Managing Reproduction of Lactating Dairy Cows with Limited Use of Timed AI Programs

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INTRODUCTION

Reproductive efficiency of dairy herds is impacted by pregnancy per AI (**P/AI**) and AI submission rate. Because milk yield is negatively correlated with estrus expression in dairy cows, timed AI (**TAI**) protocols were developed to synchronize ovulation in order to submit cows to AI in a timely manner and partly eliminate the need of detecting estrus on dairy farms. In the past decades, researchers have refined and perfected these TAI programs, which has helped producers increase reproductive efficiency, and consequently, profitability. Even though it is well-accepted that the use of TAI protocols maximizes overall efficiency in dairy herds, recent increases in public concerns related to food production may force the dairy industry to further justify current reproductive management practices. Because TAI programs require a set of treatments to synchronize the estrous cycle, research evaluating the impact of reducing the use of synchronization protocols on dairy farms is needed. Reproductive efficiency influences cost of production on dairy farms; therefore, it is of utmost importance for the dairy industry to estimate potential ramifications associated with the possible demand for reduced use of reproductive synchronization protocols.

Apart from the convenience of synchronizing the day and time of AI, synchronization protocols enable insemination of all eligible cows promptly. Hence, TAI programs eliminate the issue of reduced expression of estrus that may be caused by several intrinsic and extrinsic factors, such as anovular condition, flooring not conducive to estrus expression, and high milk production. Nonetheless, estrus detection continues to be a common part of reproductive programs for some herds because estrus detection aids (e.g., tail paint, pressure-sensitive devices, and activity monitoring systems) have been shown to be effective tools to identify cows in estrus. Indeed, these tools may be used to overcome the issue of reduced estrus expression in dairy cows.

In a hypothetical scenario in which a farm would have to reduce the use of synchronization protocols, increasing the number of inseminations based on estrus detection would be required. Although a series of research projects compared reproductive efficiency of programs that rely mostly on TAI vs. programs focusing on AI based on estrus detection, these experiments were not tailored to test the impact of reducing number of treatments before AI. Instead, researchers aimed to compare 2 management strategies. Summarizing findings from these experiments, however, is valuable to comprehend possible consequences of having to minimize the number of treatments in reproductive programs.

REDUCING THE USE OF TIMED AI PROGRAMS FOR FIRST SERVICE

Reproductive programs that do not rely predominantly on TAI for first service use prostaglandin treatment(s) to induce estrus

expression. On the other hand, programs that aim to submit a large proportion of cows to TAI use a combination of GnRH and prostaglandin to synchronize the estrous cycle, and ultimately, timing of ovulation. As a result, programs relying on TAI protocols require several treatments before AI. Both strategies have proven to be effective methods to maximize reproductive efficiency; however, studies comparing economic outcomes of these strategies are limited. In order to evaluate which reproductive management strategy results in greater reproductive efficiency and profitability, several aspects must be considered, such as P/AI and days in milk (**DIM**) at first service, calving interval, and proportion of cows initiating a subsequent lactation.

Researchers have reported inconsistent results for P/AI for both strategies. Chebel and Santos (2010) and Dolecheck et al. (2016) reported no difference in P/AI between both strategies. In contrast, Stevenson et al. (2014) and Fricke et al. (2014) showed that first-service P/AI is greater for cows submitted to TAI compared with cows inseminated based on estrus. A recent meta-analysis, a method used to compile findings from several studies, demonstrated that submitting 100 % of cows to a TAI program for first service results in greater P/AI compared with a program that incorporates estrus detection (Borchardt et al., 2016). Although DIM at first service is an important aspect to consider when comparing both strategies, this indicator will be highly influenced by the design of the reproductive program. Programs that rely mostly on TAI can submit cows to first service in a desirable range of DIM. Conversely, reproductive programs that rely mostly on estrus detection may have extended DIM at first service because of cows in anovular condition, poor response to prostaglandin treatment(s), or inefficient estrus detection. Using prostaglandin to induce luteolysis and estrus expression is effective only in cows with a corpus luteum (**CL**) present. Cows in an anovular condition or not bearing a CL do not respond to prostaglandin treatment, resulting in delayed time to first AI, and consequently, impacting reproductive performance. Although programs that use 100 % TAI for first service may present greater P/AI and tighter timeframe for first service, compliance issues in protocols that require several treatments may prevent successful outcomes.

Ultimately, reproductive performance during the entire lactation should be considered when comparing both strategies. Chebel and Santos (2010) and Dolecheck et al. (2016) demonstrated no difference in the interval from calving to pregnancy between these strategies. Regarding economic outcomes, Galvão et al. (2013) compared profitability of reproductive programs using 100 % TAI, 100 % estrus detection, or a combination of TAI for first service and estrus detection incorporated at subsequent breedings. The most profitable program consisted of submitting cows for a TAI protocol for first service (95 % compliance of treatments) followed by subsequent services based on estrus detection (60 % estrus detection rate with 95 % accuracy) and TAI. Unfortunately, Galvão et al. (2013) did not evaluate a scenario in which a certain proportion of cows were inseminated in TAI for first service in programs focusing on inseminating cows based on estrus detection after the end of the voluntary waiting period (**VWP**). Nevertheless, it is expected that programs that focus on accurate and efficient estrus detection for first AI in addition to incorporating TAI should result in profitable and efficient reproductive programs.

An experiment being conducted by our research group will determine the impact of reducing the use of reproductive treatments before first AI. In this experiment, multiparous cows (n = 1,955) from 3 dairies located in the High Plains region underwent 1 of 2 programs: Presynch-Ovsynch56, or Presynch-Ovsynch70. Programs are outlined in Figure 1. Both programs focused on inseminating cows based on estrus after the end of the VWP (53 DIM). Cows submitted to Presynch-Ovsynch56 were treated with prostaglandin within 6 d after the end of the VWP. Cows submitted to Presynch-Ovsynch70 were treated with prostaglandin between 14 to 20 d after the end of the VWP. Although both reproductive programs consisted of strategies with minimal use of TAI protocols, the Presynch-Ovsynch70 protocol represents a scenario with minimum treatments before AI. Number of treatments per AI for both strategies are represented in Table 1. In addition, Table 1 depicts the estimated number of treatments per AI of reproductive programs that rely on TAI protocols for first service. Even though initiation of treatments were delayed for cows submitted to Presynch-Ovsynch70, 55 % of cows were inseminated before the first prostaglandin treatment, which suggests that farms with efficient estrus detection do not have to rely extensively on reproductive treatments. Furthermore, P/AI did not differ between Presynch-Ovsynch56 and Presynch-Ovsynch70. Considering that we exclusively enrolled multiparous cows, both programs resulted in acceptable pregnancy outcomes at 36 d after AI (38.6 %). Average number of treatments per pregnancy were 4.3 and 2.3 for Presynch-Ovsynch56 and Presynch-Ovsynch70, respectively. Number of treatments per pregnancy in programs with 100 % TAI for first service was estimated to be between 12.5 to 15.0 (Table 1). This demonstrates that in a scenario in which producers would have to reduce the number of reproductive treatments in lactating cows, limiting the percentage of cows submitted to a TAI protocol would be a reasonable approach. It is important to note that our research focused on multiparous cows. We purposely used only

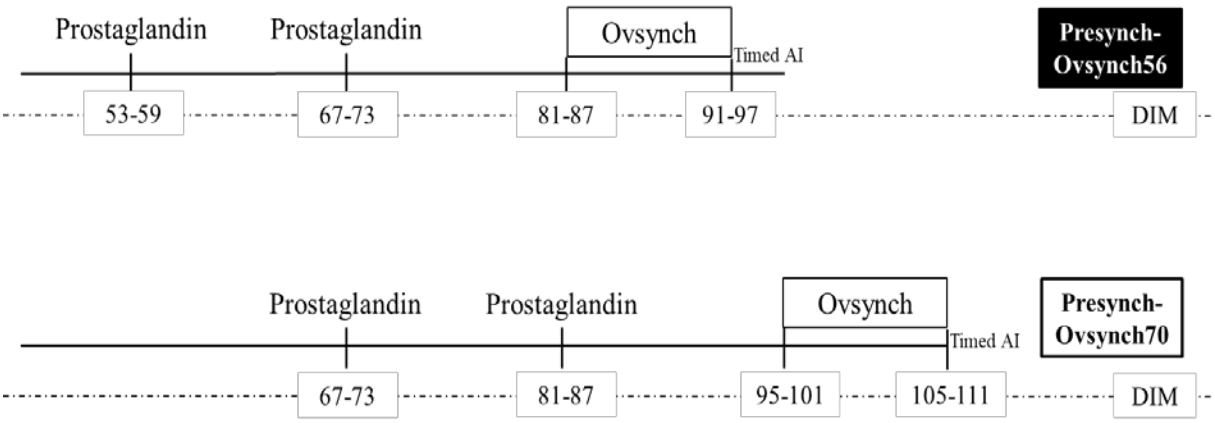

Figure 1. Outline of reproductive programs that evaluated the impact of reducing reproductive treatments of multiparous lactating cows. Programs consisted of treating cows with prostaglandin 14 d apart before initiating an Ovsynch protocol 14 d after the last prostaglandin treatment. Days in milk at initiation of treatments was the only difference between programs. Presynch-Ovsynch56 was started between 53 to 59 DIM and Presynch-Ovsynch70 was initiated between 67 to 73 DIM. Cows were deemed eligible to be inseminated after the end of the voluntary waiting period, which was 53 DIM. Estrus detection was performed once daily based on tail paint removal. Cows in estrus were inseminated and did not receive any further treatment related to first service.

Table 1. Estimated number of treatments before first service for multiparous cows submitted to reproductive programs focusing on timed AI (**TAI**) or AI based on estrus detection (**ED**)

	Reproductive programs[1]				
Item	Double-Ovsynch 100 % TAI	Presynch-Ovsynch36 100 % TAI	Presynch-Ovsynch36 ED + TAI	Presynch-Ovsynch56 ED + TAI	Presynch-Ovsynch70 ED + TAI
Average number of treatments per AI	6.0	5.0	2.9	1.5	0.8
Average number of treatments per pregnancy[2]	15.0	12.5	8.4	4.3	2.3
Cows receiving first treatment, %	100	100	100	88	45
Cows receiving second treatment, %	100	100	100	34	17
Cows receiving first GnRH of Ovsynch, %	100	100	30	10	7
Cows inseminated on TAI, %	100	100	28	8	5

[1] Presynch-Ovsynch consists of two prostaglandin treatments administered 14 d apart followed by an Ovsynch protocol initiated 14 d later. Days 36, 56, and 70 represent DIM at initiation of the program. In programs with ED, voluntary waiting period was assumed to be approximately 50 DIM.
[2] Estimated pregnancy per AI for cows submitted to 100 % TAI and ED + TAI programs were 40 % and 35 %, respectively.

multiparous cows in the study because this group of animals has poor reproductive efficiency compared with primiparous cows. Thus, our intent was to evaluate the impact of reducing treatments in cows that are less likely to become pregnant, and usually, represent a large proportion of cows in the herd (> 50 % of the lactating herd).

Median days to first AI and conception were greater ($P \leq 0.04$) for Presynch-Ovsynch70 compared with Presynch-Ovsynch56 (69 vs. 62 d and 108 vs. 102 d, respectively). Although median days to conception differed ($P = 0.04$) by 6 d between programs, the proportion of cows starting the subsequent lactation did not ($P = 0.75$) differ. The slight difference observed in days open between programs may not impact overall economic return. Our research group is currently collaborating with Dr. Victor Cabrera from the University of Wisconsin to evaluate the impact on profitability by reducing the number of reproductive treatments for first service. Despite the critical importance of determining economic impact of reducing number of reproductive treatments, it may become imperative to take into account labor required to implement reproductive programs in the future. Several factors (e.g., location of the farm, facilities, labor costs, etc.) may dictate the feasibility of implementing a specific program. Availability of workforce and compliance of treatments may be a limiting factor to rely on programs that require several treatments to create pregnancies.

REDUCING THE USE OF TIMED AI FOR COWS DIAGNOSED NOT PREGNANT

Resynchronization strategies that focus on reducing the use of TAI programs should rely on protocols that involve treating cows with prostaglandin upon non-pregnancy diagnosis, besides having an efficient and accurate estrus detection program. Because treatment with GnRH reduces estrus expression of lactating dairy cows (Mendonça et al., 2012), GnRH-based protocols are not the preferred option for resynchronization strategies if the goal is to minimize the use of TAI in a reproductive program.

Approximately 60 to 80 % of cows will be inseminated based on estrus detection after prostaglandin treatment upon non-pregnancy diagnosis (Bruno et al., 2013; Chebel et al., 2013; Rocha et al., 2014). Although a large proportion of cows is expected to respond to prostaglandin treatment, submitting a group of cows to TAI is inevitable to reduce reinsemination interval. In order to optimize resynchronization strategies when utilizing prostaglandin treatments, researchers have evaluated pregnancy outcomes of protocols based on ovarian structures present at non-pregnancy diagnosis. Even though it seems logical that cows not bearing a CL should not be treated with prostaglandin, submitting these cows to GnRH-based protocols (e.g., Ovsynch) may not be the best approach if the goal is to minimize the number of cows submitted to TAI. In a field trial conducted by our research group, we observed that cows not bearing a CL at non-pregnancy diagnosis and treated with prostaglandin have a similar reinsemination pattern compared with cows with a CL present (Figure 2). Absence of a CL at non-pregnancy diagnosis does not necessarily indicate that these cows are in an anovular condition. It is likely that a proportion of cows not bearing a CL might recently have undergone luteolysis. In fact, submitting cows in proestrus, the stage of the estrous cycle before estrus, to a GnRH-based protocol suppresses estrus expression and increases the likelihood of these cows being inseminated with TAI. In addition, accuracy of technicians in detecting the presence of a CL via ultrasound examination ranges from 57 to 70 % (Bicalho et al., 2008). Hence, determining specific reproductive protocols based on CL presence may result in a greater percentage of cows being inseminated with TAI if cows are submitted to a GnRH-based protocol.

In a scenario in which the goal is to minimize use of TAI programs, blanket treatment with prostaglandin at non-pregnancy diagnosis is one option. In situations when ovaries are being examined by ultrasonography, target treatment may be performed. In this case, cows bearing a CL may be treated with prostaglandin, and cows without a CL present may receive no treatment. Notwithstanding, further research is needed to evaluate the latter strategy. Cows not inseminated in estrus within 7 to 12 d after non-pregnancy diagnosis should be enrolled in a TAI protocol to ensure appropriate reproductive efficiency.

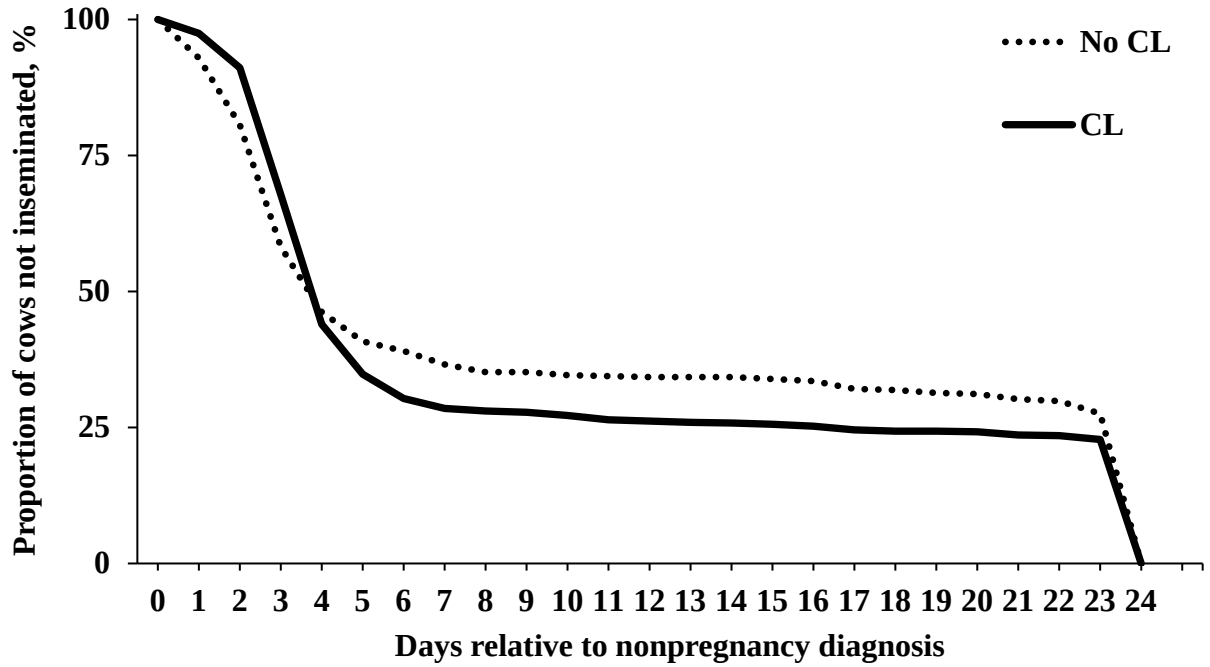

Figure 2. Survival curve for days to reinsemination according to ovarian structure from 1,479 cows from three dairies located in the High Plains region. Ovaries were scanned immediately after non-pregnancy diagnosis by transrectal ultrasonography by one experienced technician. Accuracy of corpus luteum (CL) detection was 80%, which was determined by comparing technician diagnoses with concentration of plasma progesterone from samples collected from a subgroup of cows (n = 210). Estrus detection was conducted after treating cows with prostaglandin at non-pregnancy diagnosis. Cows not inseminated based on estrus were submitted to a TAI protocol on d 7. Timed AI protocol consisted of the following treatments: GnRH on d 7, 14 and 24, and prostaglandin on d 21 (GGPG protocol). Mean days to reinsemination did not (P = 0.20) differ between cows with or without CL present (cows with CL = 9.0 ± 0.3 d and cows without CL = 10.2 ± 0.4 d). Fifty percent of cows were inseminated in the first 4 d after prostaglandin treatment.

CONCLUSIONS

It is likely that dairy farms with efficient and accurate estrus detection programs can achieve reproductive success in a scenario with limited use of synchronization protocols. Further research is needed to understand how facilities may impact reproductive efficiency of programs with reduced reproductive treatments. In fact, field trials evaluating profitability are the ultimate and critical step in determining whether reducing treatments will increase cost of production, which would demand further compensation for producers in such a setting. It is important to acknowledge that TAI protocols are comprised of treatments that are labeled for dairy cattle. These treatments are approved by the Food and Drug Administration (**FDA**) and present no risks to human health and safety.

Lastly, banning the use of reproductive treatments is cost-prohibitive. Timed AI protocols and synchronization programs are important management tools for dairy farmers to produce milk as the world population continues to grow. In addition, adoption of these tools positively impact cows' well-being by guaranteeing optimal reproductive performance. Cows with poor reproductive performance are more likely to become over-conditioned because of extended lactation, negatively impacting cow health and longevity.

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