Management Strategies to Optimize Reproductive Performance of Dairy Herds

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Take Home Messages

- A proactive, systematic, and consistent reproductive management program conducted by committed personnel that prioritizes attention to detail usually leads to successful reproductive performance of the dairy herd regardless of the approach and the level of technology utilized.

- Programs aimed at maximizing the insemination of cows after a detected estrus can be successful, however, they should be coupled with a synchronization of ovulation protocol for TAI to assure timely insemination of all cows.

- Synchronization of ovulation protocols to increase the fertility of first as well as second and subsequent TAI services are available and can be successfully implemented by dairy farms.

- Dairy farms seeking to optimize reproductive performance of their herds need to carefully evaluate the resources, personnel, and time available to implement a reproductive management program.

1. Introduction

Optimizing reproductive performance of lactating dairy cows is paramount to dairy farms because reproductive efficiency has a major impact on farm profitability. Because of the significant variation across farms in type of facilities, cows, and personnel, a thorough evaluation of the resources and conditions of a particular farm should be conducted before selecting a reproductive management program. Producers should work with their farm personnel, veterinarian, and consultants to select the strategy that optimizes reproductive performance while maximizing the profitability of the herd. Given the vast array of strategies available it may be challenging for producers to identify the program that best fits the needs of their farm. In many cases a proactive, systematic, and consistent reproductive management program conducted by detailed oriented and committed personnel leads to successful reproductive performance regardless of the approach and the level of technology utilized. This paper attempts to summarize recent research data generated to evaluate the implications of various reproductive management strategies that either favor AI after a detected estrus or through timed artificial insemination (TAI) for first as well as for second and subsequent AI services in lactating dairy cows.

2. Strategies for First AI service Postpartum

2.1Maximizing AI after a detected estrus

Maximizing insemination of cows after a detected estrus is the goal of numerous dairy farms, in particular for those that utilize an automated activity monitoring (**AAM**) system for detection of estrus or prefer to reduce their reliance on TAI programs.

In this regard some recent studies have focused on how to incorporate an AAM system into reproductive management programs for lactating dairy cows. For example, Fricke et al. (2014) evaluated potential strategies to incorporate an AAM system for first AI service postpartum only. In this study, a limited hormone intervention program that combined ED based on activity (**EDAI**) and the Ovsynch protocol for cows not inseminated in estrus was compared to the Presynch-Ovsynch protocol with (combined EDAI and TAI) or without (100% TAI) detection of estrus based on activity after the Presynch portion of the protocol. Despite differences in the rate at which cows were inseminated for first service, there were no differences in the rate at which cows became pregnant up to 300 DIM. The initial difference in the proportion of pregnant cows in favor of the 100% TAI program after first AI was compensated by the limited hormone intervention program and the combined Presynch-Ovsynch and ED program as DIM progressed (cows managed equally for subsequent AI services). An interesting finding of this study was that cows detected with increased activity after Presynch but not inseminated because were forced to receive TAI had greater P/AI than cows AI on activity after Presynch. As expected, due to the very similar reproductive performance during lactation (up to 300 DIM) there were no major economic differences between the three programs. The differences observed ranged from $8 to 4 per cow per year in favor of the 100% TAI program with Presynch-Ovsynch and the combined Presynch-Ovsynch and ED program, respectively. In this study, however, the comparison only included different programs for first service management without any specific interventions for cows failing to conceive after first service.

More recently, Stevenson et al. (2014) conducted a study to compare the reproductive performance of dairy cows managed with a program that relied on detection of estrus with an AAM system, induction of estrus with PGF, and TAI for cows not detected by the AAM system. This program consisted of a combination of induction of estrus with a PGF injection if cows were not inseminated 4 d after the end of a VWP of 50 DIM (91% of cows received PGF), were enrolled in a CIDR-Synch protocol if not AI by 75 DIM (7% of the cows) and, received TAI after resynchronization if failed to conceive after a third service (% of cows not reported). This program that combined ED and TAI was compared to a 100% TAI program with Presynch-Ovsynch and Ovsynch for the first 3 AI services postpartum. As expected the strategy that included the AAM system resulted in reduced days to insemination for first AI service (12 d for primiparous and 7 d for multiparous) because of a VWP of 50 DIM versus 71 DIM for cows enrolled in the TAI strategy. Fertility of cows was affected by a treatment by parity interaction with no difference for primiparous cows whereas greater P/AI was reported for multiparous cows receiving TAI than those inseminated in estrus. On-farm records (values obtained from PCDart not analyzed statistically) also showed a numerical difference in favor of the TAI program for P/AI (44 vs. 35%) across all 3 first services but a greater estrus detection rate (74 vs. 42%) and percentage of cows pregnant by 150 DIM (68 vs. 52%) in favor the program that used the AAM system.

In summary, the majority of recent research studies seem to indicate that AAM systems (and maybe any other efficient and accurate method of estrus detection) can be successfully used by dairy farms to inseminate cows for their first AI postpartum. Nevertheless, due to physiological limitations presented by lactating dairy cows or technical limitations of these systems that lead to inaccuracy of detection of estrus it seems clear that AAM systems should be used in combination with synchronization of estrus and ovulation protocols for TAI.

Although submitting healthy cows for insemination is critical for the success of every reproductive management program, it may even be more critical for programs that rely heavily on insemination after a detected estrus. Because the goal is to inseminate as many cows as possible in estrus, farms should strive to have cows that have resumed cyclicity and are physically sound to express estrus behavior (i.e., do not present lameness, impediments to normal locomotion, injuries) by the end of the voluntary waiting period. This is relevant because mounting evidence is linking health during the early postpartum period to estrus expression and overall reproductive success.

2.2 Increasing Fertility through TAI services

In general, strategies aimed at increasing the fertility of TAI services entail more complex synchronization of ovulation protocols that require more injections during one or more days of the week. Therefore, such strategies might be a good resource for dairy farms with dairy management software available and/or for farms in which cows are less likely to express estrous behavior due to biological limitations observed in lactating dairy cows or management constrains (e.g., tie-stall facilities, poor flooring). Also, these more complex protocols may be an excellent resource for dairy farms that want to increase fertility of AI services after failing to do so through estrus-based inseminations. Due to the increased complexity of these programs it is paramount that farm personnel critically examine the feasibility of consistently running such programs at the dairy and determine whether this is the best alternative for the herd.

Although other protocols have been examined in research studies, the most common protocols used to increase fertility of TAI for first service are the Presynch-Ovsynch (used exclusively for TAI; Moreira et al., 2001), Double-Ovsynch (Souza et al., 2008), and G-6-G (Bello et al., 2006) protocols. Although these protocols vary in complexity and the type of hormone injections used, in general they have all been designed with the goal of improving the overall response of cows to the protocol through presynchronization of the estrous cycle before the initiation of the Ovsynch-56 protocol (Breeding Ovsynch) for TAI (Figure 1). These protocols work by synchronizing estrus (Presynch-Ovsynch) or ovulation (Double-Ovsynch and G-6-G) so that cows are approximately on day 6 to 9 of the estrous cycle at the initiation of the breeding Ovsynch portion of the protocol (Figure 1). Cows at that stage of the estrous cycle should have a growing CL and an ovarian follicle (≥ 10 mm) responsive to the 1st GnRH injection Ovsynch-56 (Figure 1).

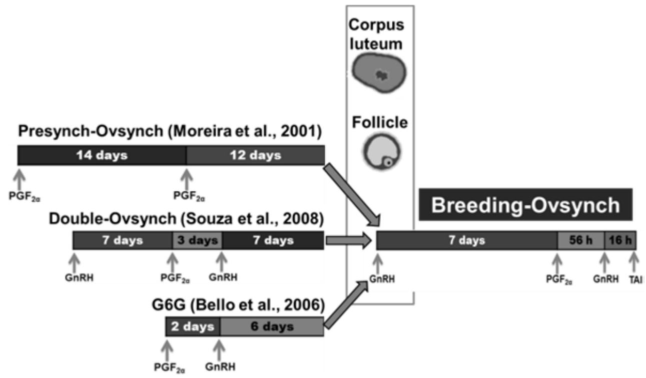

Figure 1. Schematic representation of 3 different protocols that include presynchronization of the estrous cycle before the Ovsynch-56 protocol for first AI service postpartum.

Numerous large field research studies have confirmed that these protocols improve P/AI when compared to the Ovsynch protocol without presynchronization of the estrous cycle. Thus, when these programs are correctly implemented producers should expect a 7-to-15 percentage point gain in P/AI as compared to the Ovsynch protocol alone. Some of these studies also suggest that the Double-Ovsynch protocol results in greater fertility than the Presynch-Ovsynch protocol (Herlihy et al., 2012). Likely this is because the Double-Ovsynch protocol resolves anovulation more effectively than the Presynch-Ovsynch protocol which depends largely on the enrollment of previously cycling cows to successfully synchronize ovulation (Herlihy et al., 2012). It is worth noting that the largest differences in fertility between these protocols have been observed for primiparous and multiparous cows. Indeed, observations from numerous dairy farms using the Double-Ovsynch protocol confirm that primiparous cows can achieve very high P/AI, often times ≥ 50-55%. More recently researchers have explored different alternatives to maximize the fertility of TAI with protocols that include presynchronization of the estrous cycle. One feasible alternative to increase fertility is to increase CL regression before TAI by giving an additional injection of PGF 12 or 24 h after the first PGF injection of the breeding Ovsynch. Obviously, there will be an increased labor demand and cost of the program but recent studies have shown an increment of ~4-to-5 percentage points in P/AI. Whether this strategy is suitable for all dairy farms and worth economically should be carefully evaluated by each particular dairy operation.

An important consideration at the time of selecting GnRH-based presynchronization programs such as Double-Ovsynch and G-6-G is that a relatively low proportion of cows will display estrus during the treatments. Therefore, producers will not be able to inseminate a high proportion of cows at a detected estrus. In fact, these programs will result in a majority of cows receiving a TAI service. Producers using protocols that include presynchronization of the estrous cycle before Ovsynch-56 for first service TAI should expect P/AI in the range of 45 to 55%.

3. Strategies for Second and Subsequent AI Services

3.1.1 Considerations for second and subsequent AI services management Because up to 70% of cows may fail to conceive after previous AI services, maximizing fertility and minimizing the interval between inseminations for second and subsequent AI services remains a main objective of reproductive management programs. Indeed recent economic evaluations of the value of reducing the interbreeding interval demonstrate substantial gains in cow profitability when the interbreeding interval is reduced, in particular for herds with poor detection of estrus (Giordano et al., 2013).

Likely, the major impact of implementing a resynchronization protocol for TAI in a commercial dairy operation is to assure the insemination of cows within a predefined time frame after the previous AI service to avoid lengthening of the interbreeding interval. Because the major benefit of a typical resynchronization program is to inseminate cows on TAI after they either fail to display estrus or were not detected rather than improving fertility, the systematic initiation of resynchronization at a predefined number of days after a previous AI service is critical. In dairy farms that use solely detection of estrus or choose not to use a resynchronization program after the previous AI, the pattern of re-insemination is characterized by a large variation among cows and extended periods of time without re-insemination for a significant proportion of cows (Figure 2A). Despite the fact that when estrus detection is efficient the majority of cows will be re-inseminated in estrus within 30 d of the previous AI, it is typical to observe that 30 to 40% of cows will not receive AI for up to 50 to 70 d after their previous AI and some cows will not be re-inseminated for up 90 to 100 d. Such a pattern of re-insemination for second and subsequent services is detrimental to the overall reproductive performance of the herd because the over-extended interbreeding interval for cows inseminated beyond 42 d (two 21-d cycles) after the previous AI will dramatically reduce the 21-d service rate, hence, the rate at which cows become pregnant. Conversely, dairy herds that systematically use a resynchronization program to re-inseminate cows not detected in estrus will benefit by a major reduction of the interbreeding interval for cows that receive TAI. For example, when estrus detection is combined with resynchronization initiated on a weekly basis at 32 ± 3 d after a previous AI, the pattern of re-insemination will be characterized by a reduced variation of the interbreeding interval. More importantly all cows will be re-inseminated by 45 d after TAI (Figure 2B). As a result, it is likely that the 21-d service rate will increase, hence, the overall reproductive performance of the herd.

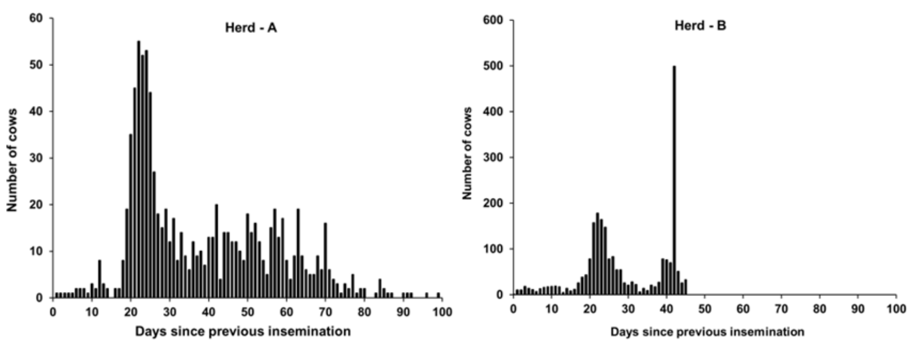

Figure 2. Distribution of re-inseminations for cows failing to conceive to a previous AI service in dairy herds using different management strategies for second and subsequent AI services. In Herd A, the majority of cows are AI after detection of estrus and no systematic use of resynchronization of ovulation is used. In Herd B, a combined approach is used with detection of estrus and TAI. All cows not detected in estrus and inseminated after their previous AI begin the resynchronization protocol 32 ± 3 d after AI to receive TAI 42 ± 3 d after the previous AI. Note the substantial number of cows not re-inseminated beyond 42 d (two 21-d cycles) of their previous AI in herd A as opposed to herd B.

3.1.2 Improving the fertility of cows without a corpus luteum in a resynchronization protocol

A very well-documented problem with lactating dairy cows enrolled in the Ovsynch protocol for resynchronization of ovulation is that cows that lack a functional CL at the time of the PGF injection will have reduced fertility when compared to cows with a CL (Giordano et al., 2012a; others). In general this problem affects ~10 to 30% of all cows resynchronized with Ovsynch and the reduction in fertility is in the order of 15 to 20% percentage points (50-60% reduction). Because in many dairy farms the day of the PGF injection coincides with the day of NPD, re-assigning cows with no CL (as determined by transrectal ultrasound) to a new treatment that improves their fertility if submitted to TAI is an alternative to improve overall fertility of second and subsequent AI services. Therefore, we recently conducted a study in 5 commercial dairy farms in NY State to test two different treatments for cows with no CL at the time of the PGF injection and NPD in cows resynchronized with the Ovsynch-56 protocol. In a preliminary study including 872 cows we first determined that a cutoff of 15 mm or less was the best size to separate cows with or without a CL at the time of the NPD 39 ± 3 d after AI and 7 d after receiving the first GnRH injection of the Ovsynch protocol. We confirmed that for cows without a CL or a CL of < 15 mm in diameter P/AI were 14% vs. 33% (P< 0.001) for cows considered to have a CL. For the follow up randomized controlled study, cows without a functional CL were enrolled into the experimental treatments as follows: 1) Ovsynch+Progesterone (P4): re-initiation of the Ovsynch protocol with progesterone supplementation via a CIDR device (EAZI BREED CIDR, Zoetis Animal Health, New York, NY) from the time of the GnRH to PGF injection of Resynchronization, and 2) PreG-Ovsynch: presynchronization of the estrous cycle with a GnRH injection 7 d before the initiation of the Ovsynch protocol. Interestingly in this study both treatments restored fertility of cows without a CL. Indeed, overall P/AI were similar between the groups (34.4 and 37.0% for Ovsynch+P4 and PreG-Ovsynch; Table 1) but much greater than that observed in the preliminary study for non-treated cows without a CL and what has been reported in the literature (10 to 15% P/AI). Thus, dairy producers have the option of using either one of these treatments to improve the fertility of cows with no CL. Farms that prefer to use the Ovsynch+P4 protocol will have the added labor required to use the P4 releasing devices but will breed cows one week earlier than if the PreG-Ovsynch program is used. A slightly greater proportion of cows might be inseminated after a detected estrus with the PreG-Ovsynch protocol.

Table 1. Pregnancies per AI for cows enrolled in a Ovsynch+P4 or a PreG-Ovsynch protocol after non-pregnancy diagnosis 39 ± 3 d after AI.

	Treatment		
Item	Ovsynch+P4	PreG-Ovsynch	P-value
P/AI at 39 d			
EDAI[1]	41.4 (12/29)	29.3 (12/41)	0.42
TAI	33.3 (61/183)	39.1(59/151)	0.37
Overall	34.4 (73/212)	37.0 (71/192)	0.57

[1]Cows AI after a detected estrus after enrollment at 39 ± 3 d after AI

3.2 <u>Maximizing AI after a detected estrus</u>

Maximizing insemination of cows after a detected estrus for second and subsequent AI services may be the goal of numerous dairy farms, in particular for those that utilize an automated activity monitoring (**AAM**) system for detection of estrus or prefer to reduce their reliance on TAI programs. Therefore, we recently conducted a study (Giordano et al., 2015) at a commercial dairy farm in New York to evaluate the impact of a reproductive management program aimed at increasing the proportion of cows AI based on physical activity (**AIAct**) after non-pregnancy diagnosis (**NPD**) and the fertility of cows reaching TAI after not being detected in estrus. To maximize the efficacy of this program, nonpregnant cows were assigned to treatments according to their ovarian status at the time of NPD. Cows enrolled in the treatment group (**TRT**; n = 616) were eligible to receive AIAct any time after a previous AI and were enrolled in two different synchronization of estrus and ovulation protocols based on the ovarian structures present on their ovaries at the time of non-pregnancy diagnosis (**NPD**). Cows bearing at least one CL (**TRT-CL**) of ≥ 20 mm in diameter received an injection of PGF (32 ± 3 d after AI) to synchronize estrus and were AIAct during 9 d after the injection (Figure 3). Cows not AIAct after the PGF injection were enrolled in a 5d-Ovsynch protocol with progesterone supplementation (**5 d-Ovsynch + P4**; GnRH + CIDR insertion-5 d-PGF + CIDR removal-1 d-PGF-32 h-GnRH-16 to 20 h-AI) to receive their next TAI service. Cows not bearing a CL or a CL <20 mm in diameter (**TRT-NoCL)** were AIAct for two additional days after enrollment (Figure 3). Cows not AIAct received an injection of GnRH for presynchronization (34 ± 3 d after A) of the estrous cycle and were enrolled in the 5 d-Ovsynch + P4 protocol 7 d later to receive TAI. The TRT program was compared to a very simple and typical strategy (**CON**) used by dairy farms which combines detection of estrus and resynchronization for TAI with the Ovsynch-56 protocol initiated 32 ± 3 d after AI.

The main objective of this study was to evaluate if our Treatment (**TRT)** strategy (Figure 3) would increase the proportion of cows inseminated after a detected estrus and reduce time to pregnancy during lactation.

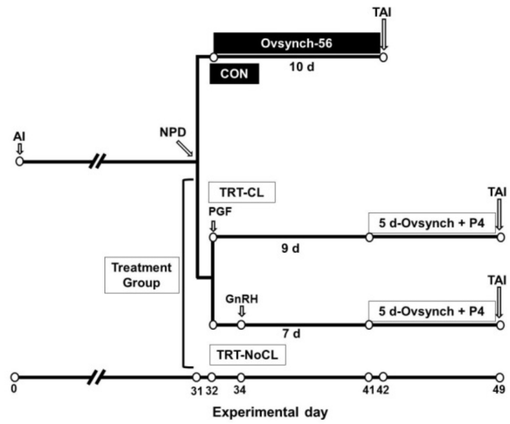

Figure 3. Schematic representation of experimental procedures for cows enrolled in the CON and TRT group (see text for details).

Interestingly, the rate at which cows became pregnant up to 270 DIM was similar between the two groups when evaluated including first AI service postpartum or starting at 104 DIM (Figure 4). Therefore, the results of the present study do not support the hypothesis that the more complex TRT strategy would be superior to the simple and widely adopted strategy used for cows in the CON group. Nevertheless, in support of our hypothesis, more cows received insemination after a detected estrus in the TRT group. Cows assigned to this group received PGF or GnRH based on the presence or absence of a CL at NPD. Interestingly, the additional percentage of cows AIAct for this group was below our expectations with only ~20% more cows receiving AIAct in the TRT than in the CON group. The fact that 65% (69.5% of the multiparous and 54.8% of the primiparous cows) of the cows met the criterion to be included in the TRT-CL group certainly contributed to the low percentage of cows AIAct. This is not surprising for nonpregnant previously inseminated lactating dairy cows and is in agreement with previous studies that evaluated the presence of a CL at NPD around 30 d after AI (McArt et al., 2010; Giordano et al., 2012a; Chebel et al., 2013). Certainly the relatively low proportion of cows with a CL ≥ 20 mm at NPD and the poor estrous response of cows to the PGF injection in the TRT-CL group contributed to the lower rate at which cows were inseminated after treatment and the lack of difference in the rate at which cows became pregnant during their lactation. This also resulted in 70% of the cows enrolled in the TRT group after NPD receiving TAI 49 ± 3 d after their previous AI which contrasts to 42 ± 3 d to re-insemination for cows in the CON group. Our results suggest that for a strategy aimed at increasing AI after a detected estrus coupled with a delayed initiation of the TAI protocol, the minimum proportion of cows to inseminate in estrus to avoid detriment to the herd reproductive performance is ~30%.

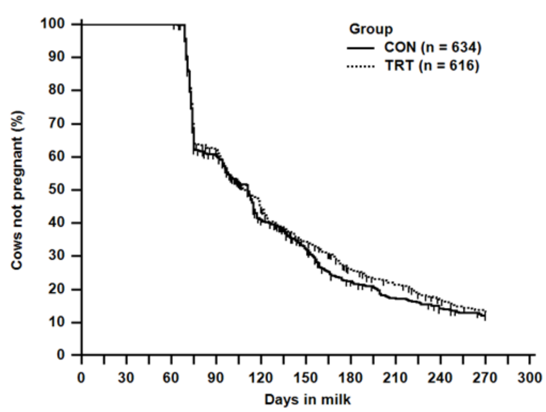

Figure 4. Survival curves for days to pregnancy from the end of the VWP until 270 DIM for cows in the CON (n = 634) and TRT (n = 616) group. The hazard of pregnancy was similar (P = 0.28) for cows in the CON and the TRT group (HR 1.07; 95% CI 0.95 to 1.21). Median days to pregnancy were 111 and 110 days for cows in the CON and the TRT group, respectively.

In summary, the results of this study support the notion that dairy farms have the option to either select a strategy that attempts to increase the proportion of inseminations based upon detection of estrus after NPD or else use a more aggressive resynchronization of ovulation strategy that assures re-insemination of cows within 10 d of NPD. When the former is used, it is imperative that a TAI protocol is included immediately after completion of the period intended to inseminate cows in estrus. This is even more relevant for farms that due to biological limitations from the lactating dairy cow or the myriad of environmental and management factors that affect estrus expression and detection cannot detect a high proportion of cows in estrus after NPD. It is uncertain at the moment whether the use of a more complex, labor intensive and costly protocol such as the 5 d-Ovsynch + P4 protocol and presynchronization of cows with GnRH is necessary to maximize the fertility of cows not inseminated in estrus or not bearing a CL at the time of NPD.

3.3 *Increasing fertility of TAI services through Presynchronization of the Estrous Cycle before Initiation of Resynchronization*

Despite improving overall service rate and decreasing the interbreeding interval, pregnancies per AI (P/AI) for resynchronized services with Ovsynch are almost always less than those at first service. One reason for the poor fertility to resynchronized services is that between 15 to 25% of cows lack a CL or have low progesterone (P4) at initiation of resynchronization and probably more important and overall poor response to the protocol. Indeed, only ~50% of cows will be correctly sychronized (Giordano et al., 2012a). As a result of the lack of major improvement in the fertility of dairy cows inseminated after resynchronization with Ovsynch alone or its variants, in recent years there has been interest in the development of new resynchronization strategies to improve fertility of lactating dairy cows after second and subsequent AI service.

To improve the fertility of resynchronized AI services, different strategies have been used to presynchronize the estrous cycle of cows before initiation of synchronization of ovulation protocols for TAI (Silva et al., 2007; Dewey et al., 2010; Giordano et al., 2012a,b; Lopes Jr. et al., 2013). As for first AI service, a major goal of presynchronization is to have a functional CL and a follicle capable of ovulating in response to the first GnRH injection of the Resynchronization protocol. Moreover, presynchronization may also induce cyclicity in cows that become or remain anovular after the previous AI service.

A major limitation of using presynchronization of the estrous cycle before resynchronization is the potential lengthening of the interval between two successive AI services which may decrease the overall reproductive efficiency of the herd if the fertility of TAI services is not sufficiently high to compensate for the longer interbreeding interval. As opposed to first service, the pregnancy status of cows after a previous AI is unknown for a variable period of time depending on the non-pregnancy diagnosis method being used at the farm. At best, the earliest the pregnancy status is known with acceptable accuracy is 28 to 29 d after AI when using transrectal ultrasonography or a chemical test and 35 d when using rectal palpation. Indeed, as the majority of the protocols require the administration of at least one PGF2α injection, they cannot be completed until the pregnancy status of cows is known. Thus, the interval between AI services is determined by the timing of the non-pregnancy diagnosis when cows in need of resynchronization are identified.

3.3.1 *Presynchronization of Resynchronized AI Services with PGF2α, GnRH, hCG, or their combination*

Given the improvement in P/AI after presynchronization of ovulation with PGF2α for first service (Moreira et al., 2001), Silva et al. (2007) evaluated the use of a single dose of PGF2α 12 d before the initiation of Ovsynch for resynchronization of ovulation and TAI. Interestingly, presynchronization with a single PGF2α injection improved P/AI by approximately 7% at 31 (31.1 vs. 38.5% for control and treatment, respectively) and almost 10% at 66 d (25.6 vs. 35.2% for control and treatment, respectively) after TAI. Despite a major improvement in fertility of TAI services with the PGF2α pre-treatment, a drawback of this presynchronization strategy was the extended length of the interbreeding interval (56 d) which may decrease overall reproductive efficiency in herds relying heavily on TAI for second and subsequent AI services. Indeed, the resulting interbreeding interval for presynchronized cows was 56 d as opposed to 42 d for the controls.

Alternatively, several studies have tested the use of GnRH to presynchornize the estrous cycle before the initiation of Ovsynch at different days after AI. For example, Dewey et al. (2010) reported an improvement in fertility of about 8 percentage points when cows were presynchronized with GnRH 7 d before initiation of Ovsynch at 39 ± 3 d after a previous AI (GGPG protocol) in cows not previously detected in estrus and inseminated. In agreement, Lopes Jr. et al. (2013) reported an increase of 5 percentage points for P/AI in lactating cows resynchronized with GGPG initiated at either 25 or 32 d after TAI. Likewise, Giordano et al. (2012b) reported a 4 percentage point increase in P/AI when 100% of cows received TAI after the GGPG protocol initiated 18 d after a previous AI. Taken together, the results of these studies demonstrated that a single GnRH injection 7 d before the initiation of Ovsynch could be an effective strategy to increase the fertility of lactating dairy cows receiving second and subsequent AI service. The response to a presynchronizing GnRH injection will likely be 4-to-5 percentage points in P/AI.

Besides GnRH, human Chorionic Gonadotropin (hCG) has been proven effective to presynchronize the estrous cycle before Ovsynch in lactating dairy cow (Giordano et al., 2012b). Indeed, a 2000 IU dose of hCG 18 d after a previous AI increased P/AI by 9 and 8 percentage points when compared to non-presynchronized cows in two different studies with lactating dairy cows (Giordano et al., 2012b). When compared to presynchronization with GnRH, hCG was even more effective to increase fertility (4 vs. 8 percentage points for GnRH and hCG, respectively) possibly through greater ovulatory response to hCG that resulted in more cows having a functional CL at the beginning of Ovsynch (Giordano et al., 2012b).

The benefits and drawbacks of presynchronization of the estrous cycle before resynchronization should be evaluated before protocol implementation. For example, presynchronization of the estrous cycle before initiating a resynchronization program is likely to improve the fertility of TAI services. The expected improvement in fertility may vary from 4 to 9-percentage points depending on the agent used for presynchronization. However, a reduction in estrus expression will be observed when started before the expected time of estrus expression after a previous AI. Reducing estrus expression by induction of ovulation will likely lead to frustrations if a goal of the farm is to AI cows in estrus. In fact, this type of strategy might be the most useful for herds that have difficulties detecting a high proportion of cows in estrus after a previous AI and not for those farms with a good track record of high estrus detection efficiency.

4. Final Considerations at the time of Selecting a Reproductive Management Program

Because of the significant variation across farms in type of facilities, cows, and personnel, a thorough evaluation of the resources and conditions of a particular farm should be conducted before selecting a reproductive management program. Producers should work with their farm personnel, veterinarian, and consultants to determine, from the vast array of available strategies, the program that can be realistically applied by the farm to achieve specific reproductive goals. Often times a proactive, systematic, and consistent reproductive management program conducted by committed personnel that prioritizes attention to detail leads to successful reproductive performance of the dairy herd regardless of the approach and the level of technology utilized.

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References

Bello, N. M., J. P. Steibel, and J. R. Pursley. (2006) Optimizing ovulation to first GnRH improved outcomes to each hormonal injection of ovsynch in lactating dairy cows. J Dairy Sci 89(9):3413-3424.

Chebel, R. C., A. A. Scanavez, P. R. Silva, J. G. Moraes, L. G. Mendonca, and G. Lopes, Jr. (2013) Evaluation of presynchronized resynchronization protocols for lactating dairy cows. Journal of dairy science 96(2):1009-1020.

Dewey, S. T., L. G. Mendonca, G. Lopes, Jr., F. A. Rivera, F. Guagnini, R. C. Chebel, and T. R. Bilby. (2010) Resynchronization strategies to improve fertility in lactating dairy cows utilizing a presynchronization injection of GnRH or supplemental progesterone: I. Pregnancy rates and ovarian responses. Journal of dairy science 93(9):4086-4095.

Fricke, P. M., J. O. Giordano, A. Valenza, G. Lopes, Jr., M. C. Amundson, and P. D. Carvalho. (2014) Reproductive performance of lactating dairy cows managed for first service using timed artificial insemination with or without detection of estrus using an activity-monitoring system. Journal of dairy science 97(5):2771-2781.

Giordano J.O., Wiltbank M. C., Bas S., Cunha A.P., Pawlisch R.A., Guenther J.N., and Fricke P.M. (2012a) Increased fertility in lactating dairy cows resynchronized with Double-Ovsynch compared with Ovsynch initiated 32 d after timed artificial insemination. Journal of Dairy Science. 95:639-53.

Giordano J.O., Wiltbank M.C., Guenther J.N., Ares M.S., Lopes Jr. G., Herlihy M.M., Fricke P.M. (2012b) Effect of presynchronization with human Chorionic Gonadotropin (hCG) or GnRH 7 d before resynchronization of ovulation on fertility in lactating dairy cows. J Dairy Sci. 95:5612-25.

Giordano J.O, P.M. Fricke, and V.E. Cabrera. (2013) Economics of resynchronization strategies including chemical tests to identify nonpregnant cows. Journal of Dairy Science. 96:949-961.

Giordano J.O., Stangaferro M.L., Wijma R., and Watters, R.D. (2015) Reproductive performance of dairy cows managed with a program aimed at increasing insemination of cows in estrus based on increased physical activtiy and fertility of timed artificial inseminations. J. Dairy Sci. (*In Press*).

Herlihy, M.M., Giordano, J.O., Souza, A.H., Ayres, H., Ferreira, R.M., Keskin, A., Nascimento, A.B., Guenther, J.N., Gaska, J.M., Kacuba, S.J., Crowe, M.A., Butler, S.T., and Wiltbank, M.C. (2012) Presynchronization with Double-Ovsynch improves fertility at first postpartum artificial insemination in lactating dairy cows. J Dairy Sci. 95:7003-14.

Lopes, G., Jr., J. O. Giordano, A. Valenza, M. M. Herlihy, J. N. Guenther, M. C. Wiltbank, and P. M. Fricke. (2013) Effect of timing of initiation of resynchronization and presynchronization with gonadotropin-releasing hormone on fertility of resynchronized inseminations in lactating dairy cows. J Dairy Sci 96(6):3788-3798.

McArt, J. A., L. S. Caixeta, V. S. Machado, C. L. Guard, K. N. Galvao, O. G. Sa Filho, and R. C. Bicalho. (2010) Ovsynch versus Ultrasynch: reproductive efficacy of a dairy cattle synchronization protocol incorporating corpus luteum function. J Dairy Sci 93(6):2525-2532.

Moreira, F., C. Orlandi, C. A. Risco, R. Mattos, F. Lopes, and W. W. Thatcher. (2001) Effects of Presynchronization and Bovine Somatotropin on Pregnancy Rates to a Timed Artificial Insemination Protocol in Lactating Dairy Cows. J Dairy Sci 84(7):1646-1659.

Silva, E., R. A. Sterry, D. Kolb, M. C. Wiltbank, and P. M. Fricke. (2007) Effect of pretreatment with prostaglandin F2alpha before resynchronization of ovulation on fertility of lactating dairy cows. J Dairy Sci 90(12):5509-5517.

Souza, A. H., H. Ayres, R. M. Ferreira, and M. C. Wiltbank. (2008) A new presynchronization system (Double-Ovsynch) increases fertility at first postpartum timed AI in lactating dairy cows. Theriogenology 70(2):208-215.

Stevenson, J. S., S. L. Hill, R. L. Nebel, and J. M. DeJarnette. (2014) Ovulation timing and conception risk after automated activity monitoring in lactating dairy cows. J Dairy Sci 97(7):4296-4308.