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Extending the duration of the voluntary waiting period from 60 to 88 days in cows that received timed artificial insemination after the Double-Ovsynch protocol affected the reproductive performance, herd exit dynamics, and lactation performance of dairy cows

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ABSTRACT

This experiment evaluated the reproductive performance, herd exit dynamics, and lactation performance of dairy cows managed with a voluntary waiting period (VWP) of 60 or 88 d. Secondary objectives were evaluating VWP effect on cyclicity status, uterine health, systemic inflammation, and body condition score (BCS) before first service. Lactating Holstein cows from 3 commercial farms in New York State were blocked by parity group and total milk yield in their previous lactation and then randomly assigned to VWP of 60 (VWP60; $n = 1,352$) or 88 (VWP88; $n = 1,359$) days in milk (DIM). All cows received the Double-Ovsynch protocol (GnRH-7 d-PGF_{2α}-3 d-GnRH-7 d-GnRH-7 d-PGF_{2α}-56 h-GnRH-16 to 20 h-timed artificial insemination; TAI) for synchronization of ovulation and TAI. For second and greater artificial insemination (AI), cows received AI after detection of estrus or the Ovsynch protocol (GnRH-7 d-PGF_{2α}-56 h-GnRH-16 to 20 h-TAI) initiated 32 ± 3 d after AI for cows not re-inseminated at detected estrus. Cyclicity status (progesterone concentration), uterine health (vaginal discharge and uterine cytology), BCS, and systemic inflammation (haptoglobin concentration) were evaluated at baseline (33 ± 3 DIM for both treatments), beginning of the Double-Ovsynch protocol, and 10 d before TAI. Effects of treatments were assessed with multivariable statistical methods relevant for each outcome variable. Extending duration of VWP from 60 to 88 DIM increased pregnancies per AI (P/AI) to first service (VWP60 = 41%; VWP88 = 47%). Nonetheless, the greatest benefit of extending VWP on first-service P/AI was for primiparous cows (VWP60 = 46%; VWP88 = 55%), as P/AI did not differ within

the multiparous cow group (VWP60 = 36%; VWP88 = 40%). Physiological status more conducive to pregnancy—characterized by improved uterine health, greater BCS, reduced systemic inflammation, and to a lesser extent more time to resume ovarian cyclicity—explained the increment in P/AI to first service. Our data also indicated that despite having greater P/AI to first service, cows with the longer VWP had delayed time to pregnancy during lactation (hazard ratio = 0.72; 95% confidence interval 0.69–0.98) and greater risk of leaving the herd, particularly for multiparous cows (hazard ratio = 1.34; 95% confidence interval 1.23–1.47). This shift in pregnancy timing led to an overall extension of the lactation length (+13 d), which resulted in greater total milk yield per lactation (+491 kg) but not greater milk yield per day of lactation. In conclusion, data from this experiment highlight the importance of considering the complex interactions between reproductive performance, herd exit dynamics, and lactation performance as well as the effects of parity at the time of defining the duration of the VWP for lactating dairy cows.

Key words: voluntary waiting period, reproductive performance, herd exit dynamics, dairy cow

INTRODUCTION

Timing of pregnancy during lactation affects the profitability of dairy herds by defining calving interval, milk production efficiency, and herd replacement dynamics (De Vries, 2006; Inchaisri et al., 2011; Giordano et al., 2012). Although insemination and conception risk after the end of the voluntary waiting period (VWP) are the 2 major determinants of time to pregnancy during lactation, the duration of the VWP can also influence timing of pregnancy because it determines when cows become eligible for insemination. Traditionally, VWP duration in US dairy farms has been ~60 d (Miller et al., 2007). Recent changes in reproductive performance and management of dairy herds, however, may

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allow the duration of the VWP to be manipulated to optimize reproductive performance and profitability. For example, aggressive management programs that substantially reduce the variation of time to pregnancy may enable dairy farms to select the optimal timing to achieve pregnancy in a substantial proportion of cows.

Extending the duration of the VWP may improve reproductive performance of cows through multiple mechanisms. For example, it may provide more time to recover uterine health (Gilbert et al., 2005; Gautam et al., 2009; Sheldon et al., 2009) through improved immune status, more time to resolve the inflammatory process established immediately after calving, or both (LeBlanc et al., 2011; LeBlanc, 2014). Likewise, a longer VWP may provide cows more time to return to reproductive hormone secretion patterns and a metabolic status that promotes resumption of ovarian cyclicity (Butler, 2003; Kawashima et al., 2012; Cheong et al., 2016). Earlier ovulation postpartum and more estrous cycles before first service were linked to reduced days to first service and greater pregnancies per AI (P/AI; Thatcher and Wilcox, 1973; Butler and Smith, 1989; Darwash et al., 1997). Finally, delaying first service beyond the negative energy balance nadir in early lactation as much as possible may improve reproductive performance by avoiding insemination of cows during severe negative energy balance and provide additional time to recover body tissue reserves. Optimum BCS at the time of insemination is strongly associated with high probability of pregnancy (Souza et al., 2007, 2008; Carvalho et al., 2014).

Despite the potential benefits of extended VWP on reproductive performance, the effect of this management strategy on overall herd performance has not been fully elucidated. Few randomized controlled experiments have evaluated the implications of VWP duration on first-service P/AI and whole-lactation reproductive performance of dairy cows. In an experiment with a limited number of second-lactation cows, Van Amburgh et al. (1997) found no differences in reproductive performance when comparing VWP of 60 versus 150 d. Similarly, Arbel et al. (2001) observed no effect of extending VWP by 60 d on reproductive performance of cows with above-average milk yield under Israeli conditions. In contrast, in an experiment conducted with above- or below-average milk-producing cows, an increment of 13 and 20 percentage points in P/AI was observed when VWP was extended from 77 to 98 or from 56 to 77 DIM for high- and low-producing cows, respectively (Tenhagen et al., 2003). More recently, Gobikrushanth et al. (2014) reported the results of a retrospective cohort study at a commercial farm in Florida that extended VWP duration during summer months only. Cows with the extended

VWP had greater first-service P/AI, more days open, and longer calving intervals. Nonetheless, season of AI might have confounded results as cows with short VWP (57 to 63 d) received first service during summer and fall, whereas cows with long VWP (64 to 121) received first service during fall only. Moreover, the reproductive program used resulted in overlapped DIM at first service for a substantial proportion of cows. Collectively, the ambiguous results and multiple exclusion criteria of previous reports did not allow decisive conclusion that extending the duration of the VWP is beneficial for the performance of dairy herds.

Thus, our primary objective was to evaluate the reproductive performance, herd exit dynamics, and lactation performance of dairy cows managed with a VWP of 60 or 88 DIM. Secondary objectives were evaluating the effect of longer VWP on uterine health, cyclicity status, BCS, and systemic inflammation before first service. We hypothesized that extending VWP duration from 60 to 88 DIM would increase P/AI to first service and improve overall reproductive performance. We further hypothesized that cows with extended VWP would have improved reproductive performance because of improved uterine health, reduced rate of anovulation, improved BCS, and reduced systemic inflammation before first service.

MATERIALS AND METHODS

All procedures performed with cows were approved by the Animal Care and Use Committee of Cornell University.

Farms and Cow Management

Lactating Holstein cows from 3 commercial farms (A, B, and C) in New York State (2 in Cayuga County and 1 in Lewis County) were enrolled in this experiment from March 2014 to March 2015. During the study period the average numbers of milking cows were 1,034, 1,248, and 793 at farms A, B, and C, respectively. Average milk yield per cow per day was 39, 40, and 40 kg for farms A, B, and C, respectively. Data for cow numbers and milk yield were retrieved from the dairy management software (DairyComp305, Valley Ag Software, Tulare, CA) using the ECON\ID command. All farms housed cows in free-stall barns with 4 or 6 rows of stalls, concrete flooring, self-locking headgates in the feedline, and fans and sprinklers in the feedline. On farms A and B, freestall surfaces were covered with either mattresses covered with sawdust or deep sand bedding, whereas on farm C freestall surfaces were covered with deep sand bedding. Farms B and C milked cows thrice daily at approximately 8-h intervals, and

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