THE "REPRODUCTIVE MANAGEMENT TOOL BOX"
What's Available to Help You be Successful?

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Most dairymen today would like more pregnant cows. They would also like more cows pregnant at a profitable time period; usually as soon after the voluntary waiting period as possible. The goal of having more pregnant cows in a timely fashion is a huge economic opportunity. Let's take a look at where we're at reproductively and what tools are available to help us reach our goals (the various reproductive hormones that can be used in combination to build synchronization programs, the different synchronization programs and which is the best blueprint for your dairy at increasing service rates, tools and management techniques to enhance conception rates); and finally what does the future hold for new ideas, devices and programs?

Trends in the reproductive performance of U.S. dairy herds:

The reproductive performance of US dairy herds as measured by common indices has decreased markedly in the last decade. Information from cow records processed at DHI Computing Services, Inc., Provo, UT gives insight into the magnitude of these changes. The average days open for herds processed at Provo has increased from 129.5 days in 1990 to 155 days in 2001. Of the 25.5 increase in days open, 18 days have occurred since the introduction of rBST into the market place in February 1994. The use of rBST has resulted in increased milk production and allowed producers additional profitable days-in-milk to breed cows in an attempt to get cows pregnant. From a management perspective, the three primary factors that control days open are days-in-milk (DIM) at first breeding, efficiency of heat detection and fertility. Days-in-milk at first breeding has increased from 81.6 days in 1990 to 85 in 2001, an increase of 3.4 days. Herd fertility can be measured as services per conception. Services per conception have increased from 2.02 in 1990 to 2.39 services in 2001. On the basis of 0.37 more services per conception, the reduction in fertility accounts for an additional 7.7 days in the days open. Services per conception are the average number of services for cows that conceive and it fails to include cows that do not conceive or become "do not breed" cows. In other words, services per conception are an overly optimistic measure of fertility. The increase in service per conception does not establish a cause-effect relationship between rBST and infertility but rather suggests that cows treated with rBST produce more milk and with the additional milk production, dairy producers may have obtained additional time to inseminate these cows. The efficiency of heat detection can be estimated by calculating the intervals between breedings from DIM at first breeding to conception. The estimated efficiency of heat detection has decreased from 44.7% in 1990 to 41.7% in 2001, a decrease of 3 percentage points. The effect that heat detection has on days open can be calculated by assuming that the remainder of the increase in days open after the effects of increased DIM at first breeding and infertility have been taken out are the result of a reduction in efficiency of heat detection. If 11.1 days of the 25.5 day increase in days open can be attributed

to greater DIM at first breeding and reduced fertility, the remaining 14.4 days increase in days open must be the result of a reduction in efficiency of heat detection. These changes indicate a reduction in performance of all the common reproductive indices in dairy herds processed at the DHI Processing Center, Provo, UT. Similar changes have been seen in the reproductive performance of herds processed at the DHI Processing Center, Raleigh, NC.

Several problems exist in using averages to measure reproductive performance of individual herds. Averages may suffer from significant lag. The effect of a change in a management practice that affects days open may not be reflected in the average days open for the herd for several months. Many of the averages used to measure reproductive performance have bias built in the measure. Services per conception are biased toward a more favorable view of the fertility of the dairy herd because only those cows that conceive enter into the calculation; the undesirable outcomes of open and repeat breeding cows are ignored. Culling and the deliberate exclusion of "do not breed" cows from many of the reproductive calculations can markedly alter the accurate expression of the dairy's true reproductive status. An even larger problem of using averages to characterize reproductive performance is that averages fail to describe the distribution or variation about the mean. The degree of variation in key reproductive indices is important to evaluating reproductive performance of dairy herds. For example, average days open of 120 may be very acceptable if all cows conceive between 80 and 150 days. However, if the spread is from 45 to 350 days, there may be a significant reproductive problem in the herd and a large percentage of cows may eventually be removed from the herd as reproductive culls. A wide distribution of days open may be the equivalent of standing with one foot in a bucket of hot water and the other in a bucket of cold water. The average temperature is acceptable but the extremes may not be tolerable. In spite of the fact that DIM at first breeding has increased, many dairies have lowered their voluntary waiting period to 40 or 45 DIM as a strategy to reduce days open. With short voluntary waiting periods, some cows conceive very early in lactation while many cows still conceive too late in lactation to justify retention in the herd, and the average days open may have improved only slightly. If cows that conceive at less than 55 DIM have calving intervals of less than 11 months, one has to ask if it is desirable to obtain calving to conception intervals of less than 55 days and calving intervals of less than 11 months. In addition to short calving intervals, a frequent consequence of short voluntary waiting periods is that the fertility of cows bred in early lactation is lower than cows bred later in lactation at 60 to 75 more DIM.

The efficiency of heat detection has decreased by 3.0 percentage points in the last decade. It is unclear as to what are the most important factors that have adversely affected the efficiency of heat detection. Two recent studies using electronic transponders for measuring mounting activity with radio transmitters for heat detection have found that the average duration of estrus ranged from seven to nine and one half hours and the average number of mounts per estrus ranged from 8.5 to 10 mounts. If the average mount lasts four seconds, there is less than one minute of mounting activity occurring over the span of less than 10 hours every 21 days which is available to detect cows in estrus. The efficiency of heat detection is a calculated value based on the intervals between heats and/or breedings and in no way reflects on the accuracy of heat detection. In fact, if the number of breedings to cows not in estrus increased, the efficiency of heat detection would appear to increase but fertility of the herd would decline. It appears heat detection has become more difficult over time. The impact of culling cows for reproductive

reasons is a frequently overlooked factor that affects the common measures of reproductive performance for the herd. If cows with excessive days open are either culled from the herd or given a "do not breed" status, the parameters that are measures of herd reproductive performance can be improved artificially. The use of averages to measure herd reproductive performance fails to give an adequate perspective of the true reproductive status of the herd. Days open, average DIM at first service and services per conception are all calculated averages but they fail to convey a perspective of the distribution or variation of each of the indices of herd reproductive performance.

Poor reproductive performance of dairy herds has multiple consequences. Actual milk production is reduced below the herd's potential as average DIM increases. The amount of milk lost with increasing average DIM is difficult to quantify because of interactions with parity of the cows, season, and use of rBST. Cows that either fail to become pregnant or become pregnant too late in lactation to justify retention in the herd may be culled for either reproductive reasons or low production. The result is a higher rate of forced culling for reproductive reasons, lower production and the loss of the opportunity to remove cows with low relative value from the herd as elective culls and replace them with heifers that have greater production potential. The forced removal of good cows from the herd that have experienced reproductive failure restricts genetic progress when cows with high genetic merit leave the herd for reproductive reasons. Genetic progress is also reduced when natural service sires of unknown genetic value are used to solve herd reproductive problems. A 1996 NAHMS survey reported that 26.7% of the cows culled from US dairy herds are culled for reproductive reasons. Another 22.4% of the cows were culled for low production. The distinction between culling for reproductive reasons and poor production is frequently blurred. However, it means that at least 10% of the average herd is culled annually for reproductive reasons. At current prices received for cull cows and the cost of producing or purchasing replacement heifers, I would suggest that every time a cow is culled for reproductive reasons, the producer incurs a cost of at least a thousand dollars for each cow culled. With an average annual reproductive culling rate of 10%, the average annual cost for reproductive culling exceeds one hundred dollars per cow in the herd. In addition to the cost of culling, the decrease in reproductive performance results in the availability of fewer replacement heifers. A 25.5 day increase in days open suggests that there has been a 5% reduction in the potential supply of replacement heifers produced by the milking herd over the last decade.

Pregnancy rate drives reproductive performance of dairy herds:

Historically, producers and veterinarians have focused on heat detection efficiency and conception rate independent of each other as the drivers that control herd reproductive performance. Pregnancy rate is gaining acceptance as a better measure of reproductive performance for the dairy herd. Pregnancy rate combines conception rate and the rate of heat detection as a measure of herd reproductive performance. Pregnancy rate is calculated by multiplying the rate of heat detection by the conception rate in a 21-day period of time. Pregnancy rate is time dependent in that it is the percentage of cows that become pregnant in one estrous cycle. Since pregnancy rate has a time component, it can also be used to monitor the distribution of pregnancies that occur over time with graphs called survival curves.

Figure 1 shows the survival curve for a herd with a voluntary waiting period of 60 days and a 14% pregnancy rate. The median days open are about 155 days. Of more concern, however, is the fact that 35% of the normal, healthy cows are still open at 200 DIM. There is nothing wrong with these cows. They are just victims of a 14% pregnancy rate and their risk of becoming reproductive culls has increased markedly.

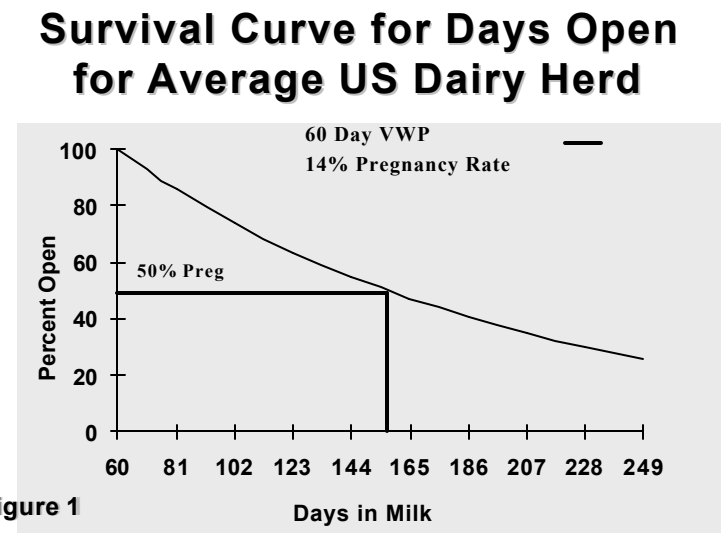


Figure 1

Under most circumstances, only cows detected in estrus are inseminated. Conception rate is the proportion of cows that are inseminated that become pregnant. Currently, the average efficiency of heat detection for US dairy herds is less than 40%. This means that an average dairy producer would detect 40 cows in heat in a group of 100 cows eligible for breeding in the period of one estrous cycle. Current conception rates for US dairy herds are about 35% and declining. With this conception rate, 35% of the 40 cows detected in estrus would conceive and the pregnancy rate for the group would be 14%. If the pregnancy rate is to be improved, either the percentage of cows eligible for insemination that are actually inseminated must be increased or the conception rate for the cows inseminated must be increased or both must be improved.

The first estrous cycle after the voluntary waiting period offers the greatest opportunity for getting the highest absolute numbers of cows pregnant in one estrous cycle. The potential number of cows that could become pregnant in one estrous cycle will never be greater than in the first estrous cycle following the voluntary waiting period. With each subsequent estrous cycle, as some of the cows become pregnant, the number of eligible cows continues to decrease with each subsequent estrous cycle. In addition to the number of cows eligible for pregnancy, only in the first estrous cycle following the voluntary waiting period are all of the cows eligible to enter an estrous synchronization or controlled breeding program.

With any estrous synchronization program that has a timed insemination component, service rate of 100% can be substituted for heat detection rate and 100% of the cows can be inseminated with a timed insemination following the estrous synchronization after the voluntary waiting period. Depending upon the frequency with which cows are inducted into the synchronization program, it is theoretically possible to have 100% of the cows bred in the first week following the voluntary waiting period if eligible cows are inducted on a weekly basis. The greatest potential improvement in pregnancy rate occurs by increasing the proportion of cows that are inseminated during the first estrous cycle following the voluntary waiting period from the average of 40% of cows that are currently detected in heat to a service rate of 100% of the cows. An estrous synchronization program could increase the insemination rate to 100% by either using an estrous synchronization program that exclusively uses timed insemination or a program that uses a combination of estrous detection followed by a timed insemination.

With current estrous synchronization programs followed by timed insemination, conception rates of cows on a controlled breeding program have been similar to cows inseminated on the basis of detected estrus; thus conception and pregnancy rates on the first cycle following the VWP have averaged between 25 and 35%. This is still twice the current pregnancy rate for the average US dairy herd on the first estrous cycle following the voluntary waiting period.

On the other hand, it seems possible that the current average conception rate of 35% for US dairy herds could be increased to between 40 and 45% by applying those management practices and technologies that improve conception rates. If we successfully applied only the management practices and technologies that enhance conception rates without improving the rate of submission to insemination, the pregnancy rate would only increase from the current 14% to 20%. However, by implementing a program that results in a 100% service rate and using the currently available management practices and technologies to enhance the conception rates, it is possible for a producer to attain as high as a 40 to 45% pregnancy rate for cows inseminated in the first estrous cycle following the voluntary waiting period! This would be almost a three-fold increase in the current pregnancy rate for the first estrous cycle following the voluntary waiting period.

The potential benefits of a program achieving nearly a 40-45% pregnancy rate during the first estrous cycle after the voluntary waiting period are multiple (Figure 2.). The median days open are less than 85 days and the percentage of the herd that is open at 200 DIM is reduced from 35% in herds with a 14% pregnancy rate to about 20% in herds with a 45% pregnancy rate at the first estrous cycle. The reduced percent open at 200 DIM includes a 14% pregnancy rate on subsequent cycles. Essentially the number of normal cows that are open at 200 DIM is halved! The program would result in the following: a reduction of the median DIM; greater milk production; a reduction in the number of cows culled for reproductive reasons; greater genetic progress achieved with more cows becoming pregnant through artificial insemination to proven sires or young AI sires and more replacement heifers available.

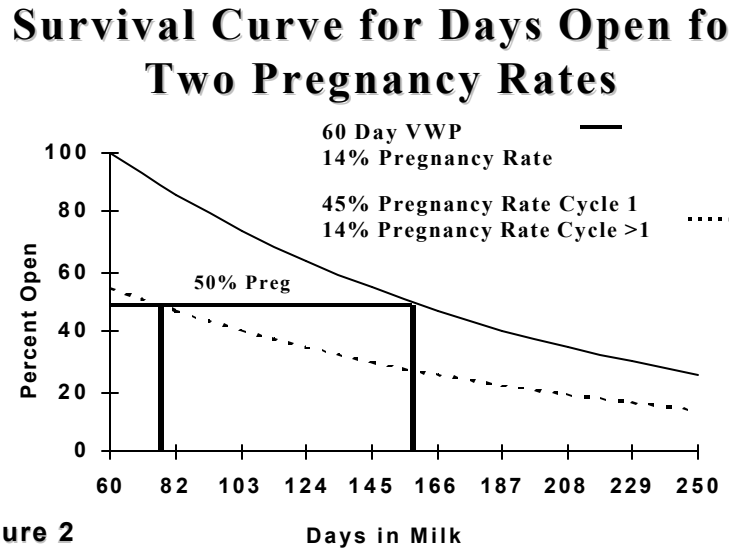


Figure 2

Enhancing Service Rates

Estrous synchronization programs with timed artificial insemination:

Numerous estrous synchronization programs have been based on the use of luteolytic prostaglandins (PGF_{2a} or Lutalyse®). The most frequently cited disadvantage of these programs was that the synchrony of estrus was not tight enough to allow for timed artificial insemination (TAI) and the achievement of acceptable conception rates. The primary reason for the lack of synchrony of estrus with Lutalyse® is the variability in the stage of the ovarian follicular waves at initiation of Lutalyse® treatment. Researchers have developed a better understanding of the dynamics of ovarian follicular waves and have used GnRH to control follicular wave development and improve estrous synchrony following Lutalyse® treatment. This has allowed for the development of estrous synchronization programs using GnRH in conjunction with Lutalyse®, which have achieved acceptable pregnancy rates with either exclusive TAI or a combination of estrous detection and TAI.

Ovsynch®, which was introduced in 1995, was really the first estrous synchronization program for dairy cattle with an effective timed insemination (TAI) component. Prior to the introduction of Ovsynch, luteolytic prostaglandins (Lutalyse®) had been utilized to synchronize estrus followed either by estrous detection or with two timed inseminations at a 24 hour interval. The double inseminations were necessary with appointment breedings to achieve reasonable success because the timing of ovulation was quite variable following the Lutalyse® injection. The Ovsynch program consists of an injection of GnRH followed in seven days by an injection of a Lutalyse®. Forty-eight hours after the Lutalyse® injection, the cows are given a second injection of GnRH that further improves the synchrony of ovulation so a timed insemination can be done at 0 to 24 hours (Figures 3 and 4). The pregnancy rates at the various intervals from the second GnRH to the TAI are shown in Table 1. The initial pregnancy rates were determined using ultrasonography 25 to 35 days following AI for determining pregnancy status. The highest pregnancy rates were achieved for cows inseminated at 16 hours after the second GnRH injection. However, the calving rate was only two percentage points better for the cows inseminated at 16 h compared to the cows inseminated at the time of the second GnRH injection. Dairy management frequently finds that it is difficult to get good lock-ups at times other than at a routine daily lock-up time making a lock-up for insemination at 16 h after the second GnRH injection difficult or impractical. With only a two percentage advantage in calving rate, producers may accept a loss of this advantage as an equitable trade if cows can be locked-up, identified, treated with GnRH and bred at the same time of the day.

The success of an Ovsynch program is affected by several factors. Two field studies have reported that there is a marked improvement in pregnancy rate when cows are inseminated after 70 to 75 days-in-milk (Table 2). Several studies have observed that the incidence of anestrous or anovulatory cows at 60 to 70 days-in-milk ranges from 20 to 30 percent. It appears that the prevalence of anestrous cows is herd dependent. Within herds the prevalence of anestrus for first lactation cows is usually two to four times greater than in second lactation and older cows. In a recent trial, the pregnancy rate of cycling cows was 37% compared to 10% for anovulatory cows (Gumen, et al., 2002). The pregnancy rate is usually lower for cows that have had periparturient health problems such as dystocia, stillbirths, retained fetal membranes, and metritis.

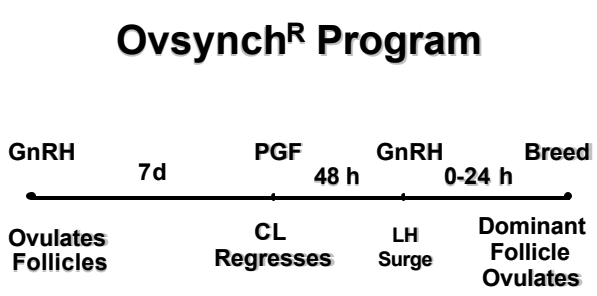


Figure 3

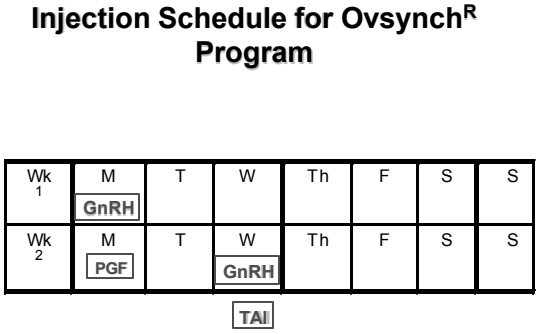


Figure 4

Table 1. Reproductive performance of cows inseminated at specific intervals after a timed insemination following the second GnRH injection.

	Time from second GnRH to AI				
	0 h	8 h	16 h	24 h	32 h
Cows, no.	149	148	149	143	143
Preg/AI, %	37	41	45	41	32
Pregnancy loss, %	9	21	21	21	32
Calving rate, %	31	31	33	29	20
Female:male ratio (%)	61:39	54:55	54:46	54:46	65:35
% Breedings w/ heifer calf	19	14	18	16	13

Adapted: Pursley, et al., 1998. JDS 81:2139.

Table 2. Effect of interval from calving to insemination on pregnancy rate.

	Early Insemination		Late Insemination	
	DIM	Pregnancy Rate	DIM	Pregnancy Rate
Pursley, et al., 1998	50-75	36	76-100	47
Pursley & Wiltbank, 1997	60-75	26	>75	43.4

Take home messages:

1) Ovsynch is an effective estrous synchronization for cattle with a first cycle pregnancy rate of approximately 30 percent.
2) Ovsynch is, as the name implies, an effective means of synchronizing ovulation but not necessarily estrus. If cows are observed for estrus, approximately 15% of cows will display a standing estrus and 85% will be bred by a TAI. Experienced inseminators may not be comfortable in inseminating cows that lack estrous mucus and uterine tone associated with breeding by TAI.

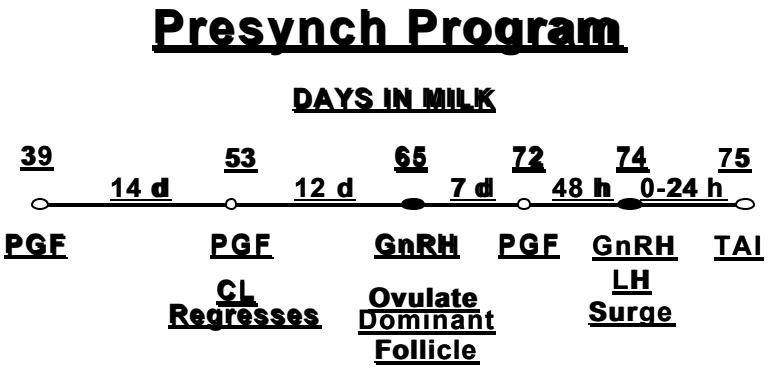
3) Pregnancy rates were better for cows synchronized with Ovsynch when cows were inseminated after 70 to 75 DIM than earlier in lactation. Some producers are able to accomplish the same proportion of pregnancies in one cycle following an Ovsynch program that previously took them two or three estrous cycles to accomplish when cows were bred on the basis of observed heat without a systematic breeding program.
4) Pregnancy rates are better for cows that are cycling at the initiation of the Ovsynch program than for anestrus cows. However, Ovsynch will induce some of the anestrus cows to cycle. Although the pregnancy rate is lower for the anovulatory cows than cycling cows with Ovsynch, the pregnancy rate for the anovulatory cows bred by TAI is still better than if cows were not treated and not bred.
5) The pregnancy rate for cows that have periparturient health problems has been considerably lower than for cows that have had an uneventful periparturient period.
6) The conception rates for replacement heifers bred on an Ovsynch program have been disappointingly low due in part to a three follicular wave mode versus two.

Co-Synch is sometimes used as a description for a specific format of the Ovsynch program when cows are bred at the same time as they receive the second GnRH injection in the protocol.

Select Synch is a term used to describe a program that consists of a GnRH injection followed in seven days by a Lutalyse® injection. After the Lutalyse® injection, cows are observed for estrus and bred on the basis of a standing heat. The advantages of this program are the reduced cost associated with one less GnRH injection than with the Ovsynch program. The potential disadvantage of this program is that the heat detection rate is less than the service rate for Ovsynch and that the ovulation rate may be less following the PGF_{2a} injection than after second GnRH injection in the Ovsynch program. In one trial (Cartmill, et al., 1999) the pregnancy rate for cows on the Select Synch program was 17.5% vs. 31.3% for cows on the Ovsynch program. The AI submission rate is usually considerably lower for cows on the Select Synch program compared to a program that has a TAI component. Some trials have also shown that the ovulation rate is significantly higher when cows are treated with either GnRH or estradiol which will induce an LH surge after the last Lutalyse® injection.

Pre-Synch is a term used to describe a program that consists of two injections of Lutalyse® administered at a fourteen day interval with the second Lutalyse® administered 12 to 14 days prior to an Ovsynch program. (Figure 5) Three field trials have compared the pregnancy rates achieved with the Ovsynch program vs. the Pre-Synch program. The pregnancy rates for the cows on the Ovsynch program ranged from 29 to 38 percent compared to pregnancy rates of 43 to 48 percent for cows on the Presynch program. In these trials, there was a 10 to 14 percent point advantage in the pregnancy rate for the cows on the Pre-Synch program over the Ovsynch program. Vasconcelos, et al., 1997, has shown that pregnancy rates of cows entering an Ovsynch program were affected by the day of the estrous cycle cows were at when they received the first GnRH injection. Cows that were between day 5 and 12 of the estrous cycle had the highest pregnancy rates. By "pre-synching" cows with two injections of Lutalyse®, prior to the first GnRH in the Ovsynch program a higher proportion of cows are between days 5 and 12 of the estrous cycle when they receive the first GnRH injection. (Figure 6). Thatcher, et al., 1998; illustrated a theoretical herd distribution of expected PR, day of cycle and pregnancies in a cyclic 100 cow herd using a pre-synchronized approach (Table 3).

Figure 5



Thatcher, 1998. AABP

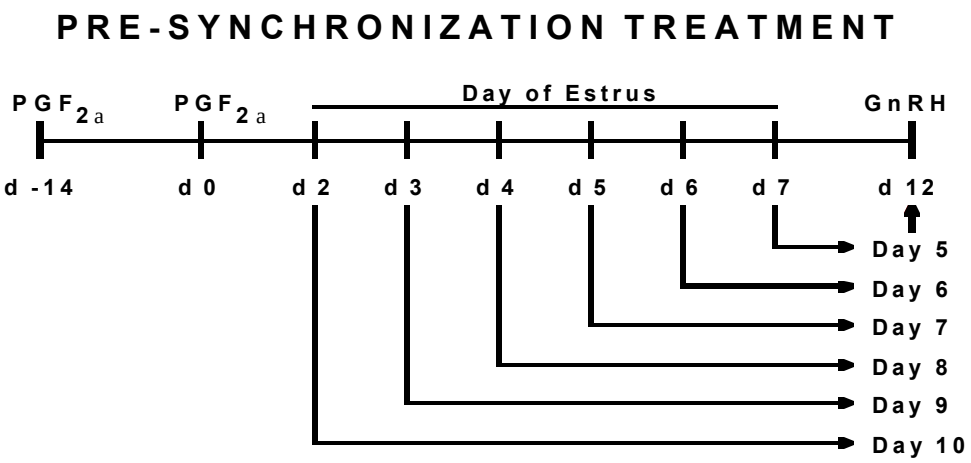


Figure 6. Pre-synchronization effect on day of cycle at time of GnRH injection.

Table 3. Herd distribution, expected pregnancy rates (PR), and pregnancies (Preg) in a 100 cyclic cow herd after pre-synchronization through two Lutalyse injections 14 days apart (the 2nd PG is given 12 days prior to initiation of the Ovsynch protocol).

Day of the cycle	Herd distribution	Expected PR	Preg in a 100 cow herd
5 to 10	90 %	50 %	45
13 to 17	5 %	20 %	1
18 to 20	5 %	50 %	2
Total	100 %	---	48 %

Take home messages:

1) Pregnancy rates can be improved by 10 to 14 percentage points over the pregnancy rates achieved with an Ovsynch program.
2) Because five injections are given over a five-week period to execute the Pre-synch program, some dairies experience a problem in getting all the injections into cows at the correct times. A failure to get cows to get the injections done at the appropriate times will reduce the success of the program.

Heat-Synch. Programs to synchronize estrus and/or timed inseminations for the first breeding of dairy cows continue to evolve. The most recent innovation has been a program called Heat-Synch which was developed by Thatcher, et al at the University of Florida and Pharmacia Animal Health. Heat-Synch is an estrous synchronization protocol that substitutes an injection of ½ cc of ECP® at 24 h after the Lutalyse® for the last GnRH in the Ovsynch protocol. The core part of the program still remains a GnRH injection followed in 7 days by a Lutalyse® injection (Figure 7). The Heat Synch uses ECP® instead of the second GnRH in the program to drive a synchronized ovulation. The advantages of using ECP® over GnRH are that the ECP® actually synchronizes both estrus and ovulation as opposed to just an ovulation. The reproductive tracts of cows synchronized with Heat Synch feel like the tracts of cows that are in estrus. The result is that there is increased inseminator confidence in the program because they are used to breeding cows in heat with increased uterine tone and increased mucus discharge for the vagina. The second potential advantage of Heat Synch is that it is diagnostic. Between 65 and 75% of the cows have had a standing estrus within a 48-hour period following the ECP® injection in most trials. If >35% of the cows are not observed in estrus following the ECP® injection, there is an indication that either heat detection is poor or there may be a higher that acceptable level of acyclic cows in the group. Cows that have not been observed in estrus in the 48 hours following the ECP® injection are inseminated as a timed group at 48 hours. The third advantage is the reduced cost of an ECP® injection vs. a GnRH injection.

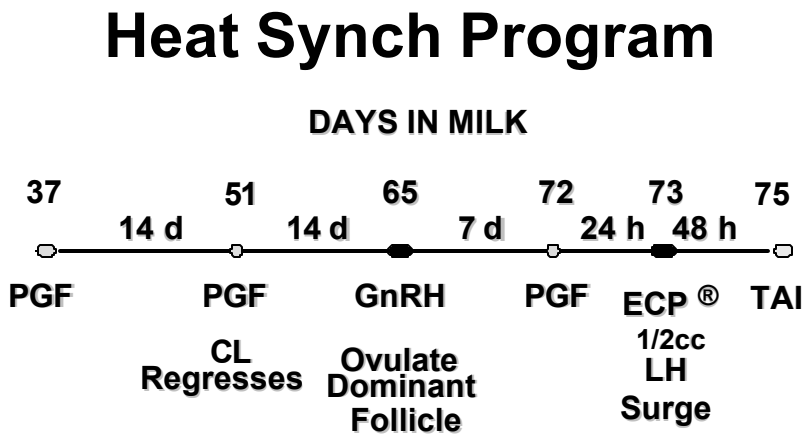


Figure 7 **Pharmacia, 2000**

Take home messages:

1) A greater proportion of cows will show estrus on the Heat-synch protocol than on the Ovsynch protocol.
    a. The Heat-synch protocol requires estrus detection for the best pregnancy rates. Dairies that aren't willing to detect estrus may do better with either Ovsynch or Pre-synch protocols.
    b. The greater proportion of cows that have estrual mucus and increased uterine tone at the time of insemination inspire greater inseminator confidence.
    c. The proportion of cows detected in estrus following the ECP injection has diagnostic value. A low proportion of cows detected in estrus suggests that there is either a problem with the intensity of heat detection or a high proportion of anestrous cows.
2) The pregnancy rate for cows bred on the basis of a standing heat is considerably higher than the pregnancy for cows bred by TAI. A strategy to take advantage of this difference in pregnancy rate is to breed the cows observed in standing estrus with more expensive, proven-sires and use less expensive young sires for the TAI breedings.

Enhancing Conception Rates

Poor conception rates are frequently attributed to the high production of today's dairy cows and there is a prevailing attitude that little can be done to improve the conception rates. Recent trials have suggested that the poor pregnancy rates do not have to be accepted as the consequence of high production. The achievement of pregnancy rates of 20% or greater seems to be attainable with the use of controlled breeding programs and current technologies. However, without attention to details, common procedures done poorly in routine reproductive programs can become a limitation to high pregnancy rates.

Relationship of nutrition to conception rate:

A sound nutrition program can improve conception rates both directly and indirectly. In the immediate postpartum period, cows are at increased risk for developing a number of diseases. These diseases include milk fever, retained fetal membranes, metritis, mastitis, ketosis, fatty liver infiltration, displacement of the abomasum, and ruminal acidosis with subsequent laminitis. These diseases adversely affect reproductive performance by lowering conception rates and efficiency of heat detection, increasing the interval to conception and increasing the risk that cows developing these diseases will be culled from the herd for reproductive reasons. Epidemiological studies show that cows having post-calving health problems frequently have 20 to 30 additional days to conception over herd mates without health problems. A sound pre-calving or transition ration fed the last three weeks of the dry period can reduce the incidence of these diseases. Cows with fewer diseases in the post-calving period equates to better conception rates and better reproductive performance of the herd. Energy balance of the cows in the post-calving period is the most important nutritional factor affecting reproductive performance of cows. Energy balance in the post-calving period affects the interval from calving to the onset of ovarian activity, the first ovulation, the first behavioral estrus associated with ovulation and the

fertility of cows at the time of insemination. The three primary factors that affect energy balance of the cow are the pounds of dry matter consumed and energy density of the ration on intake side of the equation and milk production on the output side of the equation. Since high levels of milk production are profitable, dairy producers will continue to select and manage for high levels of milk production. With respect to the energy density of the diet, the energy density of the ration is constrained by certain minimal levels of fiber that are necessary to maintain a healthy rumen and certain maximal levels of fat that can be fed without interfering with rumen fermentation. Managing the dry matter intake of the early lactation cows becomes the most important tool the producer has to minimize the negative energy balance of early lactation. This includes good feed bunk management, supplying fresh feeds, pushing up feeds frequently, providing adequate amounts of feed and providing adequate bunk space so all animals can have free access to feed. The severity of the post-calving negative energy balance can be monitored through a program of measuring the changes in body condition scores between scores at calving and 45 DIM. In addition to sound transition rations, minimizing the post-calving negative energy balance, sound trace mineral and vitamin supplementation can help minimize health problems and improve fertility.

Managing cows with peripartum health problems to improve first service conception rate:

In spite of the best transition rations and management programs for peripartum cows, there will always be cows needing assistance calving, having retained fetal membranes and developing metritis. Cows having these health problems will have first service conception rates 10 to 15 percentage points lower and 20 to 30 additional days open compared to healthy herd mates. Two strategies need to be developed for these cows.

The first strategy is to develop programmatic approaches to the early identification and treatment of cows with peripartum health problems. Usually this begins with creating a "fresh cow pen'' where fresh cows can be monitored closely for the first 10 days after calving. This includes daily observation of the cows for appetite and rumen fill, taking temperatures daily and observing the discharge coming from the vulva. Cows that have any abnormalities are examined further and then treated if necessary following a set treatment protocol. One of the primary advantages of "Fresh Cow Programs" is the early identification and treatment of diseases, one or two days before the cows become overtly ill and would have been treated in conventional programs. This can lead to more successful cures, increased milk production and decreased days open (Loeffler, et al., 1999, Theriogenology 51:1267).

The second strategy is to develop follow-up programs to restore normal fertility of cows that have had peripartum diseases. In a recent meta-analysis of the scientific literature, Olson, (1996) found that Lutalyse® between 14 and 28 DIM improved first service conception rates and reduced days open of cows experiencing peripartum health problems compared to untreated herdmates. The analysis also suggested that herds that have first service conception rates less than 40 to 45% would benefit from the routine treatment of all cows between 14 and 28 DIM with Lutalyse®. The lower the first service conception rate for the herd, the greater the potential benefit from routine treatment of all cows in the herd between 14 and 28 DIM. Risco, et al., (1994) observed that cows having dystocia or retained fetal membranes or both and getting two treatments with Lutalyse® at a two week interval beginning 12 DIM actually had better first

service conception rates than healthy contemporary cows in the herd (43% for treated cows and 29% for healthy cows). The take home message is that most herds would benefit from the routine administration of Lutalyse® between and 14 and 28 DIM and any cows that had an assisted calving, retained fetal membranes, or metritis, should receive a second treatment two weeks after the first.

Relationship of body condition scores to conception rate:

As pointed out in the previous paragraph, energy balance is the most important nutritional factor affecting conception rate of the dairy cow. Measuring body condition and changes in body condition is a means of measuring the energy balance of the cow in the postpartum period. Several studies have demonstrated that an excessive cumulative negative energy balance in the postpartum period is associated with a reduction in the first service conception rate. Cumulative changes in energy balance in the postpartum period can be measured indirectly by monitoring changes in body condition from calving to 45 DIM. Most studies suggest that the loss of one unit of body condition score or greater is associated with a reduction in first service conception rate. Butler and Smith (1989) found that the first service conception rate was 65%, 53% and 17%, respectively for cows that lost less than 0.5, .5-1.0, and greater than 1.0 unit of body condition following calving. Moreira, et al., (1998) reported that the pregnancy rate to TAI was significantly reduced for cows with body condition scores of less than 2.5 at the time of insemination. Pregnancy rates at days 27 and 45 after insemination were 18.1% and 11.1% for cows with a low BCS (81 cows) versus higher rates of 33.8% and 25.6% for cows with BCS $\geq$2.5. The proportion of cows conceiving to the first synchronized service was lower for the cows in low body condition, and this was a temporary decrease since rates of cumulative pregnancies during the ensuing 120 days postpartum were similar (Figure 8). Loeffler, et al., (1999) also showed a negative effect on conception rates with low BCS's <2.5 and >3.5 (Figure 9). This demonstrates the importance of optimizing fertility to the first service. The guidelines relative to body condition score to maximize pregnancy rates are: 1) The loss of body condition between calving and 45 DIM should not exceed one unit of condition score; 2) The lowest desirable body condition score at the time of insemination is 2.5. Body condition scores that are less than 2.5 are associated with low pregnancy rates. These observations suggest that the critical points in time to monitor body condition be at calving, at the time of first insemination and possibly at 45 DIM.

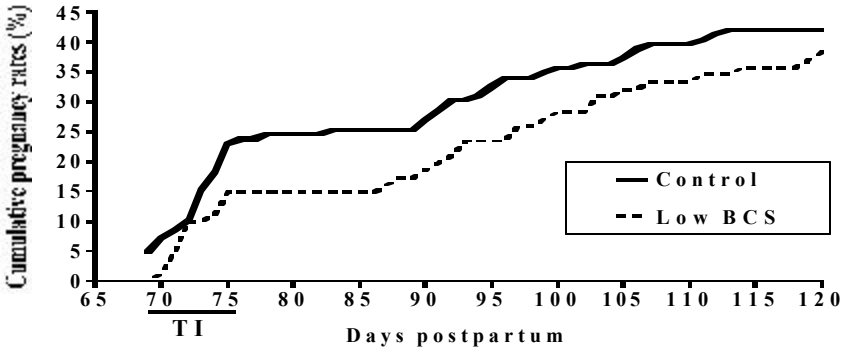


Figure8. Cumulative pregnancy rates from the first TAI until 120 d postpartum.

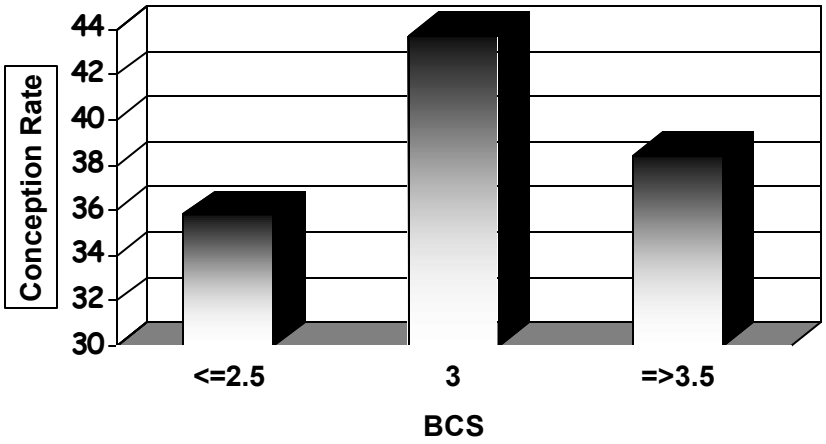


Figure 9. Loeffler, et al., 1999. Theriogenology 51.

Impact of Anestrous Cows:

Excerpt from Thatcher's work at the University of Florida. "With our ability to measure plasma progesterone in two plasma samples collected 12 days apart (on days 51 and 63 postpartum), it is possible to identify exactly what cows are anestrus when the Ovsynch/TAI program is initiated. If cows had progesterone $\leq$1 ng/ml in both samples they were considered to be anestrus. It was important for us to determine which cows are cycling since pre-synchronization treatments and potential effects of bST on pregnancy rates will not occur in cows that are not cycling. Furthermore, this assessment of anestrous status will allow us to document the frequency of this condition and its impact on reproductive performance of the herd.

For the assessment of anestrous status, 499 cows had blood samples collected on both days 51 and 63 postpartum. It is interesting that overall 23.4% of the cows were anestrus or had not started to cycle by 63 days postpartum (Table 4). Not surprising is the observation that the frequency of anestrus was greater for primiparous or first-calf heifers than multiparous cows (two lactations or more).

Table 4. Percentage of cows classified as anestrus or cyclic according to plasma progesterone samples collected at 51 DIM (second PGF $_{2a}$ injection) and at 63 DIM (first GnRH injection of the Ovsynch/TAI protocol) based on parity (cut off set at 1.0 ng/ml).

Status	Primiparous	Multiparous	Total
Cyclic	112 (64.37 %)	270 (83.08 %)	382 (76.55 %)
Anestrus	62 (35.63 %)	55 (16.92 %)	117 (23.45 %)
Total	174 (34.87 %)	325 (65.13 %)	499 (100.0 %)

The frequency of anestrus also was associated with body condition score as shown in Figure 10. The occurrence of anestrus decreased as body condition scores recorded at initiation of the Ovsynch/TAI improved. Therefore, body condition may be used to estimate the relative nutritional status of lactating dairy cows, and its impact on the frequency of anestrous cows at initiation of a reproductive management system.

Figure 10. Relationship between body condition scores and frequency of anestrous cows at 63 days postpartum.

Body condition scores could only account for 7.8% of the variation in occurrence of anestrus. Thus, body condition score is not an absolute predictor of what cows are cycling. Some cows with body condition scores of 3.0 were anestrus. As anticipated, anestrous cows did not perform as well as cyclic cows in terms of pregnancy rates to the first-service Ovsynch/TAI protocol. Pregnancy rate at 74 days after insemination was only 22.4% for anestrous cows, which was lower than the 41.7% pregnancy rate at 74 days after insemination for cyclic cows. Since cows in anestrus do not respond to injections of $PGF_{2\alpha}$, pre-synchronization did not affect pregnancy rates of anestrous cows. Also, pregnancy rates of anestrous cows following first-service Ovsynch/TAI were not affected by administration of bST. Collectively, these results indicate that use of advanced technology to tightly control the reproductive cycle and stimulate embryonic development to increase pregnancy rates may not produce the expected results if there is a high frequency of anestrous cows at breeding. Therefore, postpartum management of lactating dairy cows is of extreme importance and will greatly affect reproductive performance. Efforts to maximize cow health, comfort, and nutritional status following parturition (e.g., enhance dry matter intake) will be reflected later in the lactation in terms of a higher incidence of cycling cows and improved reproductive performance."

Relationship of days-in-milk to first service conception rate:

Records from Dairy Herd Improvement processing centers provide insight into the changes in fertility of dairy cows relative to DIM at the time of first service. Ferguson (1991) evaluated first service conception rate by DIM for cows processed at the Northeast DHI processing center. First service conception rates for cows improved from the low thirties before 60 DIM to about 38% after 60 DIM. Stewart recently analyzed DHI records for first service conception rates of dairy cows in Minnesota and found that first service conception rate for cows between 50 and 60 DIM was 35% and increased by 1% point for the next three ten day increments. Breeding cows early has been used as a means of reducing the average days open. Records from large populations of cows suggest that fertility is low before 50 DIM, increases some between 50 and 70 DIM and reaches a plateau after 70 DIM. The DIM when cows are bred following an estrous synchronization program with TAI affects the pregnancy rate. Pursley et al., 1997, observed a significant improvement in pregnancy rate from 26% for cows receiving TAI between 60 and 75 DIM compared to 43.4% for cows receiving TAI at greater than 75 DIM. In a second trial, Pursley et al., 1998, reported a trend for the improvement of the pregnancy rate of 36% for cows receiving timed AI between 50 and 75 DIM compared to 47% for cows receiving timed AI betwen76 and 100 DIM (Figure 11). An earlier study by Ferguson (1991) on 5461 first services from the Northeast DHI, also showed an increased conception rate by extending DIM at first breeding (Figure 12). With the ability to select which post partum week that cows are inseminated following a controlled breeding program with TAI, there may be an advantage in extending the voluntary waiting period to at least 70 DIM. The obvious advantage is that there may be a 10% or greater improvement in pregnancy rate for a controlled breeding program with TAI. The second advantage is that a greater proportion of cows could have closer to a twelve month calving interval with the elimination of short calving intervals as a result of cows conceiving early following short voluntary waiting periods. These two advantages should be given consideration in selecting longer voluntary waiting periods only if they are used in conjunction with a controlled breeding program!

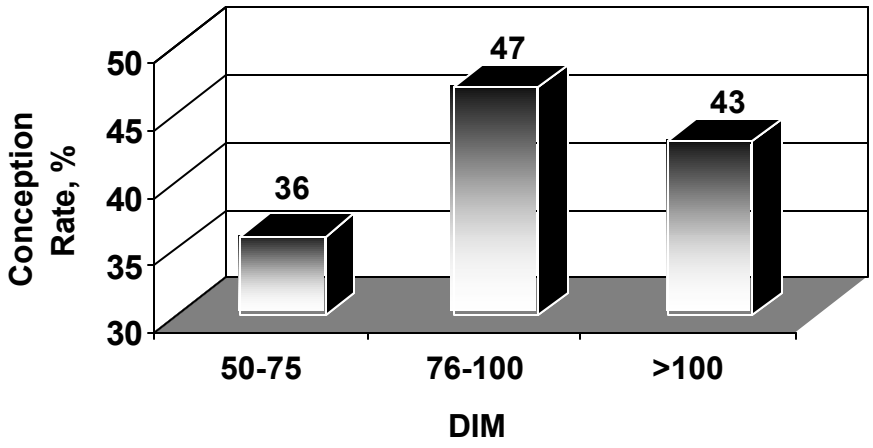


Figure 11. Pursley, et al., 1998. JDS 81:2139.

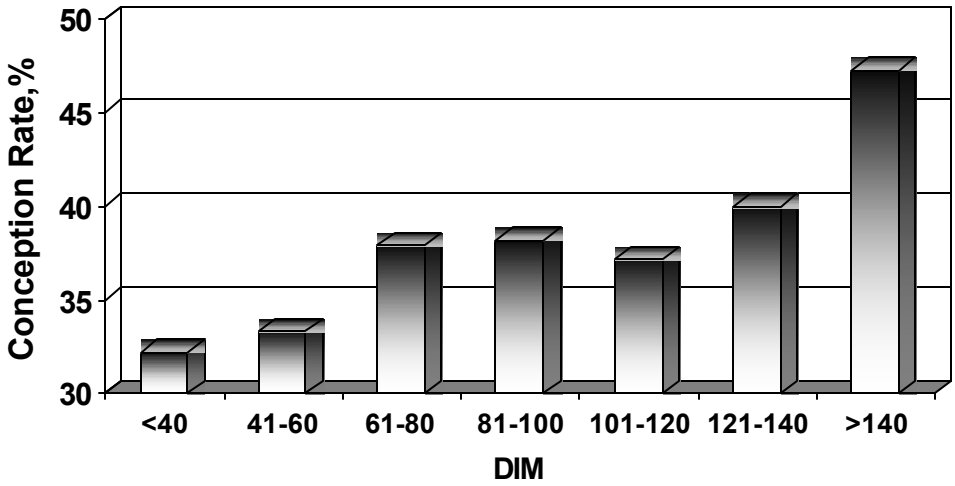


Figure 12. Ferguson, 1991. NAVet Clinics 7:483.

Synchronizing initial rBST treatment with a controlled breeding program:

Limited trials suggest that controlled breeding programs can work synergistically with the initiation of rBST to enhance pregnancy rates. Moreira, et al. (1997) compared pregnancy rates of cows beginning rBST treatment at either 63 DIM or 105 DIM. All cows were on an Ovsynch^{R} program that began at 63 DIM. The pregnancy rate for the 202 cows beginning rBST treatment at 63 DIM was 40% compared to 32% for 210 cows beginning treatment at 105 DIM. Thatcher, et al., (1999) compared pregnancy rates of cows beginning an Ovsynch^{R} program at 63 DIM and having body condition scores of 2.5 or greater with either receiving rBST at 63 DIM or not. The pregnancy rate for 67 cows receiving rBST was 38.3% and 25.6% for 126 cows not treated with rBST (Figure 13). Preliminary results suggest an eight to twelve percentage point advantage in pregnancy rates of cows receiving the first rBST treatment at the same time as the first GnRH in the Ovsynch^{R} program.

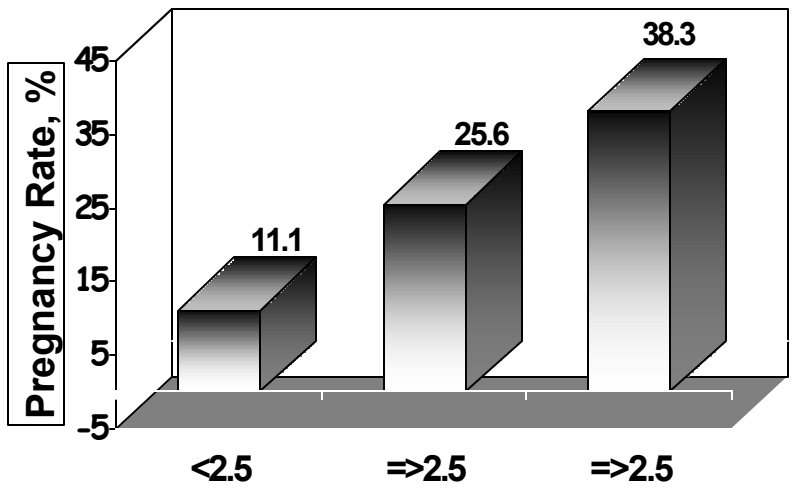


Figure 13. Thatcher, et al., 1999. SW Nutrition and Mgt Conf. pp 25.

Since anestrus has such a highly significant affect on pregnancy rates, reproductive performance was examined only in cyclic cows (Thatcher et al). First-service pregnancy rates to the Ovsynch/TAI protocol were affected by both bST pre-synchronization and bST treatments. Cows initiating bST treatment at 63 or at 73 days postpartum had increased pregnancy rates compared to controls among cows not pre-synchronized and also among cows pre-synchronized. The fact that a similar stimulation in pregnancy rates was observed in cows treated with bST at 63 (day of first GnRH injection) and at 73 days postpartum (day of timed insemination) indicates that bST is probably enhancing embryonic development and survival following insemination. Concentrations of bST are elevated throughout the 14-day period between injections such that bST injection at the time of the first GnRH injection will still elevate concentrations of bST 10 days later when the cow was inseminated. Since pregnancy rate was elevated when the first injection of bST was delayed to the time of insemination, the effects of bST appear to be targeted on the reproductive tract or on the embryo directly to enhance embryo survival.

Moreover, increased pregnancy rates were detected when cows were pre-synchronized (Figure14; gray bars; 52.3%) compared to cows not pre-synchronized (white bars; 31.1%). An additional comparison is the effect of pre-synchronization in the two groups that did not receive bST in which pre-synchronized cows had a 42.6% pregnancy rate compared to 25.3% for the control group (Figure14).

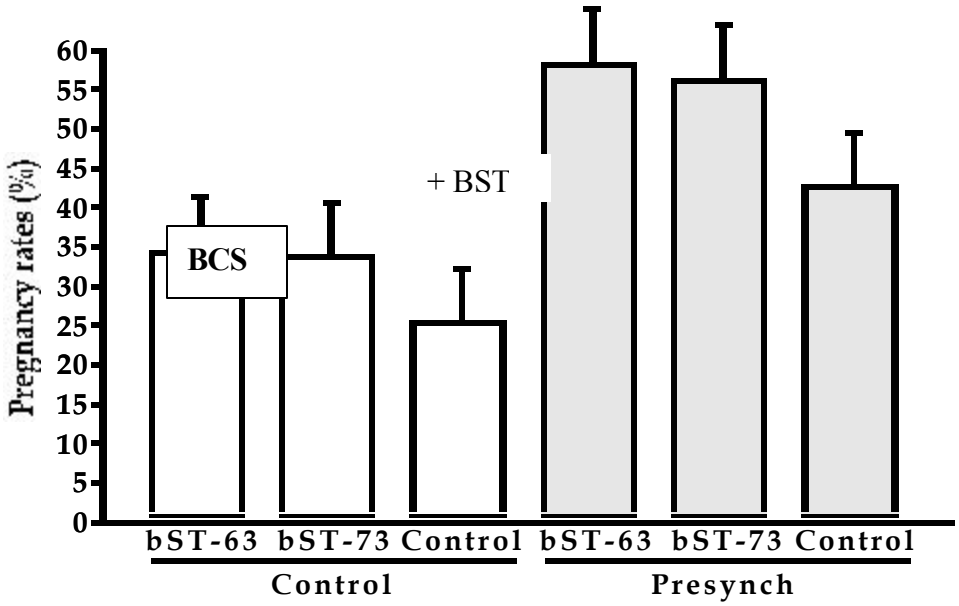


Figure 14. First-service pregnancy rates to the Presynch/TAI protocol for cyclic cows (n = 375; LSM +SE).

Monitoring success of estrous synchronization programs with TAI:

Producers frequently measure the success of breeding programs by monitoring percentage of cows pregnant of those presented for pregnancy diagnosis on scheduled herd reproductive examination. The reproductive examination of the herd is usually considered a success when 85% or more of the cows presented for pregnancy diagnosis are pregnant. This measurement of success is no longer applicable with the use of estrous synchronization programs and TAI. More cows will be inseminated, more cows will become pregnant earlier in lactation, but more cows will also be open at pregnancy examine. Success needs to be based on pregnancy rate to the synchronized estrus and TAI, not the percent cows pregnant on reproductive examinations. Monitoring procedures need to be developed to monitor the pregnancy rate of a monthly cohort of cows.

What's the future hold?

Devices to jump start acyclic animals, techniques to enhance embryo survivability, programs to resynchronize more effectively, programs and vaccines to protect against infectious pathogens that decrease fertility, cohort analysis and the list goes on.

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