# Management of the Postpartum Dairy Cow to Maximize Pregnancy Rate

CA Risco[1]
[1]University of Florida, College of Veterinary Medicine, PO Box 100136,Gainesville, Florida

## Introduction

Pregnancy rate, a function of estrus detection and conception rate (PR = EDR X CR), determines the number of days postpartum at which cows become pregnant and influences the number of days open. Figure 1, shows that as the PR increases from a higher EDR, greater CR or both, the calving to conception interval and consequently the calving interval (CI) decreases (6,21). A reduction in the CI results in an increase in the pounds of milk produced per day per herd lifetime and a reduction in cows culled for reproductive failure (21). In reality the exact net revenues depend in the individual farm circumstances, but Figure 2 is based on a widely representative farm scenario. Improvements in PR beyond 25% result in smaller incremental increases in net revenue, and virtually no increase in net revenue is experienced beyond a PR of 35%. The major factor influencing the CI of a dairy herd is the PR to first insemination (6). Cows expressing one or more estruses during the first 30 days post partum had improved pregnancy rates than cows with no estruses (24). This observation indicates that the physiological and hormonal events associated with estrus help restore uterine and ovarian function to a state conducive to the establishment of pregnancy. In an attempt to increase the number of estrous cycles prior to first insemination during the postpartum period, Prostaglandin $F_2$ alpha ($PGF_{2\alpha}$) and Gonadotropin Releasing Hormone (GnRH), have been used in dairy farms. (18,20,22).

During the postpartum period the cow experiences hypocalcemia, metritis and negative energy balance (2,8,19). These conditions alone or together affect the health and postpartum reproductive function of the postpartum dairy cow. A number of studies have demonstrated the relationship between parturient hypocalcemia with or without paresis, dystocia, and retained fetal membranes (2,19). These disorders predisposes the cow to metritis which can lower dry matter intake and exacerbate the negative energy balance already present during early postpartum (20,22). The energy status of the lactating dairy cow has differential effects on early follicular development and competence, ovulation and subsequent corpus luteum (CL) function during the postpartum period. As our understanding of the endocrinology and reproductive physiology of the postpartum cow has advanced, it is clear that reproductive and nutritional management systems need to be integrated to achieve optimal pregnancy rates. Management of postpartum dairy cows should emphasize recovery from hypocalcemia, metritis and an early return to a positive energy balance as early as possible. Objectives of this presentation are 1) to describe the association between calcium status to periparturient disorders 2) management of postpartum metritis 3)the use of $PGF_{2\alpha}$ and GnRH in postpartum dairy cattle in an attempt to improve estrus detection and conception rates.

## Association of Calcium Status to Periparturient Problems

During calving or shortly thereafter, hypocalcemia is inevitable in the dairy cow and is characterized by a blood calcium concentration < 8.0 mg/dl(2,7,8,14,19). Hypocalcemia develops as a result of the sudden drain of calcium to colostrum at the onset of lactation, resulting in a tremendous challenge to the cow=s ability to maintain calcium homeostasis. A cow producing 10 L (Kg) of colostrum (2.3 g of Ca/kg) will lose 23 g of calcium in a single milking (7,20). Representing about nine times as much calcium as that present in the entire plasma calcium pool of the cow . At parturition, 30 g or more of calcium must be replenish into the calcium pool each day to maintain normocalcemia.

Parturient paresis or milk fever is the clinical manifestation of hypocalcemia and the decreased plasma calcium content is accentuated in affected cows. In a study involving 39 hypocalcemic parturient cows, it was observed that paresis was associated with plasma calcium levels below 5 mg/100 ml (12). It was concluded that the degree of hypocalcemia appeared to be more critical for the development of paresis than did the duration of hypocalcemia. In 10 cows with milk fever, calcium levels were evaluated for 7 days post partum (19). Calcium levels were lower only in the sample prior to calcium therapy. After a single intravenous treatment with a 23 % 500 ml calcium gluconate solution , clinical signs regressed in all cases, indicating that calcium administration was sufficient to restore plasma calcium levels. Calcium deficits in a mature dairy cow with parturient paresis have been reported to be around 8 gms. A standard dose of 500 ml of a 23 per cent calcium gluconate solution provides 10.8 gms of calcium.

Hypocalcemia may affect organs that have smooth muscle function such as the uterus, rumen and the abomasum. A significant association between parturient hypocalcemia, dystocia and retained fetal membranes in dairy cows, has been reported (2,8). Cows with parturient hypocalcemia were 6.5 times more likely to have dystocia, 3.2 times more likely to have RFM and 3.4 times more likely to have a left displaced abomasum (2). Grohn et al (8)., after evaluating the lactational and health records of over 61,000 dairy cows in Finland, found that parturient hypocalcemia was a significant risk factor for dystocia, retained fetal membranes and clinical ketosis. The latter was associated with silent heats, cystic ovaries and infertility.

Reductions in blood calcium content may affect normal function of the uterus, rumen and abomasum, without causing the animal to become recumbent and unable to rise. This condition has been referred to as subclinical hypocalcemia and has been associated with various periparturient disorders (20) . In a California study, hypocalcemia without paresis was more common in cows affected with uterine prolapse than controls(17).The prolapse uterus was related to uterine atony, a delay in cervical involution and continued abdominal presses soon after parturition. Parturient hypocalcemia has been shown to delay cervical involution and cause uterine inertia (13). In the study mentioned above , there was no difference in serum calcium concentrations between 9 pairs of first parity cows which had prolapsed and their control contemporaries (17). Which supports the clinical finding that, primiparous cows seldom experience milk fever.

Hypocalcemia has been associated with displaced abomasum and reduced rumen contraction. Cows that had abomasal displacement in an Iowa study had abnormally low blood calcium content preceding displacement (10). Cows affected with hypocalcemia without paresis (total Ca < 8 ng/ml) where 4.8 times more likely to develop left displacement of the abomasum (11). In a study involving sheep, Huber et al (9)., demonstrated a true cause and effect relationship between hypocalcemia and normal smooth muscle contractility in the ruminant stomach. The major conclusions of this study were that: 1) ruminal contractions ceased long before signs of hypocalcemia were observed, 2) ruminal dysfunction may occur substantially before the clinical signs of hypocalcemia. In a study (4), that compared total serum calcium concentrations of cows diagnosed with abomasal displacement or volvulus with that of unaffected cows from the same herds, hypocalcemia occurred in over two-thirds of cows affected with displaced abomasum or volvulus , suggesting that calcium administration at the time of correction of these conditions may be beneficial.

**Management of Postpartum Metritis**

For years the recommended treatment for metritis (purulent malodorous uterine discharge) has been intrauterine infusions with antibiotics and disinfectants. Based on a better understanding of the involution and microbiology of the postpartum period, treatment of metritis with antibiotics should be limited to cows that are febrile. Affected cows should be treated systemically and locally. Most bacteria that cause toxic metritis are susceptible to penicillin, making it the antibiotic of choice for systemic treatment (20). Dosages of 10,000 IU or more per pound of body weight have given good results. However, this dose exceeds label recommendations. These cows also can be treated with 2 to 6 g of tetracycline in the uterus, which is the antibiotic of choice for intrauterine treatment early postpartum (20).

A study was conducted by Smith et al (24), to determine the efficacy of various antibiotics in treating cows affected with toxic metritis. The study involved 51 post partum Holstein cows less than 10 days in milk diagnosed with toxic metritis (fever, off feed and malodorous uterine discharge). Cows were assigned to one of three treatment groups. Groups 1 and 2 received 22,000 u/kg procaine penicillin G IM QD on days 1-5. In addition, Group 2 received an intrauterine infusion of 6 g of tetracycline on days 1, 3, and 5. Group 3 received 2.2 mg/kg ceftiofur sodium IM QD on days 1-5. Variables used to determine antibiotic efficiency included milk yield, and rectal temperature.

The results from the study demonstrated no difference in treatment efficacy between these antibiotic combination in cows suffering from toxic metritis. For treatment regimens in groups 1 and 2 (penicillin alone or in combinations with intrauterine tetracycline) antibiotic residue persisted in milk. However, no residues in milk were seen in cows in group 3 (Ceftiofur). This finding suggests that Ceftiofur can be used as an economical alternative to the treatment of toxic metritis.

Management of metritis, should emphasize daily health monitoring during the first 10 days post partum for fever, appetite, ketosis and displacement of the abomasum. These conditions generally occur during the first 10 days postpartum and when treated early, the cow has a good change of recovery. Use of antibiotics should be limited to febrile cows that have a fetid purulent uterine discharge. Because febrile cows have lower dry matter intake, they may suffer from hypocalcemia and ketosis. These cows should be treated with a calcium and energy supplement. Postpartum cows that are not febrile but are not eating, should be treated with a calcium and glucose product. Monitoring postpartum cows in this manner has worked well in reducing the cost of antibiotics, and provides a means for early detection and treatment of metritis (26 ).

Cows that are affected with retained fetal membranes can be treated with an ecbolic agent such as oxytocin or estradiol cypionate (ECP Pharmacia and Upjohn), and enter into the monitoring program. If antibiotics are going to be used in cows affected with retained fetal membranes, intrauterine oxytetracycline at a dosage of 3 to 6 g in a bolus, or in 100 ml of sterile water is the recommended antibiotics (20).

**Use of Prostaglandin ($PGF_{2\alpha)}$) during the Voluntary Waiting Period**

The most direct way to reduce the days open is to reduce the number of missed heats and to increase the number of animals submitted for insemination. This can be done by short-cycling cows and estrus synchronization. Groups of animals that are in heat facilitate accurate estrus detection because of more active animal to animal interaction (sexually active groups), The use of estrus detection aids (chalk, heat mount detectors, teaser animals) further increase the efficiency of detection. Prostaglandin F 2 alpha (PGF) is the natural substance produced by the endometrium of the cow that cause normal regression of the corpus luteum. Injection of PGF mimics the normal process. However, the corpus luteum has to be mature (days 6 to 18) to be able to responds. Heats of animals injected on days 7, 15 and 16 are more precisely synchronized on day 3 after injection of PGF. Most cows injected on days 8 to 14 show heat on days 4 to 7 after injection of PGF (5). This differential pattern is related to the occurrence of follicular waves during the estrous cycle (5). When first approved, the recommendation was to inject PGF twice 11 days apart. This protocol increases the number of animals with a mature corpus luteum at the time of the second injection. With heifers, injecting PGF twice 11 days apart results in an estrous response of 85% under field conditions (23). In lactating dairy cows, metabolic and hormonal changes associated with milk production, alter follicular development. A reduction in plasma estradiol and altered patterns of follicular development are evidence of this when lactating cows are compared with nonlactating cows (5). Lactating cows come into hear later than heifers and nonlactating cows after the injection of PGF. This means that with an 11-day interval between injections, a higher percentage of lactating cows will be at an earlier stage of the estrous cycle, days 1 to 5, a time during which the corpus hemorrhagicum or early corpus luteum is nonresponsive to the luteolytic action of PGF. Based on these observations a 14-day interval is recommended for dairy cows (5). Such an interval complies nicely with weekly herd reproductive health visits.

The **Targeted Breeding** program (Pharmacia and Upjohn) shown in Figure 3, is based on PGF injections given at 14-day intervals on a specifically scheduled day of the week. Seventeen days prior to the end of their voluntary waiting period, cows are injected with PGF. The purpose of this Aset-up@ injection to ensure that cows will respond uniformly to the Abreeding@ injection 14 days later. No cows are inseminated upon detected heats from the set-up injection. After the second (breeding) injection cows detected in heat will be inseminated at that time. All cows not detected in heat are again injected with PGF another 14 days later. With such a system over 90% of the cows should be inseminated following two injections 14 days apart. If heat detection rates fall below 50%, method of heat detection and the anestrous state of the cows should be evaluated. New cows approaching the end of their voluntary waiting period receive their first PGF injection on the same schedule, and the same day of the week. Cows are re-inseminated if seen in heat 21 days later. Cows are examined for pregnancy 6 weeks after insemination. If diagnosed open, they re-enter the pool of cows to be treated with $PGF_{2\alpha}$. For the system to work, employees must pay attention to details of heat detection and insemination. Problems are likely to arise if size of groups is too large for the abilities of the people, or capacity of the facilities for injection, observations, and inseminations.

**Synchronization of ovulation**

While estrus is a variable period of time during which a cow will stand for mounting by a bull or by another cow, ovulation is a specific event in response to a pre-ovulatory surge of luteinizing hormone ~30 hours earlier. The reason for estrus detection is simply to determine the time for insemination. The most common denominator of poor reproductive performance is a low estrus detection rate.

Estrous behavior is not detected with sufficient accuracy, nor is estrus synchronization precise enough to achieve an acceptable conception rate based on timed insemination when using PGF alone. Treatment with PGF only regulates the lifespan of the corpus luteum and requires estrus detection over a period of 5 days (5). There is a lack of precision between the time of the PGF injection and the time of ovulation relative to insemination.

Research at the University of Wisconsin and the University of Florida has led to the development of a timed artificial insemination (TAI) program with the need for detection of estrus in lactating dairy cows. Injection of GnRH can induce ovulation of a dominant follicle and, when used after synchronization of follicular growth and regression of the corpus luteum, should program ovulation to permit successful insemination at a predetermined time (1,3,1523). This program is called OvSynch and its protocol is shown in Figure 4. The first injection of GnRH induces release of luteinizing hormone (LH) and follicle stimulating hormone which will cause ovulation or luteinization of a dominant follicle, and initiate a new follicular wave. When injection during a period of time when a new follicular wave is just beginning there is no dominant follicle and neither ovulation nor luteinization will take place. Seven days later PGF injected intramuscularly causes regression of all corpora lutea. If a corpus luteum resulted in response to the initial injection of GnRH, the 7-day interval usually proved sufficient time for the corpus luteum to mature and be responsive to PGF. Forty-eight hours later, a second injection of GnRH should trigger LH release and ovulation of a dominant follicle. GnRH will induce ovulation in approximately 30 hours. Cows are inseminated approximately 16 hours before ovulation.

**Heifers** assigned to an OvSynch/ TAI treatment had similar pregnancy rates but lower conception rates when compared with heifers inseminated at detectable estrus (23). OvSynch is not recommended for use in heifers at this time unless estrus detection is not possible.

**Factors Which Affect Pregnancy Rate When Using the OvSynch/TAI Protocol**

There are several management factors that can affect success of the OVSYNCH/TAI program and need to be investigated to improve pregnancy rate. In most of the studies cited above, the OVSYNCH/TAI program was performed only for first insemination. As shown by Pursley et al.[11], the use of ultrasound at 32 to 38 days post insemination can be used effectively to determine pregnancy status, allowing resynchronization of non-pregnant cows for subsequent insemination. Several situations develop during the Ovsynch/TAI protocol that impact on decisions for the producer. At the time of $PGF_{2\alpha}$ injection and during the next 36 h approximately 10% of cows will express estrus. These cows should be inseminated at detected estrus and do not need to receive the second injection of GnRH. In our experience these cows are at approximately day 14 to 15 of the estrous cycle at the time of the first GnRH injection and fail to produce a CL in response to GnRH. Thus in 7 days, at the time of $PGF_{2\alpha}$ injection, they are in estrus and should be inseminated.

Another common question concerns the timing of AI following the second injection of GnRH given 2 days after the injection of $PGF_{2\alpha}$. Cows will ovulate 28 to 30 hours after the injection of the second GnRH of OVSYNCH/TAI, and they should be inseminated 15 h prior to ovulation to allow semen to undergo capacitation in order to fertilize the egg following ovulation. Pursley et al.,[12] evaluated the conception rate of insemination at 0 h (37%), 8 h (40%), 16 h (44%), 24 h (40%) and 32 h (32%) after injection of GnRH. Pregnancy rate was maximal at 16 h. However, a surprising percentage of the cows were pregnant when inseminated at the time of GnRH injection (0 h) and close to the time of ovulation (32 h). However, pregnancy rate was reduced significantly at 32 h. Thus alternative insemination times are possible. It is anticipated that maximal pregnancy rates will be obtained between 8 and 24 h or at 16 h after GnRH injection.

Figure 4 shows a significant relationship of increased pregnancy rates with increases in body condition score (BCS) of the cow [2]. This figure shows that cows with higher BCS at OVYSYNCH/TAI had higher pregnancy rates. Cows suffering from postpartum anestrus (progesterone concentration < 1 ng/ml for 60 days postpartum) are known to eat less feed, produce less milk, and lose more body weight, resulting in a more negative energy status than cycling cows [21]. Cows that were anestrus, determined by an absence of ovarian follicular activity or having a plasma progesterone <1.5 ng/ml, did not have improved reproductive performance when treated with GnRH over untreated controls that were also anestrus [4,9]. Therefore, cows that are not cycling should not be expected to have a normal response rate to the

OVSYNCH/TAI protocol.

Our field experiments with OVSYNCH/TAI indicate a lower fertility rate in cows identified to be anestrus. With our ability to guarantee that all cows can be inseminated precisely at a designated time postpartum with the use of OVSYNCH/TAI, producers can lengthen the VWP, since the time of first insemination is more precisely controlled. If all cows are cycling, a normal program of inseminating at detected estrus, assuming a 50% estrus detection rate, would have to be started at day 40 to ensure that mean time of insemination will be day 70 (range 40 - 100 days). However, an OVSYNCH/TAI program permits all inseminations to be made at 70 $\pm$ 3 days if implemented on a weekly basis. Furthermore, an assessment of pregnancy rates for cows that underwent OVSYNCH/TAI between 76-100 days postpartum was greater than cows that received. OVSYNCH/TAI between 50-75 days (47% vs. 35% )[12]. Thus, it may be an advantage to delay first inseminations until a period of greater fertility, using the OVSYNCH/TAI program to ensure that there will be no net loss in time to first service by controlling the time of insemination for all cows.

**Conclusions**

Figure 5, represents a protocol for management of the postpartum dairy cow with the ultimate aim of maximizing the pregnancy rate to first insemination. This protocol is based on our current understanding of postpartum physiology and the application of timed artificial insemination using the OvSynch program.

Step 1: Appropriate nutritional management of the prepartum transition dairy cow with the objective of reducing the incidence of hypocalcemia related problems (milk fever, dystocia, RFM, ketosis and metritis). These conditions alone or together results in cows having lower pregnancy rates to first insemination, regardless of hormonal treatment during the voluntary waiting period.

Step 2: Efficient and sound treatment of disorders associated with parturition (milk fever, dystocia, uterine prolapse, retained fetal membranes, mastitis, udder edema and vaginal tears).

Step 3: Health monitoring of all postpartum cows during the first 10 days postpartum. The objective of this step is to reduce the spurious and expensive use of antibiotics and hormones in cows that will not benefit from treatment. It also assures, that all postpartum cows are examined daily during the time when they are most susceptible to disease and the implementation of judicious treatment early in the course of disease.

Step 4: Cows are not palpated at the usual 3 to 4 weeks post partum to assess uterine involution and resumption of cycling. The occasional pyometra is treated by subsequent injections of $PGF_{2\alpha}$ (22). Administration of $PGF_{2\alpha}$ around 30 days post partum should only occur in cows that experienced an abnormal parturition (twins, dystocia, retained fetal membranes). Research has documented that the use of $PGF_{2\alpha}$ at this time is cost effective only in cows with these calving problems (18). Use of $PGF_{2\alpha}$ at this time post partum, in cows that calved normally has not proven to be cost effective.

Step 5: Administration of $PGF_{2\alpha}$ to all cows wether or not they experienced a normal or abnormal parturition will help promote an additional estrus event that can improve conception rates to first insemination. In addition, it assures that when cows start the OvSynch protocol around 60 days postpartum the majority will be in the diestrous phase of the cycle. As stated earlier cows that begin OvSynch during day 7 to 14 of the estrous cycle have higher pregnancy rates.

Step 6: Initiation of the OvSynch protocol at 60 days postpartum. This will assure that all cows receive a timed insemination at 70 days postpartum. All cows are palpated at the time of the first GnRH injection. Cows with uterine, oviductal, and ovarian adhesions are identified at this time and generally eliminated from the breeding program. Cows with ovarian cysts are noted but are automatically treated with the GnRH and PGF as part of the OvSynch protocol.

Step 7: Timed artificial insemination. This is the conclusion of the OvSynch protocol and assures that all cows receive an insemination by 70 days post partum which results in an increase in the pregnancy rate to first service. After timed insemination, cows should be detected daily for estrus during the next 6 weeks and inseminated at detected estrus.. Cows that have not been seen in estrus by the end of the 6 week period are palpated for pregnancy status. Cows that are found open re-assigned to the timed insemination or the Targeted Breeding programs unless previously undetected abnormalities of the reproductive tract are diagnosed.

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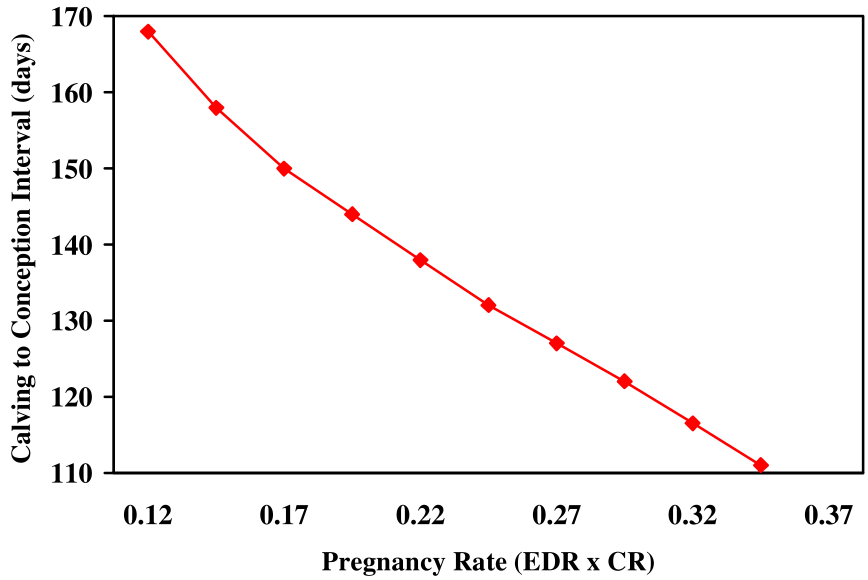



**Figure 1 Effect of pregnancy rate on calving to conception interval**

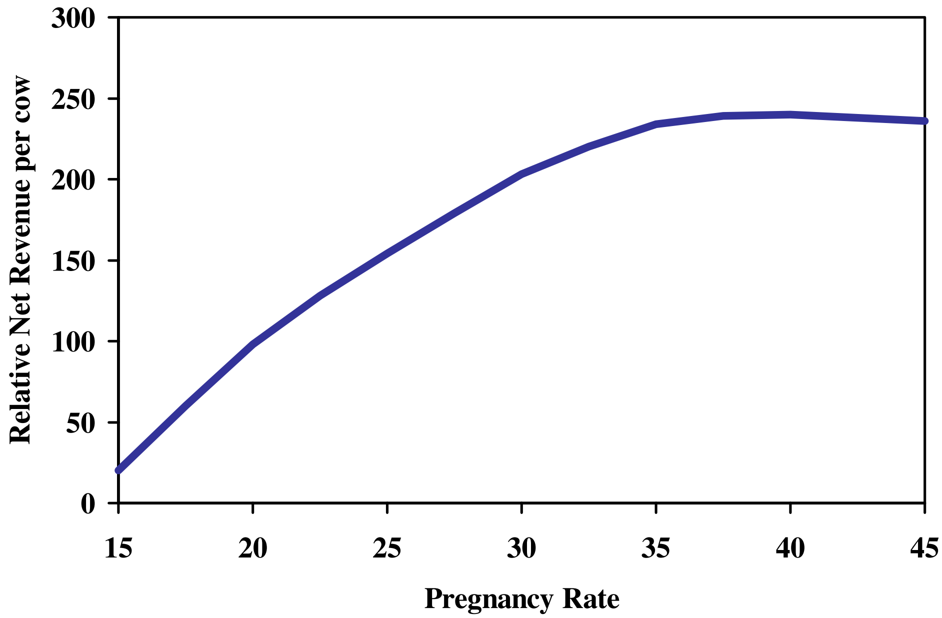



**Figure 2** Effect of pregnancy rate (estrus detection rate x conception rate) on relative increase in net revenue per cow. All income and cost variables affected by pregnancy rates are accounted for. These include milk produced, feed costs, reproductive culling, replacement costs and other variable costs

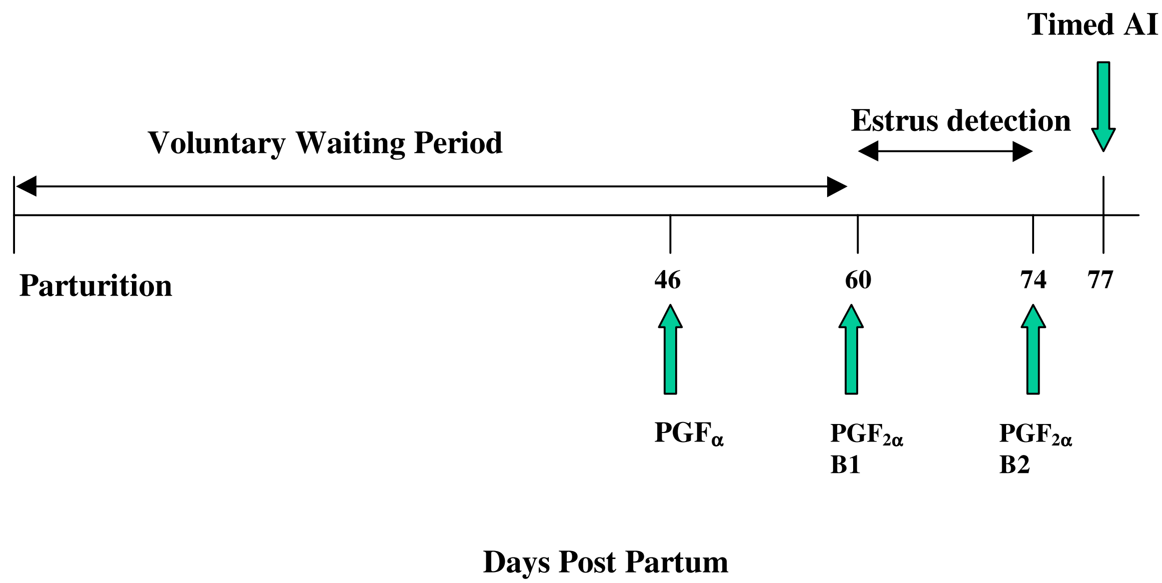
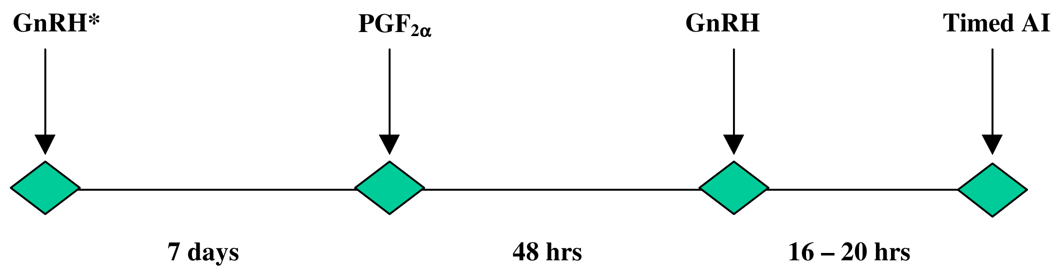



**Figure 3** Targeted Breeding Program




*** Treatments may be started at any day of the estrous cycle. Even though dosages for GnRH vary according to manufacturer the physiologic response is the same.**

**Figure 4** Ovsynch ® Protocol

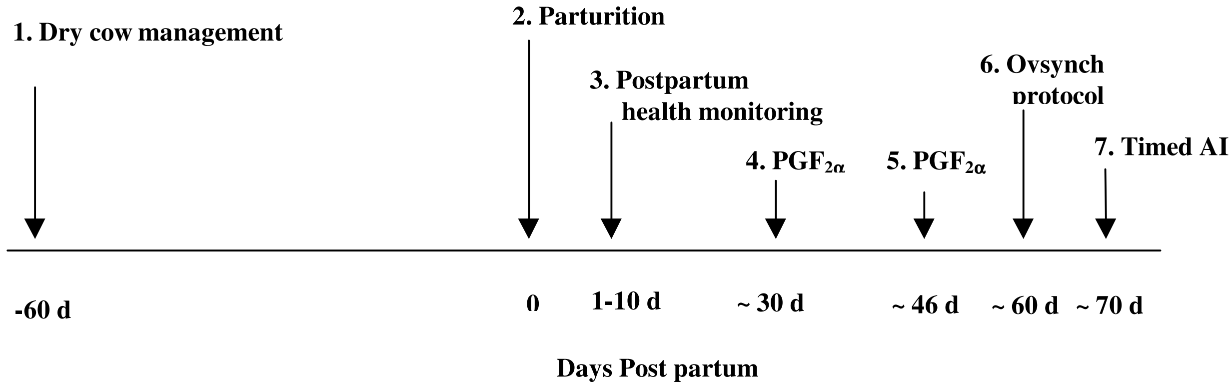



**Figure 5** Postpartum reproductive management