Effects of breeding system of origin (natural service or artificial insemination) on growth, attainment of puberty and pregnancy rates in crossbred beef heifers

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The objective of this study was to examine the growth, attainment of puberty and pregnancy rates of females born from artificial insemination (AI) or natural service. Results indicate that heifers born to dams exposed to an AI breeding system were heavier than heifers born to dams exposed solely to a natural service breeding system at weaning, despite similar weights of heifers from each breeding system at the initiation of the breeding season. In addition, similar proportions of heifers were cyclic throughout the development period, and pregnancy rates were similar among heifers born from each respective breeding system.

Summary

The objective of this study was to compare growth, attainment of puberty and pregnancy rates in beef heifers originating from two different breeding systems. One hundred and ninety crossbred Angus heifers were born to dams that were exposed to one of two treatments: 1) natural service (**NS**, cows were exposed to herd bulls only for the duration of the breeding season) or 2) fixed-time artificial insemination (**TAI**, cows exposed to ovulation synchronization and AI followed by natural-service bulls). Body weights were taken on days 0 and 189, with a mean age of 209 ± 1.2 days at the initiation of the trial (day 0). Blood samples were collected at days 0, 10, 112, 122, 219 and 229, and progesterone concentrations were used to determine the proportion of females that had attained puberty at different points during the development period. On day 229, synchronization of ovulation was initiated (7-d CO-Synch + CIDR) and all heifers were inseminated with a single TAI. Cleanup bulls were placed in breeding pastures 10 days after AI and remained with heifers until 56 days post-AI. Pregnancy rates were determined via transrectal ultrasonography on days 27 and 91 after AI. Body weight at initiation of the experiment was greater (P = 0.01) for heifers in the TAI treatment (527.8 ± 6.4 pounds), compared with heifers in the NS treatment (505.1 ± 6.2 pounds). However, no differences ($P \geq 0.14$) between treatments were observed in weights of heifers taken at the time of pasture turnout (day 189; 760.6 ± 7.5 and 744.9 ± 7.5 pounds for TAI and NS, respectively), or daily gain (1.23 ± 0.02 and 1.28 ± 0.02 pounds/day for AI and NS, respectively). At the initiation of the experiment, a greater proportion of the NS heifers (11.6 percent) tended (P = 0.06) to be cyclic, compared with TAI heifers (4.2 percent). However, no differences ($P \geq 0.40$) were observed between treatments in the proportion of heifers that were cyclic at the interim evaluation (days 112 and 122, 27.5 percent cyclic) or at the initiation of the breeding season (days 219 and 229, 85.5 percent cyclic). No differences ($P \geq 0.81$) were present between treatments in pregnancy rates to AI (32.9 percent) or season-ending pregnancy rates (91.1 percent). The breeding system of origin did not influence growth rate during the development phase, attainment of puberty or pregnancy rates in crossbred beef heifers.

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Introduction

Calving date can influence the productiveness of a female as well as her subsequent progeny's performance. Heifer calves born in the first 21 days of the calving period have lower birth weights than heifers born later in the calving season while also having higher weaning weights (Funston et al., 2012).

Older and heavier heifers may become pubertal earlier than those born later in the calving season because females generally reach puberty at a time relative to their projected mature body weight and frame size (Fox et al., 2013). Those females that reach puberty 45 days before the start of any breeding program will be beneficial to the herd because they will have several estrus cycles prior to insemination, and may conceive early in the breeding season (Hall, 2013) and experience more estrus cycles prior to breeding.

A common recommendation is for heifers to calve at 2 years of age because young heifers may need more time to recover and often are bred earlier than cows (Day and

Nogueira, 2013), therefore reproductive efficiency may be lower if females are bred at pubertal estrus. A greater proportion of heifers bred at the third estrus became pregnant when compared with heifers bred at the pubertal estrus (Byerley et al., 1987).

A major factor in the determination of the herd lifespan of a female is the onset of puberty and the ability of that female to become pregnant every year. The use of estrus synchronization would allow for the selection of heifers that become pregnant early in the breeding season (Gutierrez et al., 2014). Those heifers that become pregnant early in the breeding season and calve in the first 21 days of the calving season remain in the herd for a greater amount of time when compared with those that calve later (Cushman et al., 2013).

Our previous research has highlighted the fact that incorporating AI into a management scheme resulted in older, heavier calves at weaning, compared with a breeding systems that relied solely on natural service breeding (Steichen et al. 2012). The objective of this study was to evaluate the postweaning growth, attainment of puberty and pregnancy rates of beef heifers originating from artificial insemination or natural service breeding systems.

Experimental Procedures

One hundred ninety Angus-based crossbred virgin heifers were managed at the Central Grasslands Research Extension Center in Streeter, N.D. Heifers were born to dams randomly assigned to one of two treatments; 1) exposed to herd bulls for the duration of the breeding season (natural service; **Control**, n = 95) and 2) exposed to ovulation synchronization and fixed-time AI followed by natural-service bulls for the duration of the breeding season (Timed AI; **TAI**, n = 95).

At the start of the experiment, females were weaned (day 0), housed in a drylot for a 189-day wintering period (days 0 to 189) and then turned out to pasture for summer grazing (day 189), breeding (day 239) and ultrasound pregnancy examinations (days 266 and 320; Figure 1). Body weights were collected on two consecutive days prior to the morning feeding at the start (days minus 1 and 0) and end of the feeding period (days 188 and 189), which also coincided with pasture turnout.

Blood samples were collected via jugular venipuncture or tail venipuncture in 10-milliliter Vacutainer tubes (BD Worldwide, Franklin Lakes, N.J.) at the beginning (days 0 and 10), middle (days 112 and 122) and end (days 219 and 229) of the developmental period. Blood samples were analyzed for concentrations of progesterone via a radioimmunoassay to determine the proportion of cyclic females before the onset of breeding. Heifers were defined as cyclic at each point of the development period when either or both samples in the 10-day interval had concentrations of progesterone of ≥ 1 nanogram per milliliter (ng/mL).

Prior to ovulation synchronization and breeding, 45 heifers were culled from the herd to achieve herd management objectives, resulting in 145 heifers remaining to be bred (Control; n = 66 and AI; n = 79). All remaining females were exposed to ovulation synchronization (7-d CO-Synch + CIDR) consisting of the insertion of a controlled internal drug-releasing insert (CIDR, 1.38 grams [g] Progesterone, Zoetis Inc., Florham, N.J.) and 100 micrograms (µg) Gonadotrophin Releasing Hormone (GnRH) i.m. (2 mL Factrel, Zoetis Inc.), followed in seven days by CIDR removal and 25 milligrams (mg) of $PGF_{2\alpha}$ i.m. (5 mL Lutalyse, Zoetis Inc.), followed in 54 ± 2 hours by 100 µg GnRH i.m. and fixed-time AI (day 239 AI). Cleanup bulls were placed in breeding pastures 10 days after AI and remained with cows and heifers for 46 days (day 295).

Transrectal ultrasonography (5-MHz intrarectal transducer, Aloka 500V, Corometrics, Wallingford, Conn.) was used to determine the presence of a viable fetus (via detection of fetal heartbeat) on days 27 and 81 relative to AI. Scans on day 27 were used to determine the proportion of females that became pregnant to AI, while scans on day 81 were used to determine season-ending pregnancy rates.

All data were analyzed using the GLM procedure of SAS (SAS Inst. Inc., Cary, N.C.). The statistical model included fixed effect of treatment (natural service or AI) for response variables of age, weight, average daily gain (ADG), cyclic status, pregnancy rates and days to conception. Significance was considered at $P \leq 0.05$.

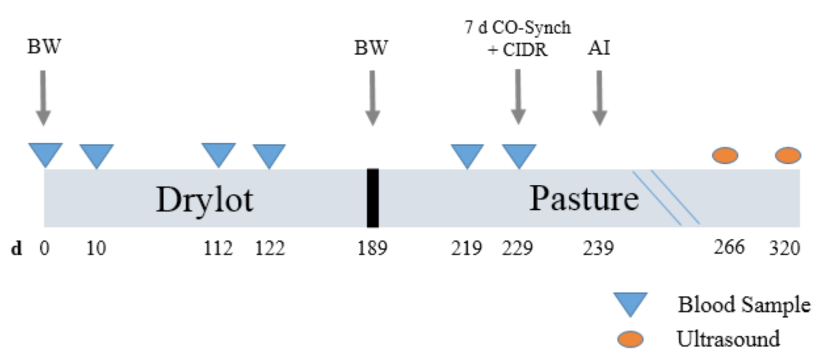

Figure 1: Schematic of experiment.

Results and Discussion

At the initiation of the study, heifers born of dams exposed to artificial insemination were older ($P = 0.004$) and heavier ($P = 0.01$), compared with heifers born from dams exposed to natural-service bulls (Table 1). However, no differences were present in body weight on day 189 ($P = 0.14$) or ADG ($P = 0.23$) between treatments.

A greater proportion of heifers in the natural-service treatment tended ($P = 0.06$) to be cyclic at the beginning of the developmental period, compared with heifers in the AI treatment (Figure 2). However, no differences ($P = 0.40$ and $P = 0.84$, respectively) were observed among treatments in the proportion of cyclic heifers at the midpoint of the development phase and the initiation of the breeding season.

Concentrations of progesterone were used to determine if heifers became cyclic around the time of weaning, a few months after weaning and finally at the time of CIDR insertion, just prior to breeding. If females had not yet become cyclic at this point in their life cycle, successful breeding and pregnancy may not be reached (Byerley et al., 1987). We found no differences between treatments in pregnancy diagnosis ($P = 0.81$ and $P = 0.96$, PG to AI and PG final, respectively) or the days to conception ($P = 0.71$; Table 1).

Artificial insemination has the potential to increase the number of calves born earlier in the calving season, as well as increasing the weaning weights of those calves. However, in this case, it did not increase the number of heifers that became cyclic or pregnant early, compared with heifers born to dams exposed to natural service. Although not evaluated in this study, commercial producers may find value in the genetic and phenotypic improvements in their herd resulting from implementing an AI breeding program.

Table 1: Effect of AI versus natural service on growth and pregnancy rates.

	AI	NS	*P*-value
Age at start, d	212.9 ± 1.7	206.0 ± 1.7	0.004
Initial BW, lb.	527.8 ± 6.2	505.1 ± 6.2	0.01
Final BW, lb.	760.6 ± 7.5	744.9 ± 7.5	0.14
Daily gain, lb/d	1.23 ± 0.02	1.28 ± 0.02	0.23
Pregnancy			
AI , %	32.9 (26/79)	34.9 (23/66)	0.81
Final , %	91.1 (72/79)	90.9 (60/66)	0.96
Days to Conception, d	28.3 ± 3.1	26.5 ± 3.3	0.71

Means differ at $P \leq 0.05$

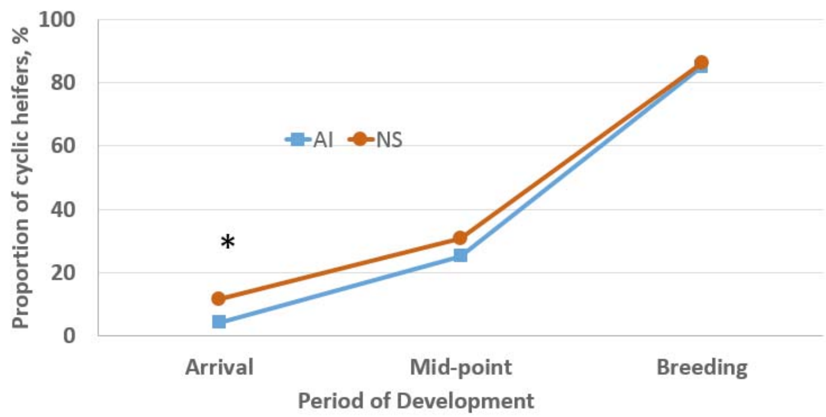

Figure 2: Effect of dam exposure to AI or natural-service breeding systems on attainment of puberty by heifer progeny. Periods of development are defined as arrival (arrival to development lot, 56 days after weaning; days 0 and 10 of experiment), midpoint (middle point of development period, days 112 and 122) and breeding (at the initiation of estrus synchronization protocol; days 219 and 229).*Means within period tend to differ $P = 0.06$.

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