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Importance of estrus expression before fixed-time AI on conception rates in beef cattle[1]

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SUMMARY

Expression of estrus prior to fixed-time AI has been reported to strongly impact overall pregnancy success. Behavioral estrus is a visual indicator that a cow or heifer's internal environment is prepared for breeding. Insemination of a cow or heifer after estrus has been expressed will yield greater pregnancy success due to adequate uterine environment, increased fertilization rates, increased accessory sperm numbers, and increased overall embryo survival. It can be difficult to analyze the effects of estrus on pregnancy success across studies due to differences in number of animals and proportion of animals exhibiting estrus per study. In order to accurately analyze such data, a meta-analysis was used to place all studies on an equal level, thus, eliminating study bias. In the present study, a meta-analysis was conducted using data available on 10,116 beef cows and heifers in 26 studies that utilized the 5 most common fixed-time AI protocols to examine the effect of expression of estrus prior to insemination on conception rates. The overall model indicated a positive effect of estrus on conception rates with cows expressing estrus before fixed-time AI having greater conception rates compared with those not exhibiting estrus. There are also numerous management factors that can influence expression of estrus. Data were available on 547 cows that were synchronized with a CIDR based fixed-time AI protocol for estrus for 2 to 4 years. Analysis of these cows indicated that days postpartum did not impact estrus expression. In contrast, Body Condition Score (BCS) influenced estrus expression with cows in a BCS of ≤ 4 having decreased expression of estrus compared to those with a BCS > 4. Initiation of estrous cycles before the breeding season also influenced estrus expression, with anestrous cows having greater expression of estrus compared with estrus-cycling cows. Fixed-time AI protocols offer producers the added benefit of reduced labor needed for heat detection, but the results of this study indicate the importance of detecting an animal in estrus prior to breeding. In conclusion, among all currently recommended fixed-time AI protocols, cows expressing estrus before fixed-time AI had improved conception rates, and BCS and estrus-cycling status had the greatest influence on expression of estrus.

INTRODUCTION

Profitability of cow-calf operations depends largely on the success of the breeding programs implemented. Development of fixed-time AI protocols that eliminate the need for heat detection greatly benefits operations where labor is limited. While these protocols are more time-efficient, detecting an animal in estrus prior to breeding will lead to better conception rates. Fixed-time AI protocols induce ovulation with an injection of GnRH regardless of whether an animal has or has not expressed estrus. Ovulation prior to estrus may lead to decreases in conception rates due to inadequate estrogen concentrations, which creates a suboptimal uterine environment needed for sperm survival (Perry and

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Perry, 2008). In a study conducted on heifers, those that showed estrus within 24 hr of fixed-time AI had increased follicle diameter, estrogen concentrations, and pregnancy rates than heifers that did not show estrus (Perry et al., 2007). Similar results have been reported in mature cows, with cows detected in estrus at fixed-time AI having higher pregnancy rates than cows that did not express estrus (Perry et al., 2005; Whittier et al, 2013; Thomas et al, 2014). The economic incentive of increased pregnancy rates from incorporating heat detection into fixed-time AI protocols could outweigh the disadvantage of labor costs.

To maximize estrus expression in the herd, certain management factors should be considered. Days postpartum and BCS work together to play a large role in estrus expression of cattle. Cows should be allowed an appropriate amount of time to recover after calving before beginning an AI protocol in order to maximize pregnancy rates. The first fertile estrus generally occurs about 40-60 d after calving in beef cattle, but this is largely dependent on nutritional status. Beef cows that have attained adequate body condition (approximately a BCS of 5) and that have had a longer postpartum period prior to the beginning of the breeding season will begin cycling earlier than those that have not. Therefore, the objective of this study was to examine the influence estrus expression prior to fixed-time AI on conception rates and to determine management factors affecting estrus expression in beef cattle.

MATERIALS AND METHODS

Data was available on 10,116 animals from 26 different studies (Table 1) that utilized one of the 5 most common fixed-time AI protocols with conventional semen on beef cows or heifers. These protocols included CO-Synch, CO-Synch+CIDR, 5-d CIDR, PG 6-d CIDR, and 14-d CIDR (for description and discussion of synchronization protocols see http://www.iowabeefcenter.org/estrus_synch.html). Studies used in the analysis reported conception rates of animals that did and did not show estrus prior to or at fixed-time AI. An omnibus Chi-square meta-analysis was conducted using data analysis software in order to accurately analyze these multiple studies with varying sample sizes.
For the subset of animals used to examine factors influencing estrus expression, data were available on 547 cows that were synchronized with a CIDR based fixed-time AI protocol for 2 to 4 years. Data for days postpartum, estrus-cycling status at the start of the synchronization protocol, BCS, and estrus expression prior to fixed-time AI were used in the analysis. This data was analyzed using data analysis software.

RESULTS AND DISCUSSION

The results from the meta-analysis indicate a 27% improvement in AI conception rate among animals that expressed estrus compared to animals that did not express estrus ($P < 0.01$; 95% CI = 22% to 32%; Figure 1). Days postpartum did not impact estrus expression ($P = 0.22$), but cows in a BCS of ≤ 4 (51 ± 5%) had decreased expression of estrus than those with a BCS > 4 (≥ 70 ± 4%). Anestrous cows had greater expression of estrus compared with estrus-cycling cows ($P = 0.03$; 78 ± 5% versus 70 ± 5%, respectively).

This study indicates the importance of estrus expression for pregnancy success. A 27% improvement in AI conception rates translates into an economically significant value for beef operations. Estrus expression was not affected by days postpartum in the present study. This can be attributed to the management of the herds included in the analysis, as very few animals were bred at less than 40 days postpartum. Body condition was shown to impact estrus expression, with under-conditioned animals having decreased expression of estrus. Cows that have not reached adequate condition at calving will take longer to start cycling, thus, failing to show estrus. Unexpectedly, anestrous cows (cows there were

not having normal estrous cycles prior to the start of the synchronization protocol) had greater estrus expression than estrus-cycling cows. The reason behind this could be that anestrous cows may respond to synchronization protocols better than estrus-cycling cows. Studies have found that anestrous cows express estrus earlier and with decreased time to estrus variation after injection of prostaglandin during a fixed-time AI compared to cycling cows. Although anestrous cows tend to express estrus more readily than cycling cows, it has been shown that anestrous cows still have lower conception rates than cycling cows. Because estrus-cycling cows could be at any stage of the estrous cycle at the time of synchronization, they may not respond as well as animals that are not cycling at all, therefore, having decreased estrus expression. While not every animal that is cycling will display behavioral estrus, breeding those that do after they are detected in estrus can be beneficial. Incorporation of heat detection (either by observing estrus or using an estrus detection aid to determine prior expression of estrus) into fixed-time AI breeding programs should be considered for improvements in pregnancy success, leading to greater economic gains.

LITERATURE CITED

Bridges, G. A., J. K. Ahola, C. Brauner, L. H. Cruppe, J. C. Currins, M. L. Day, P. J.Gunn, J. R. Jaeger, S. L. Lake, G. C. Lamb, G. H. Marquezini, R. K. Peel, A. E. Radunz, J. S. Stevenson, and W. D. Whittier. 2012. Determination of the appropriate delivery of prostaglandin F2α in the five-day CO-Synch + controlled intravaginal drug release protocol in suckled beef cows. J. Anim. Sci. 90:4814-4822.

Bridges, G. A., S. l. Lake, S. G. Kruse, S. Bird, B. J. Funnell, R. Arias, J. A. Walker, J. K. Grant, and G. A. Perry. 2014. Comparison of three CIDR-based fixed-time AI protocols in beef heifers. J. Anim.Sci. 92:3127-3133.

Geary, T. W., E. R. Downing, J. E. Bruemmer, and J. C. Whittier. 2000. Ovarian and estrous response of suckled beef cows to the Select Synch estrous synchronization protocol. Prof. Anim. Sci. 16:1-5.

Geary, T. W, J. C. Whittier, D. M. Hallford., and M. D. MacNeil. 2001. Calf removal improves conception rates to the Ovsynch and Co-Synch protocols. J. Anim. Sci. 79:1-4.

Hill, S. L., G. A. Perry, V. R. G. Mercadante, G. C. Lamb, J. R. Jaeger, KC Olson, and J. S. Stevenson. 2014. Altered progesterone concentrations by hormonal manipulations before a fixed-time artificial insemination (TAI) CO-Synch + CIDR program in suckled beef cows. Theriogenology. 82:104-113.

Kasimanickam, R., M. L. Day, J. S. Rudolph, J. B. Hall, and W. D. Whittier. 2009. Two doses of prostaglandin improve pregnancy rates to timed-AI in a 5-day progesterone-based synchronization protocol in beef cows. Theriogenology. 71:762-767.

Lares, S. F., S. D. Fields, B. L. Perry, D. G. Chen, and G. A. Perry. 2008. Relationship between uterine pH at fixed-time AI and pregnancy success in beef cattle. J. Anim. Sci. 86(E-Suppl. 2): Abstr 721.

Mallory, D. A., J. M. Nash, M. R. Ellersieck, M. F. Smith, and D. J. Patterson. 2011. Comparison of long-term progestin-based protocols to synchronize estrus before fixed-time artificial insemination in beef heifers. J. Anim. Sci. 89:1358-1365.

Martin, N. T., J. M. Thomas, J. M. Nash, D. A. Mallory, S. E. Poock, M. F. Smith, and D. J. Patterson. 2014. Comparison of a 16- versus a 19-day interval between controlled internal drug release removal and prostaglandin F2α following a 14-day controlled internal drug release treatment and fixed-time artificial insemination in postpartum beef cows. J. Anim. Sci. 92:1759-1767.

Nash, J. M., D. A. Mallory, M.R. Ellersick, S.E. Poock, M. F. Smith, and D. J. Patterson. 2012. Comparison of long- versus short-term CIDR-based protocols to synchronize estrus prior to fixed-time AI in postpartum beef cows. J. Anim. Sci. 132:11-16.

Perry, G. A., M. F. Smith, M. C. Lucy, J.A. Green, Parks, T. E., A. J. Roberts, M. D. MacNeil and T. W. Geary. 2005. Relationship between follicle size at ovulation and pregnancy success in beef cattle. Proceedings of the National Academy of Science. 102:5268-5273.

Perry, G. A., M. F. Smith, A. J. Roberts, M. D. MacNeil, and T. W. Geary. 2007. Relationship between size of ovulatory follicle and pregnancy success in beef heifers. J. Anim. Sci. 85:684-689.

Perry, G. A. and B. L. Perry. 2008. Effect of preovulatory concentrations of estradiol and initiation of standing estrus on uterine pH in beef cows. Dom. Anim. Endo. 34:333-338.

Perry, G. A., B. L. Perry, and C. A. Roberts. 2011. Estrous response following the PG 6-d CIDR protocol for heifer that do and do not exhibit estrus prior to CIDR insertion and its usefulness as a fixed-time AI protocol. J. Anim. Sci. 89(E-supp. 2): Abstr. 63.

Swanson, O. L., J. K. Grant, K. L. Gebhart, L. K. Kill, and G. A. Perry. 2012. Impact of initiation of standing estrus at time of a controlled internal drug releasing device insertion on fertility in beef heifers. J. Anim. Sci. 90(supp 2): Abstr. 339P.

Thomas, J. M., S. L. Lock, S. E. Poock, M. R. Ellersieck, M. F. Smith, and D. J. Patterson. 2014. Delayed insemination of nonestrous cows improves pregnancy rates when using sex-sorted semen in timed artificial insemination of suckled beef cows. J. Anim. Sci. 92:1747-1752.

Whittier, W. D., J. F. Currin, H. Schramm, S. Holland, and R. K. Kasimanickam. 2013. Fertility in Angus cross beef cows following 5-day CO-Synch + CIDR or 7-day CO-Synch + CIDR estrus synchronization and timed artificial insemination. Theriogenology. 80:963-969.

Table 1. Study details for meta-analysis. Protocol 1: Co-Synch; 2: Co-Synch + CIDR; 3: PG 6-day CIDR; 4: 5-day; 5: 14-16 day; 5.1: 14-19 day

STUDY	REFERENCE	PROTOCOL	N	MATURITY
1	*SDSU Cow Camp 2010*	1	68	Cows
2	*Lares et al., 2006*	1	214	Cows
3	*Perry et al., 2005*	1	173	Cows
4	*Perry et al., 2005*	1	108	Heifers
5	*SDSU Cow-Calf Unit, 2009*	2	119	Cows
6	*SDSU Antelope Station, 2013*	2	298	Cows
7	*SDSU Cow Camp, 2008*	2	35	Cows
8	*Hill et al., 2013*	2	1667	Cows
9	*SDSU Cow-Calf Unit, 2012*	2	41	Heifers
10	*Nash et al., 2012*	2	177	Cows
11	*Thomas et al., 2014*	2	218	Cows
12	*Swanson et al., 2012*	3	292	Heifers
13	*SDSU Cow Camp, 2008*	3	38	Heifers
14	*Bridges et al., 2014*	3	126	Heifers
15	*SDSU Cow Camp, 2011*	3	82	Cows
16	*Perry et al., 2011*	3	366	Heifers
17	*Whittier et al., 2013*	2, 4	1817	Cows
18	*Bridges et al., 2014*	4	133	Heifers
19	*SDSU Cottonwood Station, 2013*	4	124	Heifers
20	*Bridges et al., 2012*	4	2421	Cows/Heifers
21	*Kasimanickam et al., 2009*	4	830	Cows
22	*Bridges et al., 2012*	5	135	Heifers
23	*Mallory et al., 2011*	5	77	Heifers
24	*Nash et al., 2012*	5	167	Cows
25	*Martin et al., 2014*	5	194	Cows
26	*Martin et al., 2014*	5.1	196	Cows

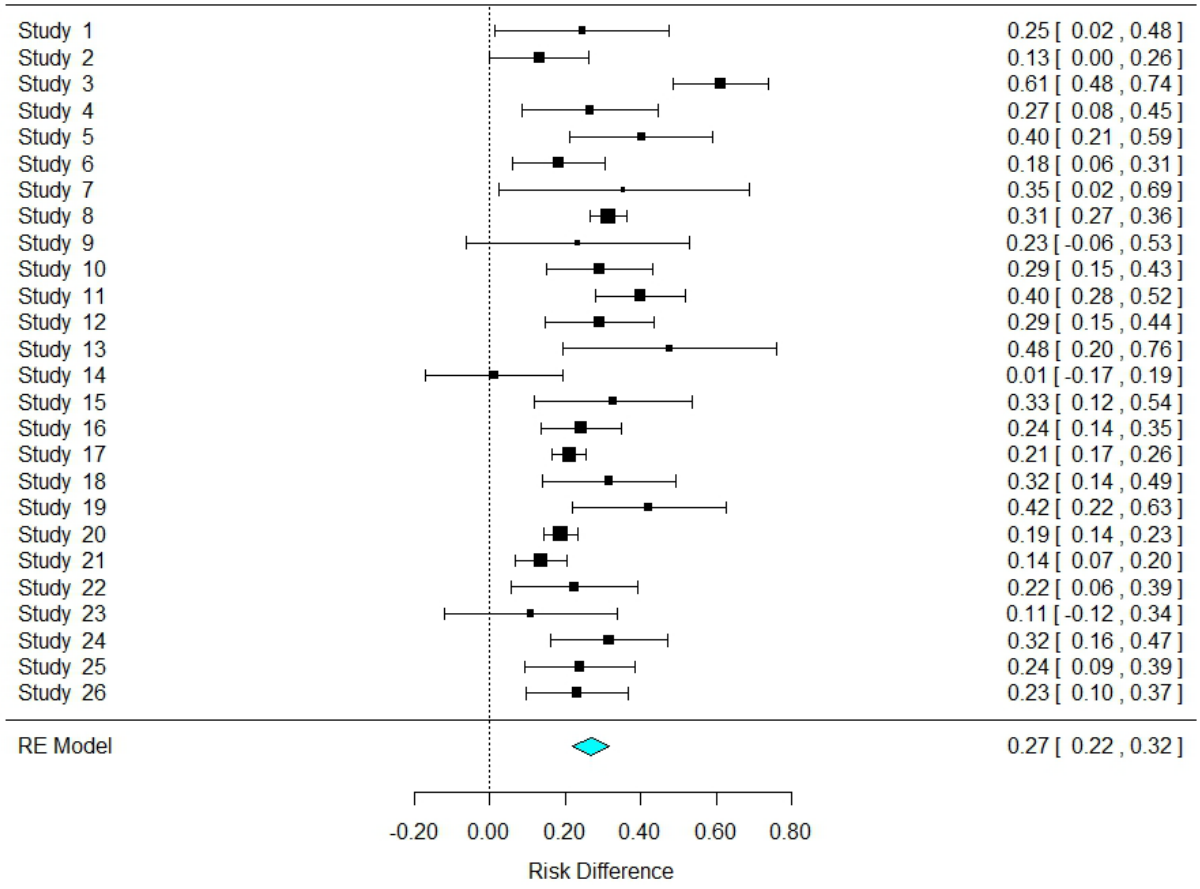

Figure 1. Means and standard errors from the 26 studies listed in Table 1 used in the Meta-analysis. The overall (RE) model indicates a 27% ± 5% increase in conception rates among animals that exhibited estrus prior to fixed-time AI.