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Factors associated with fertility outcomes in cows treated with protocols to synchronize estrus and ovulation in seasonal-calving, pasture-based dairy production systems

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ABSTRACT

Logistic regression was used to identify factors associated with fertility outcomes in cows treated with protocols to synchronize estrus and ovulation. Lactating dairy cows (n = 1,538) were enrolled in a completely randomized block design study to evaluate synchronization treatments. Within each herd (n = 8), cows were divided into 3 calving groups: early [≥42 d in milk (DIM) at mating start date (MSD); n = 1,244], mid (21 to 41 DIM at MSD; n = 179), and late (0 to 20 DIM at MSD; n = 115), based on DIM at MSD. Cows in the early-, mid-, and late-calving groups were synchronized to facilitate estrus or timed artificial insemination (TAI) at MSD (planned breeding 1; PB1), 21 d (PB2), and 42 d (PB3) after MSD, respectively. For each PB, cows in the relevant calving group were stratified by parity and calving date and randomly assigned to (1) d −10 GnRH (10 μg i.m. of buserelin) and CIDR [controlled internal drug release insert, 1.38 g of progesterone (P4)]; d −3 $PGF_{2\alpha}$ (25 mg i.m. of dinoprost); d −2 CIDR out and AI at observed estrus (CIDR_OBS); (2) same as CIDR_OBS, but GnRH 36 h after CIDR out and TAI 18 h later (CIDR_TAI); (3) same as CIDR_TAI, but no CIDR (i.e., Ovsynch); or (4) untreated controls (CTRL). Use of a CIDR-based ovulation synchronization protocol (i.e., CIDR_TAI) increased synchronization rates in anovular cows. Both CIDR_OBS and CIDR_TAI animals without a corpus luteum (CL) had increased likelihood of conception at first service compared with Ovsynch animals without a CL. Animals with low body condition score (BCS) treated with CIDR_OBS had an increased likelihood of conceiving at first service compared with low-BCS animals treated with CIDR_TAI, Ovsynch, or CTRL. Animals <60 d in milk (DIM) treated with CIDR_OBS and CIDR_TAI had increased likelihood of conceiving at first service compared with animals treated with Ovsynch. Treatment with CIDR_TAI increased synchronization rate in cows categorized as low BCS, anovulatory, and <60 DIM compared with both CIDR_OBS and Ovsynch, and increased submission rate compared with CIDR_OBS. Conception rate in cows within these categories, however, was greatest for CIDR_OBS, resulting in minimal differences in actual pregnancy rates between CIDR_OBS and CIDR_TAI treatments, both of which were superior to Ovsynch. Treatment differences in the response variables investigated were minimal in cows categorized as medium or high BCS, ovulatory, and >60 DIM, indicating that CIDR-based protocols could be targeted at particular cows, and all other cows could be synchronized using Ovsynch.

Key words: estrous synchronization, Ovsynch, dairy cow, seasonal calving

INTRODUCTION

The success of a seasonal-calving, pasture-based milk production system is largely dependent on achieving a compact calving pattern to coincide with the start of the grass growing season, thus matching the seasonal supply of pasture to the herd intake demand (Dillon et al., 1995). A key measure of reproductive performance in seasonal-calving dairy herds is the 42-d pregnancy rate (McDougall, 2006), which is defined as the percentage of the herd confirmed pregnant to inseminations performed during the first 42 d following the mating start date (**MSD**). The 42-d pregnancy rate of a herd is primarily influenced by the 21-d submission rate and the conception rate at first service.

Synchronization can play a critical part in maintaining a herd's seasonally concentrated calving pattern. Programs for estrous cycle control facilitate the breeding of large numbers of animals over a short time using either estrus detection or AI at a predetermined time

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(timed AI; **TAI**) without the requirement for detection of estrus (Macmillan, 2010). Several cow factors affect synchronization and conception rates after application of TAI protocols in lactating dairy cows. These include stage of the estrous cycle at the onset of TAI protocols, DIM, BCS at calving and AI, parity, and presence or absence of a corpus luteum (**CL**) at the onset of synchronization (Tenhagen et al., 2004; Bello et al., 2006; Galvão and Santos, 2010).

Greater DIM results in increased likelihood of conception in cows early postpartum following insemination based on observed estrus (Butler and Smith, 1989) or after TAI (Tenhagen et al., 2003). Greater conception rates in primiparous cows compared with multiparous cows following Ovsynch have been reported (Tenhagen et al., 2001, 2004). Lopez et al. (2004) reported that increased milk production (≥39.5 kg/d) decreased the duration of estrus in nonsynchronized lactating dairy cows. When TAI protocols are used, however, animals are submitted for AI without reliance on behavioral estrus detection. Thus, use of TAI protocols facilitates 100% submission rates in all cows, regardless of level of milk production. Cows in low BCS at parturition or that experienced excessive BCS loss early postpartum are less likely to ovulate before the planned start of mating, and thus have reduced submission rates to AI, reduced conception rates, and increased likelihood of pregnancy loss (Roche et al., 2009). Recent studies have indicated that BCS is also an important factor affecting conception rates following TAI protocols (Moreira et al., 2000; Galvão and Santos, 2010).

The single most important ovarian factor influencing success rates achieved with TAI protocols is the cyclicity status of the animal. A recent study conducted in seasonal-calving dairy herds in New Zealand reported greater first-service conception rates for anestrous cows that had a CL present at protocol enrollment compared with cows without a CL (43.1 vs. 33.4%, respectively; McDougall, 2010a). Gümen et al. (2003) reported reduced fertility performance following Ovsynch in cows identified as anovular at the onset of synchronization compared with ovular cows, possibly due to increased incidence of premature luteal regression in the former. Improved pregnancy outcomes were documented when an intravaginal progesterone (**P4**) insert was included during Ovsynch for anovular cows, where GnRH was used to synchronize the growth of a new follicular wave at protocol initiation and to synchronize ovulation (Stevenson et al., 2008; Chebel et al., 2010; McDougall, 2010a). Following P4 withdrawal at the end of a treatment period, a rapid decrease in circulating concentrations of P4 promotes a synchronous estrus within the herd, allowing for AI of large numbers of animals (Macmillan and Peterson, 1993).

Herlihy et al. (2011) reported that the use of TAI protocols in seasonal-calving cows on pasture-based dairy production systems resulted in both shorter intervals from calving to first service and shorter intervals from MSD to conception. The objective of this study was to further analyze this data set to identify factors associated with fertility outcomes in cows treated with protocols to synchronize estrus and ovulation. The results will aid identification of the optimum synchronization protocol for cows in different physiological conditions.

MATERIALS AND METHODS

Experimental Design

In this study, 1,538 lactating dairy cows in 8 Irish commercial spring-calving dairy herds were used in a completely randomized block experimental design to evaluate synchronization protocols between April and June 2008, as previously described (Herlihy et al., 2011). Briefly, within each herd, cows were divided into 3 groups: early, mid, and late calving based on DIM at the farm MSD. Early-calving cows (n = 1,244) were ≥42 DIM at MSD, mid-calving cows (n = 179) were 21 to 41 DIM at MSD, and late-calving cows (n = 115) were 0 to 20 DIM at MSD. Synchronization protocols commenced 10 d before MSD for the early-calving cows, facilitating estrus or TAI at MSD [planned breeding (**PB**)1] as illustrated in Figure 1 (upper panel). All early-calving cows were ≥42 DIM at AI (range 42 to 105). Synchronization treatments commenced on d 11 and 32 after MSD for the mid- and late-calving cows, respectively. The treatments facilitated estrus or TAI 21 d after MSD (PB2) and 42 d after MSD (PB3) for the mid- and late-calving cows, respectively. All mid- and late-calving cows were between 42 and 62 DIM at AI. Thus, the experimental treatments were imposed on all cows that had calved up to and including MSD. All experimental procedures involving animals were licensed by the Department of Health and Children, Ireland, in accordance with the Cruelty to Animals Act (Ireland 1876) and European Community Directive 86/609/EC, and were sanctioned by the University College Dublin Animal Research Ethics Committee.

Synchronization Treatments and AI

Within each calving group, cows were stratified by parity and DIM and randomly assigned to 1 of the 4 treatments illustrated in Figure 1 (lower panel). One protocol was an estrous synchronization protocol: **CIDR_OBS**: d −10 GnRH [**GnRH1**; 10 μg of buserelin (2.5 mL of Receptal), i.m.] and controlled internal drug release insert [**CIDR**; 1.38 g of progesterone (**P4**)];