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Comparison of the pregnancy rates and costs per calf born after fixed-time artificial insemination or artificial insemination after estrus detection in *Bos indicus* heifers

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ABSTRACT

This study compared pregnancy rates (PRs) and costs per calf born after fixed-time artificial insemination (FTAI) or AI after estrus detection (i.e., estrus detection and AI, EDAI), before and after a single PGF2α treatment in *Bos indicus* (Brahman-cross) heifers. On Day 0, the body weight, body condition score, and presence of a CL (46% of heifers) were determined. The heifers were then alternately allocated to one of two FTAI groups (FTAI-1, n = 139) and (FTAI-2, n = 141) and an EDAI group (n = 273). Heifers in the FTAI groups received an intravaginal progesterone-releasing device (IPRD; 0.78 g of progesterone) and 1 mg of estradiol benzoate intramuscularly (im) on Day 0. Eight days later, the IPRD was removed and heifers received 500 μg of PGF2α and 300 IU of eCG im; 24 hours later, they received 1 mg estradiol benzoate im and were submitted to FTAI 30 to 34 hours later (54 and 58 hours after IPRD removal). Heifers in the FTAI-2 group started treatment 8 days after those in the FTAI-1 group. Heifers in the EDAI group were inseminated approximately 12 hours after the detection of estrus between Days 4 and 9 at which time the heifers that had not been detected in estrus received 500 μg of PGF2α im and EDAI continued until Day 13. Heifers in the FTAI groups had a higher overall PR (proportion pregnant as per the entire group) than the EDAI group (34.6% vs. 23.2%; P = 0.003), however, conception rate (PR of heifers submitted for AI) tended to favor the estrus detection group (34.6% vs. 44.1%; P = 0.059). The cost per AI calf born was estimated to be $267.67 and $291.37 for the FTAI and EDAI groups, respectively. It was concluded that in Brahman heifers typical of those annually mated in northern Australia FTAI compared with EDAI increases the number of heifers pregnant and reduces the cost per calf born.

1. Introduction

The success of an artificial insemination (AI) program is often judged on the number of females pregnant after one insemination and the cost per calf produced. The north Australian beef industry mostly comprised Brahman (*Bos indicus*) or Brahman-infused genotypes [1]. Cattle are generally extensively managed on large properties and are often only mustered twice a year to conduct various husbandry procedures. Consequently, the dissemination of improved genetics through the use of AI poses challenges for cattle producers in this region. It is important to identify the most efficacious and cost-effective means of using AI in these herds to increase genetic improvement in the north Australian beef industry.

B. indicus cattle have a unique reproductive physiology compared with their *Bos taurus* counterparts, which needs to be considered when recommending the most appropriate

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ovulation synchronization protocol. For example, Brahman cattle commonly attain puberty at a later age than *B. taurus* genotypes [2,3]. As a result, the proportion of 2-year-old Brahman heifers in northern Australia that have a CL at commencement of breeding has been reported to be 43% compared with 63% in tropical composites (50% *B. taurus*, 50% *B. indicus*) [3]. This implies that a considerable proportion of Brahman females in northern Australia are prepubertal at the commencement of the breeding period. The use of PGF2α alone for estrus synchronization is ineffective in prepubertal heifers as a prerequisite for its use is the presence of a responsive CL [4]. Treatment of heifers with progesterone (P_4) has been shown to advance the onset of puberty [5], whereas typical ovulation synchronization protocols that enable fixed-time artificial insemination (FTAI) use intravaginal progesterone-releasing devices (IPRDs) and estradiol benzoate (EB) [6,7]. Therefore, prepubertal heifers may benefit from FTAI protocols as they can be induced to ovulate, form a CL, and have the opportunity to become pregnant after FTAI.

The objectives of this study were to compare the most suitable AI programs for a group of high-grade Brahman heifers that were typical of those mated in northern Australia. The pregnancy rates (PRs) and costs per calf born after ovulation synchronization and FTAI were compared with that after estrus detection and AI (EDAI), before and after a single PGF2α treatment. The program with the most heifers pregnant and the lowest cost per calf born would be considered the most suitable for use in northern Australia.

2. Materials and methods

2.1. Field study

2.1.1. Heifer selection and management

The study was performed on a commercial beef cattle property in central Queensland, Australia (25°01′44.42″S, 150°26′06.21″E) during late spring-early summer (November-December). Ethical approval was granted by The University of Queensland's Animal Ethic Committee—approval number SVS/210/11/MLA. A group of rising 2-year-old high-grade Brahman heifers (>75% Brahman content; n = 589) were used in the study. The heifers were representative of Brahman and Brahman-cross heifers mated annually in this region. All heifers were managed in a 2806.36 ha paddock, which contained a variety of blue grass (*Dichanthium sericeum*), spear grass (*Austrostipa* spp.), and buffel grass (*Cenchrus ciliaris*) pasture before and after the trial. Before and during the trial all heifers had *ad libitum* access to a dry season supplement (10% urea, 2% phosphate, and 52%–60% protein) fed in troughs.

At the start of the study (Day 0), all heifers were weighed and body condition score (BCS) was assessed (1 = poor to 5 = fat [8,9]) and then underwent a transrectal ultrasonographic reproductive examination using a SonoSite M-Turbo ultrasound machine equipped with an L52X/10 to 5 MHz linear array transrectal transducer (SonoSite Inc., Bothel, WA, USA). The presence or absence of a CL (diagnosed by the presence of the echogenic appearance of a CL [10,11]), pregnancy, and any reproductive tract abnormality were recorded. Heifers that had a body weight (BW) less than 280 kg (n = 28), a BCS less than 2 (n = 2), were pregnant (n = 3), had an immature reproductive tract (reproductive tract score 1; [12,13]), or other abnormalities (n = 3) were rejected from the study. The selected heifers (n = 553) had a mean (±SEM) BW of 327.4 ± 1.1 kg (range, 280–418 kg) and BCS of 2.5 ± 0.0 (range, 2–3). At pregnancy diagnosis, approximately 6 to 8 weeks after AI the BW and BCS were again recorded. All heifers were vaccinated for clostridial diseases and leptospirosis before the trial.

2.1.2. Experimental design and treatment allocation

On Day 0, heifers were allocated to a treatment group as they presented in the squeeze chute. Heifers were allocated alternately to an FTAI group (n = 280) or an EDAI group (n = 273). The heifers of FTAI group were further subdivided into two similar sized groups FTAI-1 (n = 139) and FTAI-2 (n = 141) to ensure that all heifers in this group were inseminated between 54 and 58 hours after removal of the IPRD; heifers in the FTAI-2 group were put on treatment 8 days after those in the FTAI-1 group. The allocation procedure was retrospectively analyzed for evidence of bias between the allocation of heifers in FTAI-1, FTAI-2, and EDAI groups with regard to BW, BCS, and the presence of a CL on Day 0 (Table 1). Heifers in the treatment group FTAI-1 were managed in a 261 ha paddock from Days 0 to 8 and a 50 ha paddock from Days 8 to 10. Heifers from the FTAI-2 group were managed in a 409 ha paddock from Days 8 to 16 and a 50 ha paddock from Days 16 to 18. Heifers in the EDAI group were managed in a 154 ha paddock nearby the handling facility from Days 4 to 13. All aforementioned paddocks were similar with respect to pasture species and quality and quantity of available pasture.

Treatment to synchronize ovulation commenced on Day 0 for FTAI-1 and Day 8 for FTAI-2. Each heifer in the FTAI groups had a half-dose IPRD (Cue-Mate, 0.78 g of P_4; Bioniche Animal Health Australia/Asia, Sydney, NSW, Australia) inserted intravaginally. The half-dose IPRD was prepared as previously described [6,7]. At the time of IPRD insertion all heifers received 1 mg of EB (Bomerol; Bayer Australia, Sydney, NSW, Australia) intramuscularly (im). Eight days later, the IPRDs were removed and all heifers received 500 μg of cloprostenol (PGF2α, Ovuprost; Bayer Australia) im and 300 IU of eCG (Pregnecol; Bioniche Animal Health Australia/Asia) im and were submitted to FTAI 30 to 34 hours later. Approximately 24 hours after IPRD removal, all heifers in the FTAI groups received 1 mg of EB im. All heifers in the EDAI group initially received no treatment, but were observed twice daily (morning and afternoon for a duration of 2.5–3 hours) from Days 4 to 9 for signs of estrus (standing to be mounted, riding) and were inseminated 12 hours later. No estrus detection aids were used. On Day 9, all heifers that had not been detected in estrus (n = 217) were treated with 500 μg of PGF2α (Ovuprost; Bayer Australia) im and subsequently observed for signs of estrus and inseminated until Day 13. All heifer treatments are outlined in Figure 1.

2.1.3. Sire allocation and AI

Sires used in the experiment (n = 34) were part of a large-scale genetic evaluation project. Heifers were allocated to sire on presentation for AI. Sires were used in numerical order from 1 to 34 across all groups until semen