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Enhancing Fertility of Lactating Dairy Cows

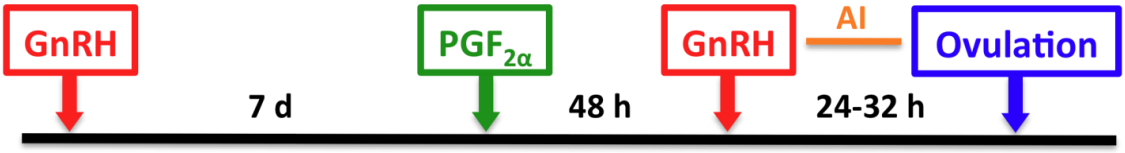
Richard Pursley and João Paulo Martins
Dept. of Animal Science

Introduction

The lactating dairy cow is not as fertile as she once was. And the likely culprit is not going to go away. But wait, there's hope for ol' Bessie. This story will outline the likely reasons for the decline of dairy cow fertility and discuss reproductive management methods to help alleviate this problem.

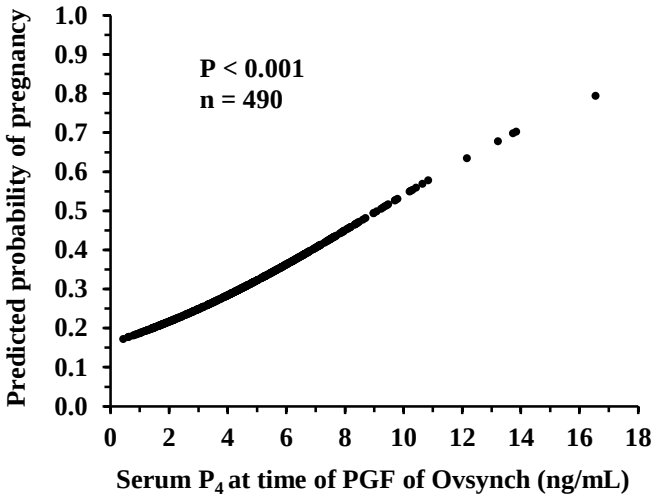
Infertility of the lactating dairy cow continues to be a critical problem limiting profitability and sustainability of dairy farms [1, 2]. Reproductive performance of lactating dairy cows is dependent upon service rate (or estrus detection rate), fertility of the service sire, and maternal fertility. Service rate can be controlled utilizing Ovsynch technology (Figure 1; [3, 4]). The majority of dairy producers in the U.S. regulate time to 1st and subsequent artificial inseminations (AI) with Ovsynch technology [5]. High fertility sires can be chosen utilizing the USDA-ARS sire conception rate summaries. Yet, maternal fertility, defined as the mother's ability to ovulate a competent oocyte and provide an oviductal and uterine environment capable of fertilization and complete embryonic and fetal development, continues to be the key limiting factor for profitable reproductive performance in lactating dairy cows. Conception rates of lactating cows are approximately 30% (unpublished data from our laboratory) compared to 60% in virgin dairy heifers [4, 6] when inseminated following a detected estrus. Increasing conception rates of lactating cows to that of heifers would allow producers to employ the most profitable calving interval strategies for cows with different production levels and increase profit. However, aspects of maternal fertility that are limiting to conception and embryonic/fetal development, and methods whereby Ovsynch can be modified to enhance maternal fertility while continuing to control service rate, are becoming better understood.

Figure1: Description of the original Ovsynch program utilizing GnRH and PGF to control the time of ovulation in lactating dairy cows.



Why is fertility compromised in the lactating dairy cow?
A significant change in circulating concentrations of steroid hormones takes place following the transition from heifer to lactating cow. Data from Sartori et al., 2004 [7] describe a number of differences in reproductive measurements in heifers vs. lactating cows. Progesterone (P4) and estrogen concentrations in circulation are quite different in cows compared to heifers. Even though the corpus luteum (the structure in the ovary that produces progesterone) and ovulatory follicle (the structure in the ovary that produces estrogen and ovulates the egg) are larger in cows vs. heifers, serum concentrations of these two hormones are reduced by about 50% in cows versus heifers. Duration of estrus is also longer in heifers. This is likely due to greater amounts of estrogen in circulation compared to cows. The difference in progesterone appears to influence follicle growth by prolonging the age of the ovulatory follicle. Oocytes (eggs) from this ovulatory follicle may be less competent to fertilize or develop into a competent embryo compared to oocytes from heifers with greater concentrations of progesterone [9].

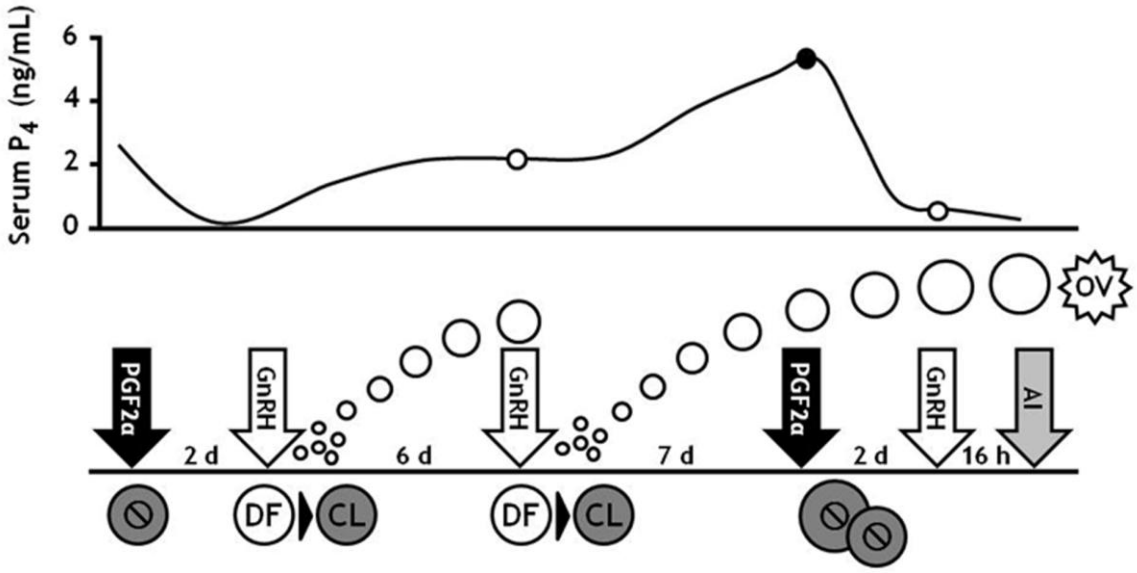
Figure 2: Predicted probability of pregnancy based on concentrations of progesterone (P_4) at time of PGF administration in Ovsynch for cows with functional corpus luteum (CL) at time of treatment (n = 490).
**Predicted probability (chance) of pregnancy: 0.0 = 0%; 0.5 = 50%; 1.0 = 100%.*



What is causing the differences in these reproductive parameters between cows and heifers and are they really important in fertility of dairy cattle?
Wiltbank and co-workers at the University of Wisconsin-Madison have very eloquently delineated the relationship in the parameters described above and lactation [10]. In studies that compared high producing dairy cows, heifers and non-pregnant dry cows, these scientists found that dry matter intake differences had a dramatic impact on circulating concentrations of progesterone and estrogen. These hormones are primarily metabolized in the liver. Above studies showed that when dry matter intake was increased so was blood flow through the liver. Thus, it appears that the greater the blood flow through the liver, the greater steroid hormone metabolism, resulting in less estradiol and progesterone remaining in circulation (Figure 2). So, it appears that lactation per se is not the root of the problem. It appears that the reduced hormone

concentrations are associated with the very large amount of dry matter that lactating cows must consume in order to produce large amounts of milk.

Figure 3: Description of control of follicle and CL development utilizing a simple PGF – GnRH pre-synchronization scheme (G6G). The initiation of Ovsynch on d 6 of the estrous cycle induces the ovulation of a dominant follicle (DF) and forms an accessory corpus luteum (CL) which increases progesterone (P4) prior to PGF of Ovsynch.
Φ= luteolysis, OV= ovulation, AI= artificial insemination



How can we resolve this problem?
Our data strongly suggest that initiating Ovsynch on d 6 or 7 of the estrous cycle induces ovulation to the 1st GnRH > 90% of the time and induces an accessory corpus luteum (CL) thereby increasing concentrations of progesterone prior to prostaglandin $F_{2\alpha}$ (PGF) of Ovsynch 7 d later [11]. Inducing ovulation and a new accessory CL also induces a new follicular wave and the growth of a new dominant follicle. This allows for greater control of ovulation of a young yet mature ovulatory follicle.

Evidence that GnRH induction of accessory CL during Ovsynch increases progesterone concentrations at time of PGF of Ovsynch
Multiple strategies have been previously tested to increase progesterone prior to PGF injection of Ovsynch. In studies that used exogenous progesterone (controlled progesterone releasing intravaginal device or CIDR) to achieve greater concentrations of progesterone prior to AI, there was no significant increase in progesterone on d of PGF of Ovsynch or in resulting conception rates of cycling cows [12]. In cycling cows with a CIDR, concentrations of progesterone were 2.7 versus 2.8 ng/mL in cows without a CIDR [12]. Thus, use of a CIDR does not represent a viable strategy to increase progesterone concentrations and enhance fertility in lactating dairy cows. We therefore examined the possibility that GnRH inducement of an *accessory* CL during Ovsynch could be used to more effectively enhance progesterone concentrations. As mentioned above, when cows were on d 6 of the estrous cycle when the 1st GnRH of Ovsynch was initiated, 97% ovulated a first wave dominant follicle *and* formed an *accessory* CL. When the PGF of Ovsynch was administered 7 d later, cows that ovulated had both a primary d 13 CL *and* a d 7 *accessory* CL and correspondingly greater (P > 0.004) circulating concentrations of progesterone at time of the PGF of

Ovsynch compared with cows that did not receive GnRH and only had a d 13 CL (Figure 3). Thus, presence of a young (d 7) *accessory* CL during Ovsynch positively impacts progesterone concentrations before AI.

Evidence that progesterone concentrations at time of PGF of Ovsynch are positively associated with fertility.

Fonseca et al., [13] were the first to report that Holstein and Jersey dairy cows that became pregnant had greater concentrations of progesterone in a 12 d period prior to AI compared to cows that did not become pregnant. In two studies conducted recently in our laboratory, progesterone concentrations at the time of the PGF of Ovsynch had a substantial impact on the probability of a pregnancy in Holstein dairy cows (Figure 4). Thus, enhancing progesterone concentrations prior to PGF of Ovsynch is expected to enhance fertility. To induce *accessory CL* following the 1st GnRH of Ovsynch cows must be pre-synchronized (prior to Ovsynch) to ensure that cows are in a stage of the estrous cycle that has both a high probability of ovulation of a dominant follicle to the 1st GnRH and control of subsequent luteolysis (corpus luteum regression) with PGF, i.e., prior to endogenous luteolysis. So, in two previous studies [11], (published and unpublished data), we tested and compared rate of induction of *accessory CL* at 4, 5, 6, 7, or 8 d of the estrous cycle at the time of the 1st GnRH of Ovsynch. The "d 6" interval (referred to as G6G; Figure 5) resulted in a significantly greater percentage of cows ovulating to the 1st GnRH and inducing *accessory* CL compared to the other intervals. If cows responded to both PGF and GnRH pre-synchrony treatments and were on d 6 of the cycle at time of 1st GnRH of Ovsynch, 97% of cows contained accessory CL, had significantly greater progesterone concentrations, and had a greater probability of a pregnancy.

What current programs seem to be working the best to achieve greater conception rates?

The three programs we recommend for 1st AI are: Double Ovsynch, G6G, and Presynch-11. The resynchronization programs (setting cows up for AI following a pregnancy diagnosis) we recommend are: G6G, GGPG (for cows without a CL at diagnosis), and an abbreviated Presynch-11 (see Calendars).

Summary

Above described data provide a basis for the concept that low progesterone in lactating dairy cows due to enhanced steroid metabolism may be the underlying cause of the low fertility that has plagued dairy herds for the past two decades. We feel we have developed synchronization strategies that partially solve this problem. Enhancing the percentage of cows that respond to the 1st GnRH of Ovsynch allows for more cows with accessory CL, greater concentrations of progesterone at time of induced luteolysis (PGF of Ovsynch), and a greater chance for pregnancy.

Rolling Acres Farm, Allegan, MI

Merle Coffey, owner of Rolling Acres Farm, Allegan, MI utilizes G6G (see Calendar on page 23, and Figure 3 on page 2) to increase the reproductive performance of his 800-cow herd. Only cows ready for 1st AI receive the G6G program. Average days to first service for his herd is now 100 days. After first AI, if cows are detected in estrus, they are inseminated using the AM/PM rule. If cows reach pregnancy diagnosis (Biopryn at 32 d after AI) and are diagnosed as not pregnant, they are re-synchronized with Ovsynch. Monthly conception rates are displayed in Figures 4 and 5).

Figure 4: Monthly 1st service conception rates using G6G at Rolling Acres Farm, Merle and Arlyn Coffey from October 2008 to December 2010. All cows receive G6G for 1st service.

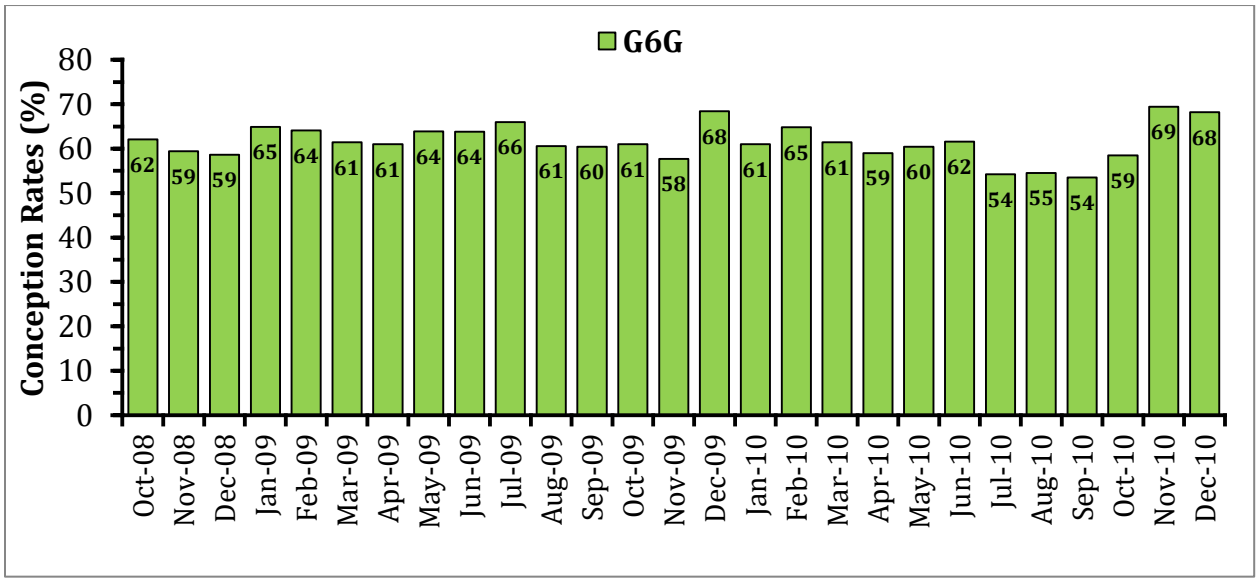
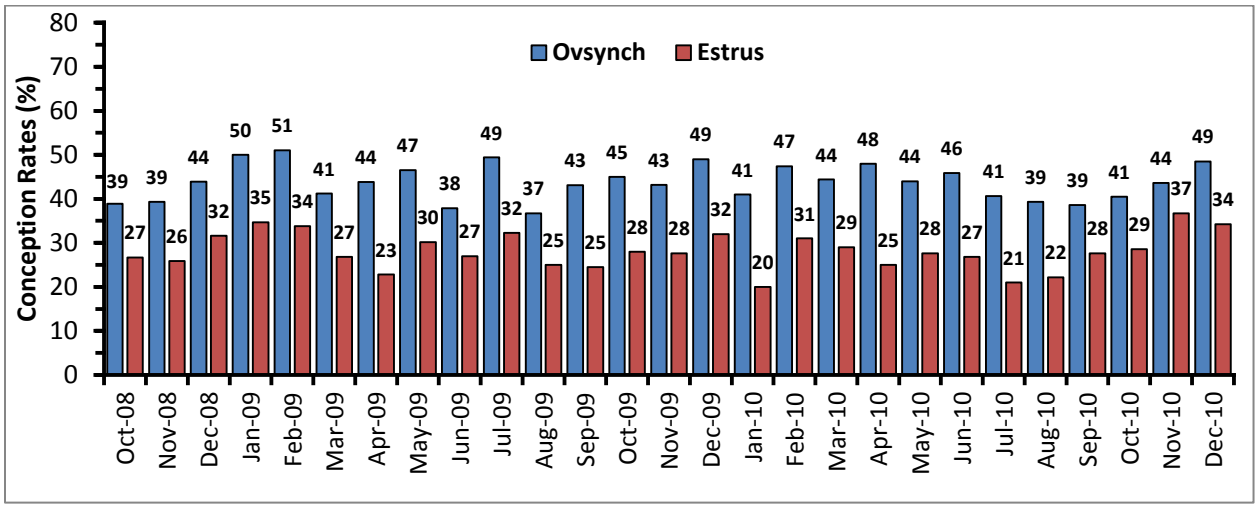


Figure 5: Monthly conception rates for cows receiving 2nd service or greater following detection of estrus or resynchronized using Ovsynch following a not-pregnant diagnosis at Rolling Acres Farm, Merle and Arlyn Coffey from October 2008 to December 2010.



Calendars for Several Timed-AI Protocols

Pre-Synch-11 for 1st AI

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				PGF 45-51 DIM		
				PGF		
	GnRH					
	PGF am	PGF-am 2+parity	GnRH pm	AI am		

G6G for 1st AI

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
PGF 62-68 DIM		GnRH				
	GnRH					
	PGF am	PGF-am 2+parity	GnRH pm	AI am		

Double Ovsynch for 1st AI

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					GnRH 53-59 DIM	
					PGF	
	GnRH					
	GnRH					
	PGF am	PGF-am 2+parity	GnRH pm	AI am		

G6G for AI Following Diagnosis of NOT-Pregnant

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
PGF		GnRH				
	GnRH					
	PGF am	PG-am 2+parity	GnRH pm	AI am		

Abbreviated Presynch-11 for AI Following Diagnosis of NOT-Pregnant

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				PGF		
	GnRH					
	PGF am	PGF-am 2+parity	GnRH pm	AI am		

GGPG for AI Following Diagnosis of NOT-Pregnant NO CL at NOT-Pregnant Diagnosis

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	GnRH					
	GnRH					
	PGF am	PFG-am 2+parity	GnRH pm	AI am		

These Producers Get Cows Pregnant

Congratulations to Henk Knevelbaard of Fremont, MI for being awarded the 2010 Dairy Cattle Reproductive Conference Platinum Level Award. Henk and his crew (pictured) milk 1,100 cows most of which are Holstein, although, a portion of the herd is being crossed to Swedish Red and Montbeliard sires. Henk utilizes both estrus detection and timed-AI to achieve top reproductive performance. Approximately 75 % of cows that are eligible for AI are inseminated following a detected estrus and about 25 % are timed-inseminated following a Presynch-14/Ovsynch program.

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