Effects of natural service and artificial insemination breeding systems on pregnancy rates and days to conception

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The objectives of this study were to determine pregnancy rates and days to conception in a breeding system that incorporates estrous synchronization and fixed-time artificial insemination with the use of cleanup bulls versus a traditional bull breeding system. For the current experiment, cattle receiving a timed artificial insemination had reduced days to conception; however, pregnancy rates increased if cattle were cyclic at the start of the breeding season when receiving a timed artificial insemination treatment versus the noncyclic timed artificial insemination treatment group. Cattle producers may observe improved pregnancy rates in cyclic cattle than noncyclic cattle and also see a greater proportion of calves born earlier in the calving season if they implement a fixed-time artificial insemination protocol.

Summary

Crossbred beef cows and heifers (n = 480 and 86, respectively) were used to compare the effects of two breeding systems on pregnancy rates and days to conception. Cattle were stratified by age and body condition score (BCS), and assigned randomly to one of two treatments: 1) Females exposed to natural service bulls for the duration of the breeding season (NS; n = 284) or 2) females exposed to estrous synchronization and a fixed-time AI [d 0; 7-d Co-Synch + CIDR (Busch et al., 200)], followed by exposure to natural service bulls for the duration of the breeding season (TAI, n = 282). Bulls were introduced on day one and both treatments were managed as a cohort in the same pastures. Blood samples were collected on day minus 20 and minus 10 to determine cyclic status. On day 49 and again at least 40 days after bull removal from pastures, transrectal ultrasonography was used to determine pregnancy status and fetal age. Overall, 42.8 percent of cattle were cyclic at the beginning of the breeding season. Treatment by cyclic status interactions ($P < 0.01$) were present for the proportion of cows detected pregnant on the first pregnancy check (day 49), the proportion of cows pregnant at the end of the breeding season and days from the beginning of the breeding season to conception.

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A greater proportion ($P < 0.05$) of cyclic cattle in the TAI (88 percent) had a viable fetus detected on the first pregnancy check compared with cyclic cattle in the NS treatment (74 percent), noncyclic cattle in the TAI treatment (75 percent) and noncyclic cattle in the NS treatment (77 percent). A greater proportion ($P < 0.05$) of cyclic cattle in the TAI treatment (94 percent) was pregnant at the end of the breeding season, compared with noncyclic cattle in the TAI treatment (84 percent), whereas cyclic (88 percent) and noncyclic (89 percent) cattle in the NS treatment were intermediate. Both cyclic (11.6 ± 1.4 d) and noncyclic (14.5 ± 1.4 d) cattle in the TAI treatment became pregnant earlier in the breeding season ($P < 0.05$) compared with cyclic (19.9 ± 1.4 d) and noncyclic (17.9 ± 1.4 d) cattle in the NS treatment. Breeding systems for beef cattle that incorporated TAI altered pregnancy rates and decreased days to conception, compared with natural service breeding systems.

Introduction

The area of production very critical in terms of profit potential in beef cow-calf operations is the ability of a cow to give birth and raise a healthy calf until weaning (Dickerson, 1970). Reproductive performance is variable among herds (Larson et al., 2006; Dahlen et al., 2010) and estimates indicate the beef industry loses $2.8 billion in revenue as a result of infertility (Lamb et al., 2011). Incorporating estrous synchronization (ES) and AI into beef operations may result in improved reproductive performance, weaning weight, carcass quality and genetic value, along with reduced calving difficulty (Sprott, 2000).

The implementation of fixed-time AI protocols has resulted in similar pregnancy rates to protocols that require heat detection (Lemaster et al., 2001) without added labor for heat detection. These fixed-timed AI protocols allow every cow in the herd an opportunity to become pregnant on the first day of the breeding season.

Experiments have used cleanup bulls after the use of ES and AI (Geary et al., 2001; Stevenson et al., 1997) but lack the use of a traditional breeding system as a control. Natural service with no ES protocol needs to be used as a control to determine the overall effect of an ES and AI breeding system. For example, Sa Filho et al. (2009) reported significantly greater pregnancy rates when AI and ES were used compared with natural service in *Bos indicus* cattle.

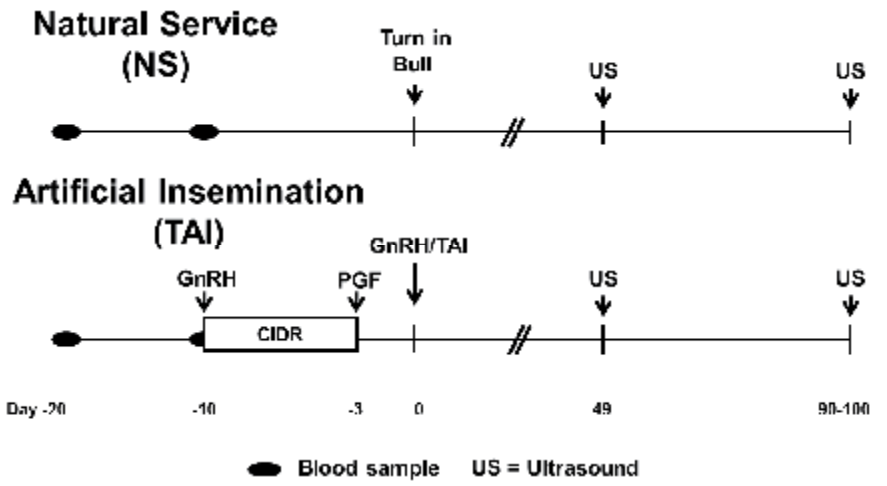
Due to the limited number of studies comparing various breeding systems, the current experiment was designed to examine reproductive efficiency in cattle treated to a fixed-time AI followed by cleanup bulls versus a natural service breeding system. Moreover, these findings will help cattle producers better decide the management for their operation.

Procedures

This project was approved by the Institutional Animal Care and Use Committee of North Dakota State University. A combination of crossbred Angus cows and heifers (n = 566) were used in two locations: 1) Central Grasslands Research Extension Center (CGREC; n = 86 heifers and n = 405 cows) and 2) Hettinger Research Extension Center (HREC; n = 81 cows). All animals were stratified by age, BCS and days postpartum (cows only), then assigned to one of two treatments in a completely randomized design: 1) natural service (NS, n = 284), exposed to natural service bulls for the duration of the breeding season or 2) artificial insemination (TAI, n = 282), exposed to ES [7-d Co-Synch + CIDR (Larson et al., 2006)] and a fixed-time AI (day 0) followed by exposure to natural service bulls (cleanup bulls) for the duration of the breeding season.

Bulls were turned out to pastures with all cattle on day one, and both treatments were managed as

Figure 1. Schematic of experimental treatments



a cohort in the same pastures. All bulls passed a breeding soundness exam (Barth et al., 2000) and were stocked at a rate of 30 cows/bull and 15 heifers/bull. The breeding season for the CGREC and HREC was 49 and 63 days, respectively.

Blood samples for all females were collected on day minus 20 and minus 10 via coccygeal venipuncture into 10 milliliters Vacutainer tubes containing sodium heparin (BD, Franklin Lakes, N.J) and analyzed for concentrations of progesterone. Cattle were considered cyclic if progesterone levels were greater than 1 nanogram per milliliter (ng/mL) (Perry et al., 1991).

Transrectal ultrasonography (Aloka 500 with a 5 MHz linear probe) was used to determine the presence of a viable fetus on day 49 (to determine if pregnancy was due to AI) and again at least 40 days after the bulls were removed from breeding pastures. The crown-rump length of each fetus identified was measured as a determinant of fetal age.

Results and Discussion

At the initiation of the breeding season, 42.8 percent of all cattle were cyclic. The mean days postpartum was 65.6 days (range of 21 to 99 days) for suckled cows at the time of 0 (the day of AI for cattle in the TAI treatment). Treatment by cyclic status interactions ($P < 0.01$) were observed for the proportion of cows detected pregnant on day 49, the proportion of cows pregnant at the end of the breeding season and days from the beginning of the breeding season to conception (days to conception).

A greater proportion ($P < 0.05$) of cyclic cattle in the TAI treatment (88 percent, 104 of 118) had a viable fetus detected on day 49 of the breeding season, compared with cyclic cattle in the NS treatment (74 percent, 88 of 119), noncyclic cattle in the TAI treatment (75 percent, 122 of 163) and noncyclic cattle in the NS treatment (77 percent, 120 of 156).

Geary et al. (2001) reported no difference in TAI pregnancy rates between cyclic and non-cyclic cattle receiving two different ES protocols. In contrast, Stevenson et al. (1997) stated cyclic cattle that receive ES and AI had greater pregnancy rates to AI than noncyclic cattle.

Overall pregnancy rates to the AI for cattle in the TAI treatment were 55 percent in the current study. The use of the ES and AI allowed more cattle to become pregnant on the first day of the breeding season. This reduction in the number of nonpregnant cows at the start of the breeding season would allow bull stocking rate to be reduced. The bulls needed for an operation that utilizes ES and AI on a whole herd basis may be reduced by half, recouping most, if not all, expenses needed for ES and AI (Johnson and Jones, 2008).

Producers should evaluate the bull purchase price, maintenance and health costs, and interest on purchases and compare them with the additional costs of ES and AI to determine whether this is a management practice that would improve profitability for their operation. In addition, nutritional status of cattle and compliance with ES protocol schedules need to be excellent to obtain satisfactory pregnancy rates from AI and cleanup bull breedings.

A greater proportion ($P < 0.05$) of cyclic cattle in the TAI treatment (94 percent, 111 of 118) were pregnant at the end of the breeding season, compared with noncyclic cattle in the TAI treatment (84 percent, 136 of 162), whereas cyclic (88 percent, 105 of 119) and noncyclic (89 percent, 140 of 157) cattle in the NS treatment were intermediate. Interestingly, fewer noncyclic cattle in the TAI treatment were pregnant at the final pregnancy check, compared with cyclic cattle in the TAI treatment.

In contrast to our study, Stevens et al. (1997) reported no differences in final pregnancy rates among cyclic and noncyclic of cows and heifers that received an ES protocol with an injection of GnRH. Another note, although different within the TAI treatment, season-ending pregnancy rates were similar between cattle in the TAI treatment and cattle in the NS treatment. This goes against a common theory that states ES protocols may initiate cyclicity in a proportion of noncyclic cattle and result in greater overall pregnancy rates at the end of the breeding season compared with a system of natural service breeding.

The discrepancy between our season-ending pregnancy rates and stated theory require further verification to substantiate common industry claims.

Cyclic (11.6 ± 1.4 d) and noncyclic (14.5 ± 1.4 d) cattle in the TAI treatment became pregnant earlier in the breeding season ($P < 0.05$), compared with cyclic (19.9 ± 1.4 d) and noncyclic (17.9 ± 1.4 d) cattle in the NS treatment. The decreased days to conception are due primarily to the greater proportion of cattle bred to AI on the first day of the breeding season. The reduction in days to conception potentially could reduce the calving season length and labor needed with a more concentrated calving season (Sprott, 1999).

However, the length of the calving season is dictated by the

length of the breeding season. Rodgers et al. (2012) reported the calving date was altered by ES and AI, but the length of the calving season was not different, compared with that of the natural service treatment. If days to conception are a true indication of date of calving in the current study, cattle in the TAI treatment would have calves earlier in the calving season with the potential to be heavier at weaning.

Cattle producers who implement a timed artificial insemination breeding system may see reduced days to conception and an increase in their cyclic cattle pregnancy rates. This study still is ongoing, and calving season and calf performance will be evaluated to determine the weaning and postweaning effects of the two different breeding systems. In addition, cattle will be managed according to their assigned breeding system for multiple years to look at the long-term effects of AI breeding systems compared with bull breeding.

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