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Estrous synchronization programs for the dairy herd

Michael L. O'Connor

DAIRY& ANIMAL SCIENCE

Department of Dairy and Animal Science
The Pennsylvania State University
324 Henning Building
University Park, PA 16802
(814) 865-5491 • FAX (814) 865-7442
www.das.psu.edu/teamdairy/

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INTRODUCTION

The major factor limiting optimum reproductive performance on many farms is failure to detect estrus in a timely and accurate manner. Several prostaglandin (PG) products are available for use in synchronizing estrus in heifers and lactating dairy cattle. These products were originally used to treat individual cows that had not exhibited heat by the time of desired first service.

Several controlled or *programmed* breeding programs have been developed for synchronizing groups of lactating cattle. Recently, a new program, Ovsynch, using gonadotropin-releasing hormone (GnRH) with PG has been introduced.

In contrast to synchronization of estrus of dairy heifers and beef cattle, controlled breeding of the lactating herd is conducted on a continuing basis. Such programs must allow for the introduction of cows that become eligible for first insemination after calving and for cows that do not conceive to the initial insemination of the program. Controlled breeding can be directed to cows that possess a corpus luteum (CL), as determined by rectal palpation of the ovaries or administering PG to all open cows within a breeding group without palpation. The Ovsynch program can be used any day regardless of the ovarian status. The potential advantages of controlled breeding are listed below.

Potential advantages of controlled breeding

1. Improve the efficiency of heat detection
2. Achieve more timely first service
3. Reduce the variation in calving intervals among cows
4. Possibly reduce involuntary culling for reproductive reasons
5. Concentrate labor for reproductive management to specific periods
6. Improve the overall reproductive performance of the herd

PROSTAGLANDIN PROGRAMS

1. Controlled breeding using ovarian palpation

Initially, controlled breeding programs were based upon ovarian palpation by a veterinarian to determine which cows had a functional CL, and thus would likely respond to PG. Such a program could be set up on a weekly, biweekly, or monthly schedule. However, the monthly program is not recommended, since too much time will elapse between injections.

With these programs, all cows eligible for breeding after the voluntary waiting period (55 to 75 days) are palpated on a given day of the week. Cows with a CL receive PG and are observed for heat several times daily on days 2, 3, 4, and 5, post-injection. Cows exhibiting standing behavior are inseminated accordingly. Cows without a CL, and those not observed in heat following the initial PG injection, are examined again during the next veterinary visit. This program continues on a routine basis and cows remain on the program until diagnosed pregnant or until a specific number of repeat inseminations have been attempted. Figure 1 on the following page illustrates this program.

Appointment insemination after injection is not recommended because the interval from the PG injection to onset of heat varies depending on the stage of the cycle when PG is administered. Therefore, the age of the CL and status of the developing follicle determine time to the onset of the heat following the PG injection. Cows in the early (day 7 and 8) and later (day 15-17) stages of the cycle tend to exhibit heat between 48 and 72 hours post-injection. However, cows in mid-cycle have a more variable pattern of response, which may be why appointment insemination generally has not been successful.

Figure 1. Basic system with ovarian palpation

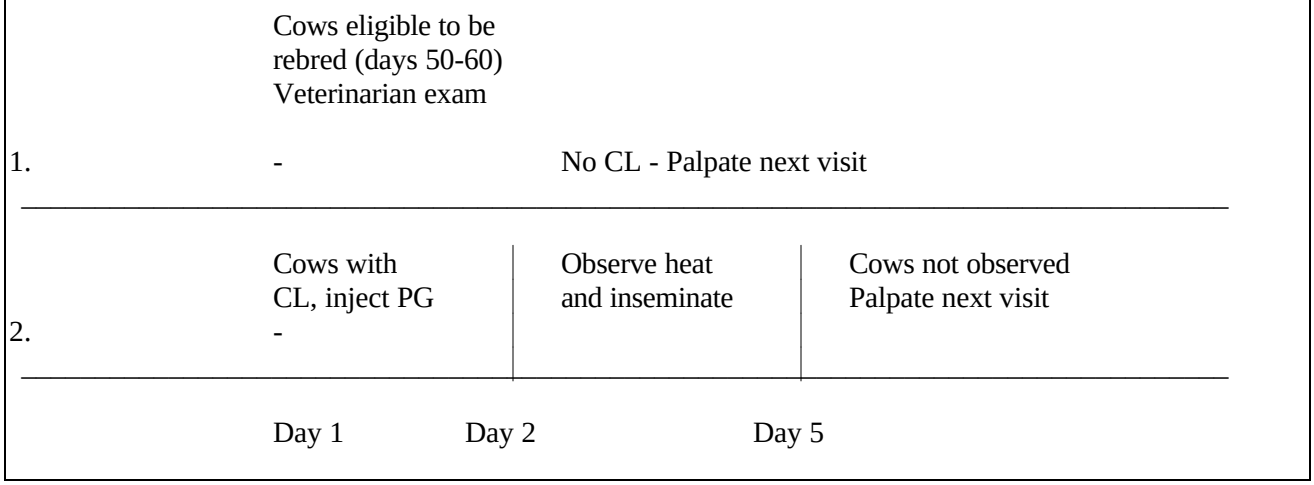


Table 1 illustrates the results of a weekly synchronization program for lactating cows. Cows in three Minnesota herds were assigned to either a synchronization program similar to the above example or were inseminated based on routine observation for heat (control).

A total of 262 doses of PG were used for the 219 cows, with 70 percent of the treatments resulting in observed heats and insemination 2 to 5 days post-injection. Of the cows that responded, 88 percent of the first inseminations and 82 percent of all inseminations occurred on day 2 through 5. Days to first insemination, days open, and conception rates were improved for the group of synchronized cows. *One of the essential factors for a successful controlled breeding plan is accurate diagnosis of a functional CL.*

Combined data from four studies summarized at the College of Veterinary Medicine at the University of Illinois revealed that 20 percent of the cows selected by palpation for treatment with PG were not likely to respond, and 30 percent of the cows not selected for treatment could have been treated because functional luteal tissue was present. This does not indicate poor palpation technique, but suggests the difficulty in determining with a high degree of accuracy the functional status of the CL based on CL size and firmness. Furthermore, some corpora lutea are present but not palpable. Generally, veterinarians can easily distinguish between a CL and a follicle. However, it is more difficult to determine whether the CL is at a stage of development where it is likely to respond to PG.

Table 1. Results of a weekly controlled breeding program based on ovarian palpation by a veterinarian

	Control	*Treated*
Number of cows	228	219
Days to first insemination	81	70
Days open	111	93
First service conception (%)	47	55

Sequin et. al., 1983, J. Amer. Vet. Med. Assoc.

PROSTAGLANDIN PROGRAMS (continued)

2. Controlled breeding without ovarian palpation

Since several studies have shown a significant error rate in determining the presence of a functional CL based on palpation, other programs have been designed so that all eligible cows are injected with PG without ovarian palpation. *Although PG will be administered to some cows that do not have a functional CL, this error is less costly than failure to administer PG to eligible cattle possessing a CL.*

A. 7-day program

Cows eligible to be bred are injected with PG on a given day of the week. Cattle observed in heat are inseminated, and those not seen in heat are reinjected on the same day of the following week. This system is repeated on the third week, after which a veterinarian examines the cow. This practice is frequently referred to as the *Monday morning* program, since administering PG on Mondays will induce most heats between Wednesday and Saturday. Thus almost all inseminations will occur on weekdays. A second option is the *Saturday AM* program, where cattle are injected on Saturday so that inseminations occur on Monday through Thursday.

A study was conducted at the University of Pennsylvania to compare controlled breeding programs in four herds with and without use of rectal palpation to determine ovarian status (presence of a CL). One synchronization program involved weekly PG injections every Monday to eligible cows that were 50 days postpartum. Cows observed in estrus were inseminated, and those not in estrus were injected the following Monday. Cows not seen in estrus after three weekly injections were examined, treated appropriately, and returned to the program.

The second program was the reproductive program currently used in the four herds. This consisted of either weekly or biweekly PG programs based on the presence of a CL via rectal palpation for all cows more than 50 days postpartum (similar to the program described in the section titled *Controlled breeding using ovarian palpation*). A summary of the trial results is presented in Table 2.

Fifty percent of the cows on the weekly program without palpation were pregnant by 97 days, compared to 110 days for the program using rectal palpation. There was a numerical increase in first service conception rate. However, the major factor contributing to the improved performance in the weekly PG program was the reduction in days to first service. Partial budget analysis showed that it cost $3.73 more per cow to use the program without palpation, but this program reduced the median days open by 13. An estimate for the cost of a day open over 90 days is $2 and the net benefit was $22.27/cow [(13 days x $2) - $3.73].

B. 11-day or 14-day program

The 11-day program is a modification of the original two-injection program that was used when prostaglandins were introduced in 1979 for synchronization of beef cattle and dairy heifers. Based on the voluntary waiting period (VWP), eligible cows that receive PG are observed for heat two to five days after injection and inseminated accordingly. Cows that do not exhibit heat are reinjected 11 days later, observed for heat, and inseminated. Injections are continued at 11-day intervals until heat is exhibited. Some veterinarians may prefer to examine cows that fail to exhibit heat after the second or third PG injection.

The potential disadvantage of the 11-day program is that repeat injections and periods of concentrated heat detection and insemination does not occur on similar days of subsequent weeks. That means that scheduling farm labor and a veterinarian is more complicated.

The 14-day program is similar to those described above, with the exception that there is a 14-day interval between injections for cattle that do not exhibit heat following the previous injection. Frequently dairy producers, veterinarians, AI technicians have asked: why do the newer systems use a 14-day interval between PG injections instead of the original 11-day interval? Obviously, the 14-day program fits conveniently into a management schedule, but there is also a physiological reason for the change.

Table 2. Reproductive performance and costs associated with two controlled breeding programs

Item	*Weekly PG program without palpation*	*Traditional PG program with palpation*
Number of cows	156	154
Average days to 1st service	72.5 *	78.3
First service conception (%)	46.9	42.0
Inseminated cows pregnant (%)	85	82
Cows culled (%)	16.8	14.5
Doses of PG	555	169
Cost of PG ($3/dose)	1665	507
Number of rectal palpations	547	835
Cost of palpations ($2/each)	1094	1670
Total cost ($)	2759	2177
Cost difference per cow ($)	3.73	–
Median days open per cow	97	110
Net benefit assuming $2/day open	$22.27	–

* denotes significance

Adapted from Kristula et. al. 1992, J. Dairy Sci 75:2713

In 1990, Israeli researchers compared the 11- and 14-day intervals between PG injections in lactating cows. Although the conception rates to AI were similar for both groups, the percentage of cows that conceived within 30 days after first service and within 150 days after calving were significantly greater in the group given PG 14 days apart. The reason for the improvement with the 14-day program is likely due to more cows being in the diestrous stage of the cycle after the initial injection. Cows in diestrous are responsive to PG and more likely to exhibit heat. *Therefore, the 14-day is the program of choice.*

C. 7-day vs. 11- or 14-day program

In contrast to the 7-day program, cows that fail to respond to the initial PG injection during an 11- or 14-day program are in a stage of the estrous cycle where they are more likely to respond to the next injection. However, the 7-day program provides cattle an opportunity to respond to at least one of three PG injections over a 21-day period.

D. Setup PG treatment prior to breeding period

An aggressive program, termed *targeted breeding* has been proposed by which cows are administered PG prior to the end of the VWP. The purpose of this treatment is to setup cows into a stage of the cycle, when they are most likely to respond to the breeding shot of PG administered 14 days later. Generally with this system, cows are not inseminated if they exhibit estrus following the initial PG injection.

Once a VWP is established for the herd, cows are listed chronologically according to calving dates. Those cows within 14 days of the end of the VWP are administered the setup shot. Fourteen days later, the cows receive the first breeding injection of PG and are observed for heat two to five days after injection and inseminated accordingly.

PROSTAGLANDIN PROGRAMS (continued)

Cows that do not exhibit heat are reinjected 14 days later, observed for heat, and inseminated. Injections are continued at 14-day intervals until estrus is exhibited. Some veterinarians and producers may prefer to examine cows that fail to exhibit heat after the third PG injection. Others may wish to *appointment breed* at a specified time after the third injection.

Another systematic approach involves administering PG to all cows between 25 to 32 days postpartum for uterine therapy and again for estrous synchronization. Cornell researchers compared three reproductive management systems. In the first program cows received PG at 25 to 32 days postpartum for uterine therapy (PG), while cows in the second program received an additional PG injection 14 days later, 39 to 46 days postpartum for estrus synchronization (scheduled intervals - SI). These systems were compared with a traditional program involving postpartum rectal palpation (RP) based on veterinary intervention.

In order that all cows were initially inseminated at approximately the same time, they received PG at 53 to 60 days postpartum and were observed for estrus and inseminated accordingly. If not observed in estrus they were reinjected 14 days after the previous injection. Cows determined to be open at pregnancy examination were injected with PG and continued on the 14-day plan.

The investigators concluded that the PG program, injection at 25 to 32 days, was less expensive and the reproductive performance was equal to that of the RP program based on rectal palpation and veterinary intervention (Table 3). Partial budget analysis, considering all costs except labor, showed that the SI program with PG at a specified interval, cost $3.61 less per cow than the RP program and saved six days open. The improved reproductive performance with the SI program was likely due to the improved synchronization of estrus.

Table 3. Partial budget[1] analysis for postpartum therapeutic PG injections and PG treatments at scheduled intervals (SI) compared to rectal palpation (RP) treatment

Item	*RP*	*PG*	*SI*
Number of cows	472	443	461
Doses of PG[2,3]	1289	1630	1890
PG at $2.25 per dose[2,3]	2900	3668	4235
Number of rectal palpations[4]	944	0	0
Cost of rectal palpations @ $2.25	2124	–	–
Cost[5] of postpartum therapy @ $10.88	1055	435	163
Total costs ($)	**6079**	**4103**	**4416**
$ difference between treatments	–	- 1976	- 1663
$ difference per cow	–	- 4.46	- 3.61
Median days open saved per cow	–	0	- 6
Value days open saved @ $2.00/d/cow	–	–	- 12.00
Net cost per cow vs. RP treatment ($)	**–**	**- 4.46**	**- 15.61**

[1] Using baseline costs

[2] All postpartum and breeding period injections

[3] Lutalyse

[4] All prebreeding palpations excludes pregnancy palpations

[5] Costs (drugs and additional palpations) incurred between 25 to 100 days postpartum

Adapted from Pankowski et al. 1995, J. Dairy Sci. 78:1477

OVSYNCH: GnRH-PG-GnRH PROGRAM

A new program has been developed that synchronizes ovulation allowing better results to timed AI than with PG injections. An injection of GnRH or one of its analogs followed seven days later with PG has been shown to synchronize estrus effectively. GnRH affects follicular growth by causing either ovulation or luteinization of the largest follicle and prevents estrus until after the PG injection, which causes the corpus luteum or luteinized follicle to regress. A new dominant follicle forms and is available to be ovulated by the second GnRH injection given 48 hours after the PG injection, (Figure 2).

During an initial study, inseminations were timed between 20 to 24 hours after the last GnRH injection, Table 4. Compared to control cows on the same farms observed twice daily for estrus without use of a synchronization program, pregnancy rates at the first insemination were similar between controls and synchronized cows. However, days to first insemination, days open, and the proportion pregnant by 60 to 100 days in milk were improved for the synchronized group.

In a subsequent but slightly different study in Kansas, the second GnRH injection was given sooner at 32 hours and the cows were inseminated at 18 hours post GnRH. The reproductive performance of this group of 61 cows was compared to 56 cows synchronized with the weekly *Monday morning* PG program. The pregnancy rates were good but similar for both groups.

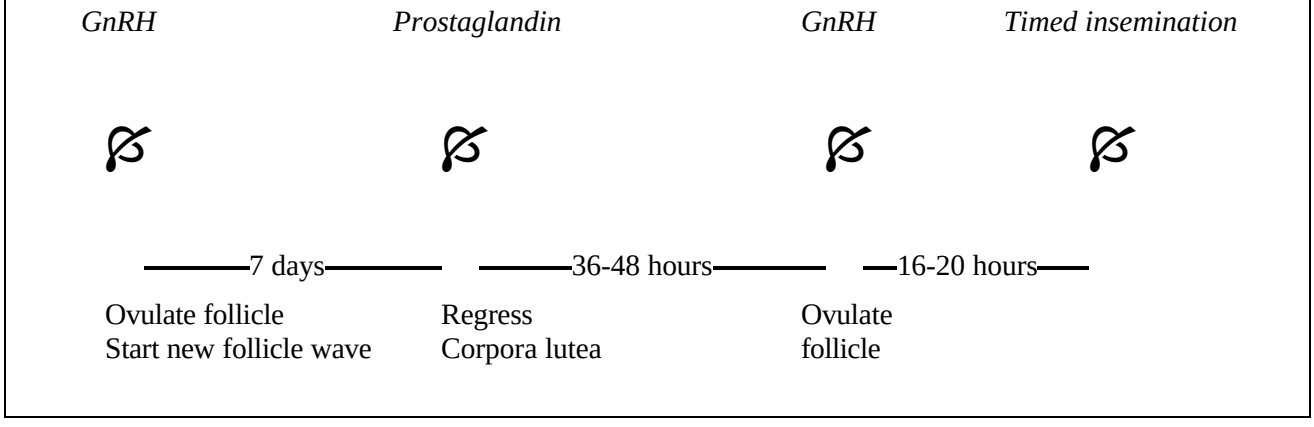
According to these preliminary results the new Ovsynch program is effective in improving the percentage of cows pregnant by 60 and 100 days in milk and may reduce the days to first service. *Based on several field trials, adjustments in the time intervals between injections and insemination have been made (see Figure 2).* The timing of the first GnRH injection is not critical. However, the timing of the other injections is critical so that insemination occurs at a reasonable time of day. For example, inject the PG at 4:00 p.m. on the Monday following the initial GnRH injection and the second GnRH injection at 4:00 p.m. on Wednesday. The cattle can then be inseminated between 8 to 10 a.m. on Thursday. Some points to consider when using this program:

1. The conception rate with Ovsynch is generally lower compared to insemination after detected estrus. However, the advantage is that all cows are time-inseminated without estrus detection.

2. This program should not be used for heifers.

3. Conception rates based on ultrasonography at 25 to 35 days after insemination, were slightly greater when the insemination was made at 16 hours after the second GnRH injection compared to other time intervals.

Figure 2. Timing and purpose of hormone injections using the Ovsynch program



OVSYNCH: GnRH-PG-GnRH PROGRAM (continued)

Table 4. Fixed-time inseminations at first service using prostaglandin and GnRH

Item	Detected estrus (AM/PM)	GnRH/PG/ $GnRH_{48}/AI_{24}$
Number of inseminations	167	166
Days to first AI	81	54
Pregnancy rate at first AI, %	39.1	37.1
Days open	121	98
Pregnant by 60 days in milk, %	5	35
Pregnant by 100 days in milk, %	35	53

Adapted from Pursley et. al. 1994, Suppl. 1 J. Dairy Sci. 77:69

4. If a cow exhibits estrus before the completion of the hormonal treatments, she should be inseminated and the remaining injections should not be administered. One of the major concerns with this program is that few cows exhibit estrus following the complete hormonal treatment. The likely reason for the general lack of estrus is that the second GnRH injection stimulates the release of luteinizing hormone (LH). This induces the follicle to ovulate, terminating estrogen production and allowing for the formation of a corpus luteum. Estrogen is responsible for expression of signs of heat.

5. Since the cost of the program may be too high for routine use for all cows on some farms, it may seem appropriate to use only for problem breeders. This is probably not the correct approach since repeat breeders may likely have a abnormal follicular development and this standard protocol will not correct the problem. However, it may be very useful for cows that simply do not express estrus after several attempts with PG. This program is also useful in herds where cattle are not turned-out for heat detection on a routine basis.

As with any new management practice one should make the decision about adopting the program based upon the labor and drug costs and anticipated success rates. If the procedure is adopted, make sure enough breeding results are obtained before making the decision as to whether to continue or discontinue the program.

ADDITIONAL CONSIDERATIONS FOR BOTH PROGRAMS

Cows eligible for controlled breeding

1. Reproductively healthy cows approaching the VWP
2. Cows open at pregnancy examination
3. Cows known to have aborted
4. Cows observed in heat following previous insemination

Pregnancy examinations

Incorporate routine examinations for pregnancy into a controlled breeding program so that open cows can be identified early and recycled back into the program.

ADDITIONAL CONSIDERATIONS (continued)

Estrous detection aids

Apply chalk, crayon, paint markings, or Kamar patches to cattle at the time of PG injection. This should enhance the efficiency of estrous detection with the PG program.

Numerous cows in estrus simultaneously

Inducing estrus in groups of cattle improves the likelihood of detecting heat among the herd because mounting and standing behaviors increase when several cows are in estrus, Table 5.

Table 5. Effect of number of cows in heat on mounting activity.

Number of cows	*Average mounts per cow in heat*
1	11.2
2	36.6
3	52.6
4 or more	49.8

J. Hurnick et al. 1975, Applied Animal Ethology 2:55.

REQUIREMENTS OF CONTROLLED BREEDING PROGRAMS

A. Cows must be cycling normally. Nutritional, environmental, or disease factors that cause anestrus or repeat breeding must be corrected before starting a controlled breeding program.

B. Herd managers and veterinarians must make a commitment to the estrous synchronization program.

C. Accurate records must be kept. A list of eligible cows must be updated regularly.

D. Efficient and accurate heat detection for the specified days is essential when using the PG program.

E. Herd managers and veterinarians must adhere to the time schedule for injections, heat detection, insemination, and pregnancy examinations.

SUMMARY

All the estrus synchronization programs described in this publication are effective. Results from several field studies reveal that controlled breeding programs for lactating cattle are beneficial where the level of management was good before the program
was adopted.

If herd and reproductive management practices are poor, then the benefits of such programs will not be obtained. Controlled breeding should be considered a tool to improve reproductive efficiency through a systematic, timely, and labor efficient management of reproductive events.

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