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Short communication: Field fertility in Holstein bulls: Can type of breeding strategy (artificial insemination following estrus versus timed artificial insemination) alter service sire fertility?

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ABSTRACT

The aim of this study was to compare pregnancy per artificial insemination (P/AI) from service sires used on artificial insemination after estrus detection (EAI) or timed artificial insemination (TAI) breedings. Confirmed artificial insemination outcome records from 3 national data centers were merged and used as a data source. Criteria edits were herd's overall P/AI within 20 and 60%, a minimum of 30 breedings reported per herd-year, service sires that were used in at least 10 different herds with no more than 40% of the breedings performed in a single herd, breeding records from lactating Holstein cows receiving their first to fifth postpartum breedings occurring within 45 to 375 d in milk, and cows with 1 to 5 lactations producing a minimum of 6,804 kg. Initially 1,142,859 breeding records were available for analysis. After editing, a subset of the data (n = 857,539) was used to classify breeding codes into either EAI or TAI based on weekly insemination profile in each individual herd. The procedure HPMIXED of SAS was used and took into account effects of state, farm, cow identification, breeding month, year, parity, days in milk at breeding, and service sire. This model was used independently for the 2 types of breeding codes (EAI vs. TAI), and service sire P/AI rankings within each breeding code were performed for sires with >700 breedings (94 sires) and for sires with >1,000 breedings (n = 56 sires) following both EAI and TAI. Correlation for service sire fertility rankings following EAI and TAI was performed with the PROC CORR of SAS. Service sire P/AI rankings produced with EAI and TAI were 0.81 (for sires with >700 breedings) and 0.84 (for sires with >1,000 breedings). In addition, important changes occurred in service sire P/AI ranking to EAI and TAI for sires with less than 10,000 recorded artificial inseminations. In conclusion, the type of breeding strategy (EAI or TAI) was associated with some changes in service sire P/AI ranking, but ranking changes declined as number of breedings per service sire increased. Future randomized studies need to explore whether changes in P/AI ranking to EAI versus TAI are due to specific semen characteristics.
Key words: sire fertility, conception rate, dairy cow

Short Communication

In commercial dairy herds worldwide, detection of behavioral estrus is performed by visual observation following the am/pm (before/after midday) AI routine (Trimberger, 1948), AI once a day in association to daily tail chalk (Nebel et al., 1994), utilizing heat-mount detectors such as Kamars (Kamar Inc., Steamboat Springs, CO), or even electronic activity meters (Caraviello et al., 2006; Michaelis et al., 2013). However, none of these strategies are accurate to predict the timing of ovulation following estrus detection even in cows equipped with more advanced electronic activity devices (Valenza et al., 2012). For example, Valenza et al. (2012), using advanced estrus activity devices equipped with accelerometers (Heatime, SCR Engineers Ltd.) and evaluating the time of ovulation with frequent ultrasound exams, reported that in a twice-daily breeding program the AI-to-ovulation interval varied from −12 to 26 h. As a result, Valenza et al. (2012) observed that approximately 25% of the cows were bred too early in relation to ovulation time (>12 h before ovulation), whereas a further 20% of the cows were bred too late (after ovulation had occurred). These findings are in agreement with several other studies describing the great variation in the interval

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from estrus to ovulation in cattle (Hernández-Cerón et al., 1993; Saumande and Humblot, 2005; Bloch et al., 2006; Hockey et al., 2010; Valenza et al., 2012). Because of this wide variation, numerous research groups have evaluated the most appropriate timing of artificial insemination relative to the onset of estrous, ovulation, or both, in cows (Rankin et al., 1992; Dransfield et al., 1998; Pursley et al., 1998; Roelofs et al., 2006; Hockey et al., 2010; Sales et al., 2011; Valenza et al., 2012). They all seem to agree that this wide variation in AI-to-ovulation interval may compromise oocyte fertilization when cows are breed too early and lower embryo quality if cows are bred too late, which in turn will affect pregnancy per AI (**P/AI**; Hockey et al., 2010).

Timed AI (**TAI**) programs such as the Ovsynch protocol use a combination of GnRH and $PGF_{2\alpha}$ to control timing of ovulation (Pursley et al., 1995). These synchronization programs have been adopted at different degrees by most US dairies (Caraviello et al., 2006; Souza et al., 2013). Synchronization protocols for TAI will cause most cows to ovulate synchronously within a short 8 to 12 h window (Pursley et al., 1995; Souza et al., 2009), making the time of ovulation more predictable and creating an opportunity to improve AI-to-ovulation intervals in relation to AI performed following detection of estrus (**EAI**).

The optimal time at which insemination should take place relative to ovulation appears to depend on the fertility lifespan of spermatozoa and the viable lifespan of the oocyte in the female genital tract after ovulation occurs (Dransfield et al., 1998; Roelofs et al., 2006; Hockey et al., 2010; Gosálvez et al., 2011). Accordingly, if AI takes place at long intervals before ovulation, sires with improved semen quality would probably be less likely to have reduced conception results due to their longer sperm cell lifespan as compared with sires with shorter lifespan in the female tract (MacMillan and Watson, 1975; Hockey et al., 2010). Consequently, assuming the variation in semen quality traits from different sires and the possibility of precisely control timing of ovulation with timed AI protocols, it is reasonable to hypothesize that some service sires may yield results of P/AI that may differ if AI is performed after EAI or following TAI programs. Thus, the main objective of this study was to compare P/AI from same service sires used both following AI after EAI and TAI.

Confirmed AI outcome records from 3 US data centers (AgSource, Verona, WI; Agritech Analytics, Visalia, CA; and Data Records Management Services, Raleigh, NC) were merged and used as data sources. It is important to clarify that this evaluation is not genetic but phenotypic, and criteria edits to the whole data set included only breedings with confirmed conception results that took place in US Holstein herds from January 1, 2008, to April 30, 2012, only herds with overall P/AI within 20 and 60%, a minimum of 30 breedings reported per herd, sires that were used in at least 10 different herds with no more than 40% of the breedings performed in a single herd, breeding records from lactating Holstein cows only that received their first to fifth postpartum breedings occurring within 45 to 375 DIM, and only cows that had 5 or less lactations producing a minimum of 6,804 kg. After editing, a total of 857,539 breeding records were used and classified into breeding codes as either EAI or TAI based on weekly insemination profile in each individual herd. First, regardless of the days of the week, breedings that took place before 60 DIM were all assumed to have occurred following estrus. Second, a subset of farms (n = 10) with known breeding codes was used to determine the distribution of breeding events occurring after EAI and TAI (Figure 1). Thus, we used a subset of 10 herds in which we had access to the actual breeding codes (Ovsynch or Estrus) recorded in the farm's management software to validate the classification method used to categorize breedings into EAI or TAI. Herds breeding cows only following estrus detection would have AI events occurring more evenly throughout all days of the week and, thereby, should have approximately 14% (100% of the breedings divided by the 7 d of the week) of the cows being bred at any given day of the week. In contrast, herds utilizing TAI would have a sharp increase in proportion of AI that take place at specific days of the week. Thus, we calculated the standard deviation of the weekly breeding distribution for each individual herd, then assumed that TAI breedings within a herd were those that took place in days of the week with more than 2 standard deviations above the farm's daily average number of breedings, which is 14.3% (or 100%/7). For example, a herd that has the breeding distribution as follows: Monday = 32 AI; Tuesday = 40 AI; Wednesday = 27 AI; Thursday = 145 AI; Friday = 47 AI; Saturday = 21 AI; Sunday = 15 AI, would have in terms of percentage of weekly breeding distribution as follows: Monday = 9.8%; Tuesday = 12.2%; Wednesday = 8.3%; Thursday = 44.3%; Friday = 14.4%; Saturday = 6.4%; Sunday = 4.6%. Thus, average daily percentage of AI would be 14.3% (a constant parameter across herds using EAI only), and the standard deviation for percentage of breedings would be 13.7%. Then, 2 times the SD (13.7%) would be 27.3% plus 14.3% is 41.6%. In this case, the breedings performed on Thursdays are 44.3% of total breedings, which is greater than 41.6%, and those breedings performed on Thursday were then classified as TAI as shown in Figure 1. This criteria was then applied to all herds in the database. It is important to highlight that the 2 SD above average was chosen after testing 0.1