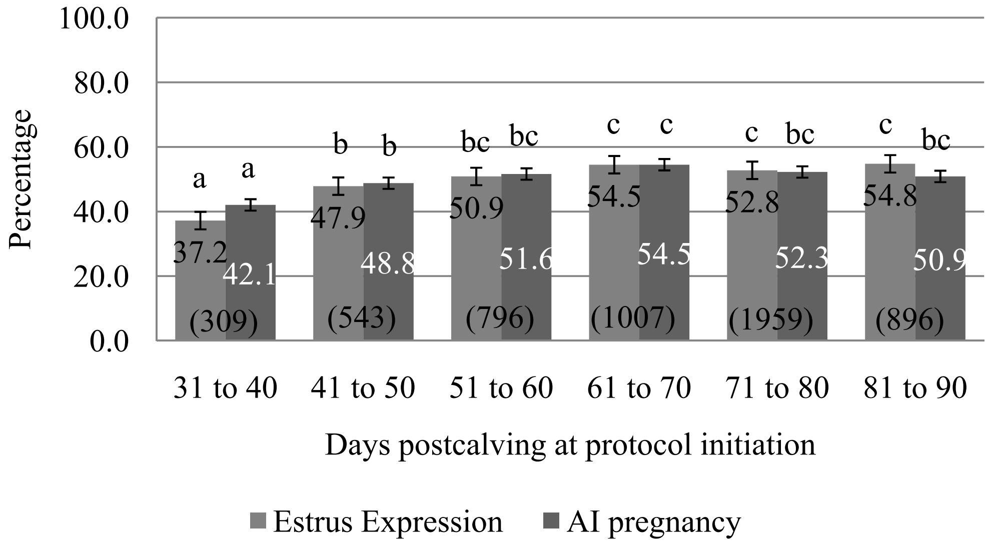


Figure 1. Treatment protocols for estrous synchronization. Angus crossbred beef cows (N = 5510) from 12 locations (six spring and six fall breeding locations) were synchronized with Ovsynch-CIDR, or CO-Synch-CIDR protocols. Cows synchronized with Ovsynch-CIDR protocols received 100 μg gonadotropin-releasing hormone (GnRH; Cystorelin®, Merial, Athens, GA) + controlled internal drug release device (CIDR; Eazi-Breed™ CIDR®, Pfizer Animal Health, New York, NY) on Day 0, 25 mg prostaglandin F2α (PGF; Lutalyse®, Pfizer Animal Health) and CIDR removal on Day 7, 100 μg GnRH 48 h after PGF on Day 9, and fixed-time AI 16 h after GnRH on Day 10. Cows synchronized with CO-Synch-CIDR protocols received 100 μg GnRH + CIDR device on Day 0, 25 mg PGF and CIDR device removal on Day 5 (5-d CO-Synch-CIDR; N=830) or 7 (7-d CO-Synch-CIDR; N=2504), and 100 μg GnRH on Day 10 at the time of AI, 72 h (5-d CO-Synch-CIDR) or 66 h (7-d CO-Synch-CIDR) after CIDR removal. Cow BCS (1-emaciated; 9-obese) were recorded on Day 0 of synchronization. Five-d CO-Synch CIDR and 7-d Co-Synch CIDR were pooled as CO-Synch-CIDR for the analysis.



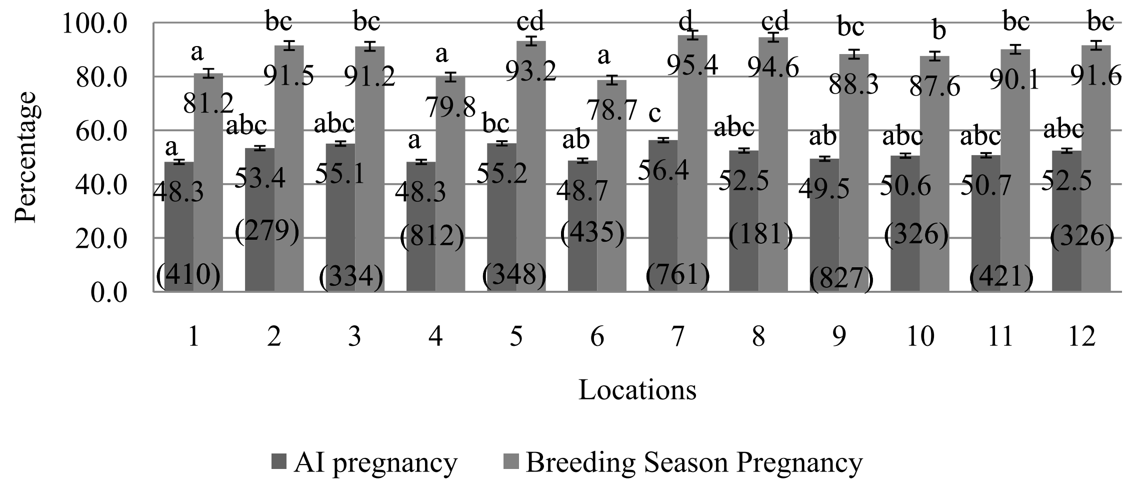
r[abc] Different superscripts within estrus expression are statistically significant ($P<0.05$)
[ab] Different superscripts within AI pregnancy are statistically significant ($P<0.05$)
[ab] Different superscripts within breeding season pregnancy are statistically significant ($P<0.05$)

Figure 2. Influence of body condition score on on estrus expression, and AI and breeding season pregnancy (Mean percentage ± SEM) in cows (N=5510) following porgesterone supplemented synchronization protocol. Numbers in paenthesis are number of cows for the corresponding body condition scores. Numbers in black are percentage of cows expressed estrus. Numbers in white are percentage of cows pregnant to AI. Numbers in the box are percentage of cows pregnant for the breeding season pregnancy.



[abc] Different superscripts within AI pregnancy are statistically significant (P<0.05)
[abc] Different superscripts within AI pregnancy are statistically significant (P<0.05)

Figure 3. Effect of days post-calving at protocol initiation on estrus expression and AI pregnancy (Mean percentage ± SEM) in cows (N=5510) following porgesterone supplemented synchronization protocol. Numbers in parenthesis are number of cows for the corresponding days post-calving. Numbers in black are percentage of cows expressed estrus. Numbers in white are percentage of cows pregnant to AI. Numbers in the box are percentage of cows pregnant for the breeding season pregnancy.



[ab] Different superscripts are statistically significant ($P<0.05$)

Figure 4. Effect of locations (N=12) on AI pregnancy (Mean percentage ± SEM) in beef cows (N=5510) synchronized with progesterone supplemented protocols. Numbers in parenthesis are number of cows inseminated from the corresponding location.