

# UNDERSTANDING ESTRUS SYNCHRONIZATION OF CATTLE

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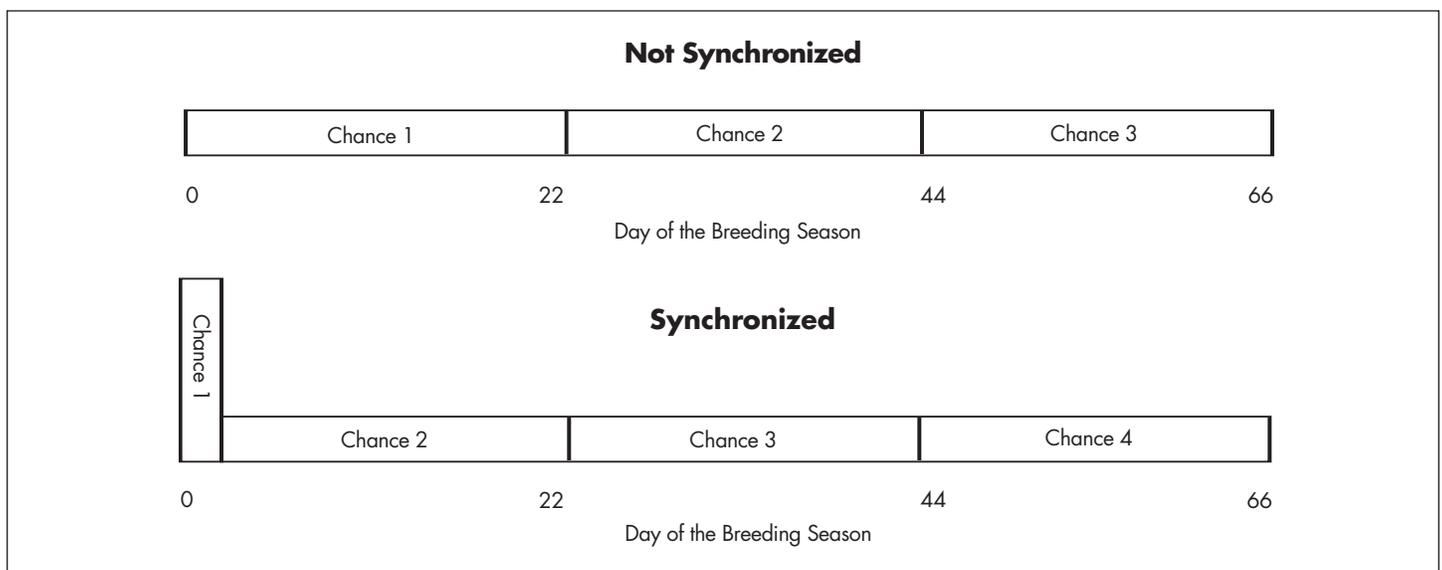
Reproductive failure is a major source of economic loss in the beef industry. The majority of this loss occurs because cows do not become pregnant during a defined breeding season.

You can give cows an additional chance to become pregnant during a defined breeding season by using estrous synchronization. Synchronizing estrus is simply manipulating the bovine estrous cycle (see Fact Sheet FS921A for details of the estrous cycle) to cause the majority of cows to show standing estrus around the same time.

Because a cow's estrous cycle is 21 days, she only has one chance to become pregnant every 21 days of the breeding season (three chances during a 66-day breeding season). However, cows that are

synchronized to cycle at the start of the breeding season have an additional opportunity (four chances) to become pregnant during that same 66-day breeding season (Figure 1).

Estrous synchronization also can decrease the labor associated with artificial insemination and can increase the proportion of cows that become pregnant early in the breeding season, resulting in more calves born earlier in the calving season. Some estrous synchronization protocols have the ability to induce cows to initiate estrous cycles and shorten the anestrus postpartum interval.



**Figure 1.** Comparison of the number of chances a nonsynchronized and a synchronized cow have to become pregnant during a 66-day breeding season. Nonsynchronized animals have one chance every 21 days to become pregnant. Synchronized animals will show estrus in the first few days of the breeding season and will therefore gain an extra opportunity to become pregnant during the 66-day breeding season.

## Types of synchronization protocols

Successful synchronization of estrus requires control of both the luteal and follicular phases of the estrous cycle. Estrous synchronization protocols can be grouped into four main classes: 1) prostaglandin F2 $\alpha$  (PG) based, 2) gonadotropin releasing hormone (GnRH) based, 3) progestin based, and 4) combination.

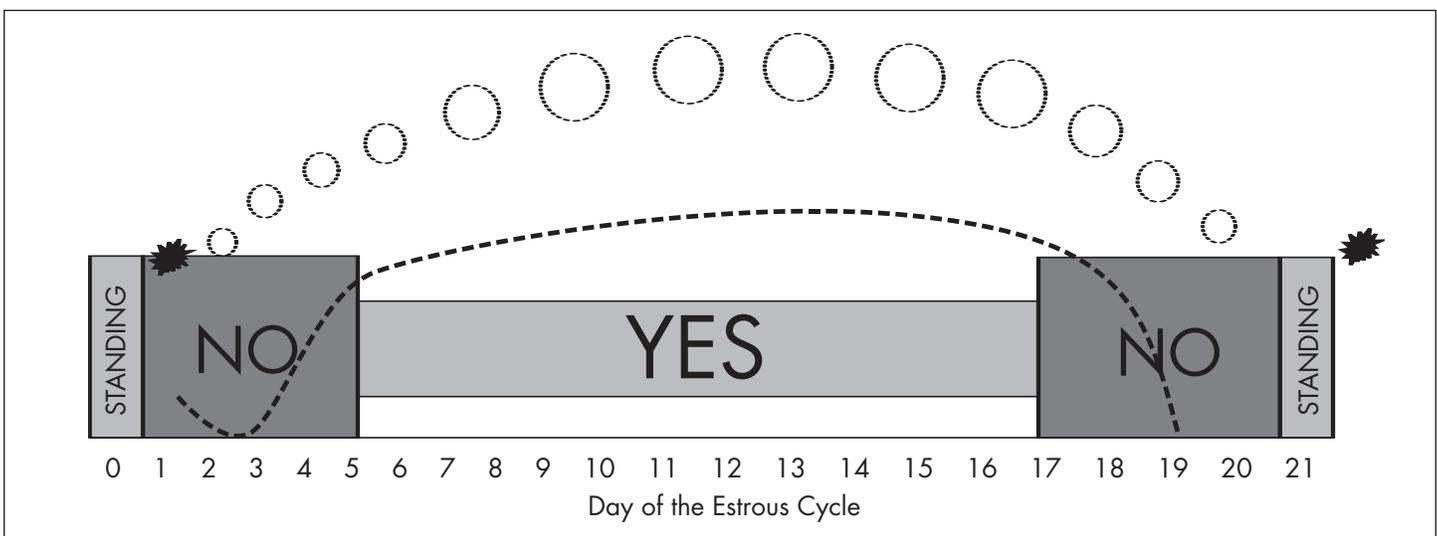
### 1. Prostaglandin F2 $\alpha$ (PG)-based protocols

Following ovulation, the different cells that make up the ovulatory follicle from which the egg emerged change function and become luteal cells that form the **corpus luteum (CL)**. The primary purpose of the CL is to produce **progesterone**, a hormone that regulates several physiological functions: preparing the uterus for pregnancy, maintaining the pregnancy if fertilization occurs, and inhibiting signs of standing estrus and ovulation.

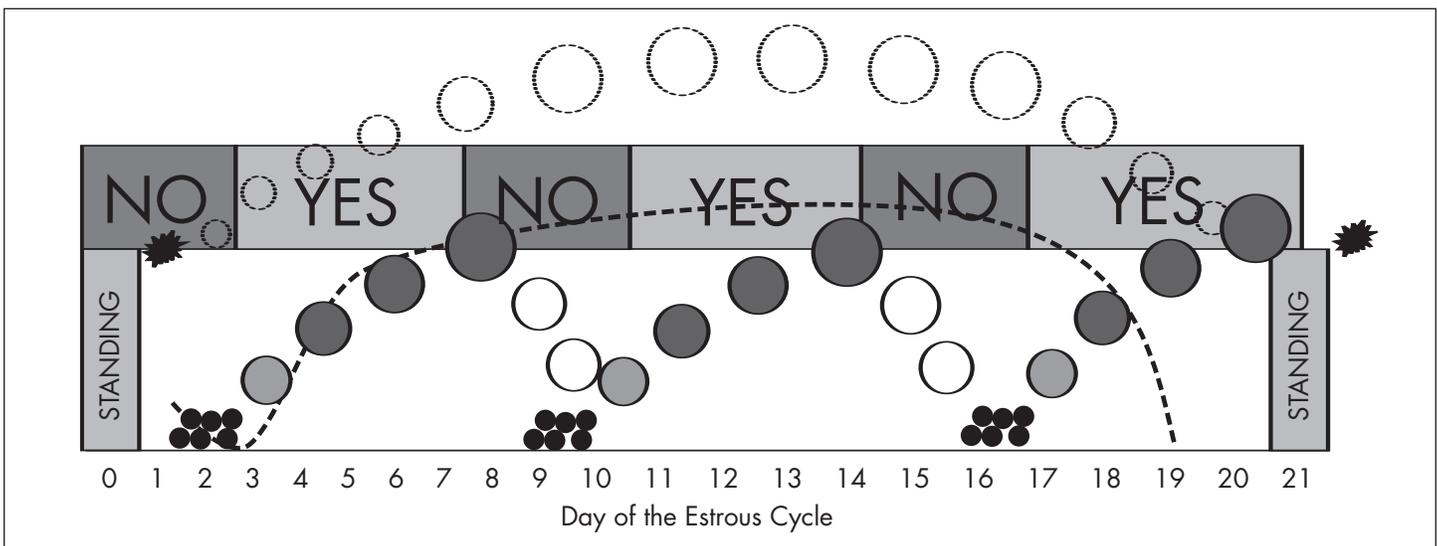
**Prostaglandin F2 $\alpha$  (PG)** is a naturally occurring hormone that signals the CL to degenerate (regress) if a pregnancy does not occur, allowing the cow to return to standing estrus. Giving an injection of PG will cause the regression of a CL before it would normally regress on its own; thus, PG allows for control of the luteal phase of the estrous cycle.

During the first 5 days of luteal development and during natural CL regression (after day 17 of the estrous cycle), the CL is not responsive to PG. Therefore, PG will only work to regress the CL from days 5 to 17 of the estrous cycle (Figure 2). When an injection of PG is given during the responsive period (days 5 to 17), the CL will regress and cause the animal to exhibit standing estrus 48 to 120 hours after the injection.

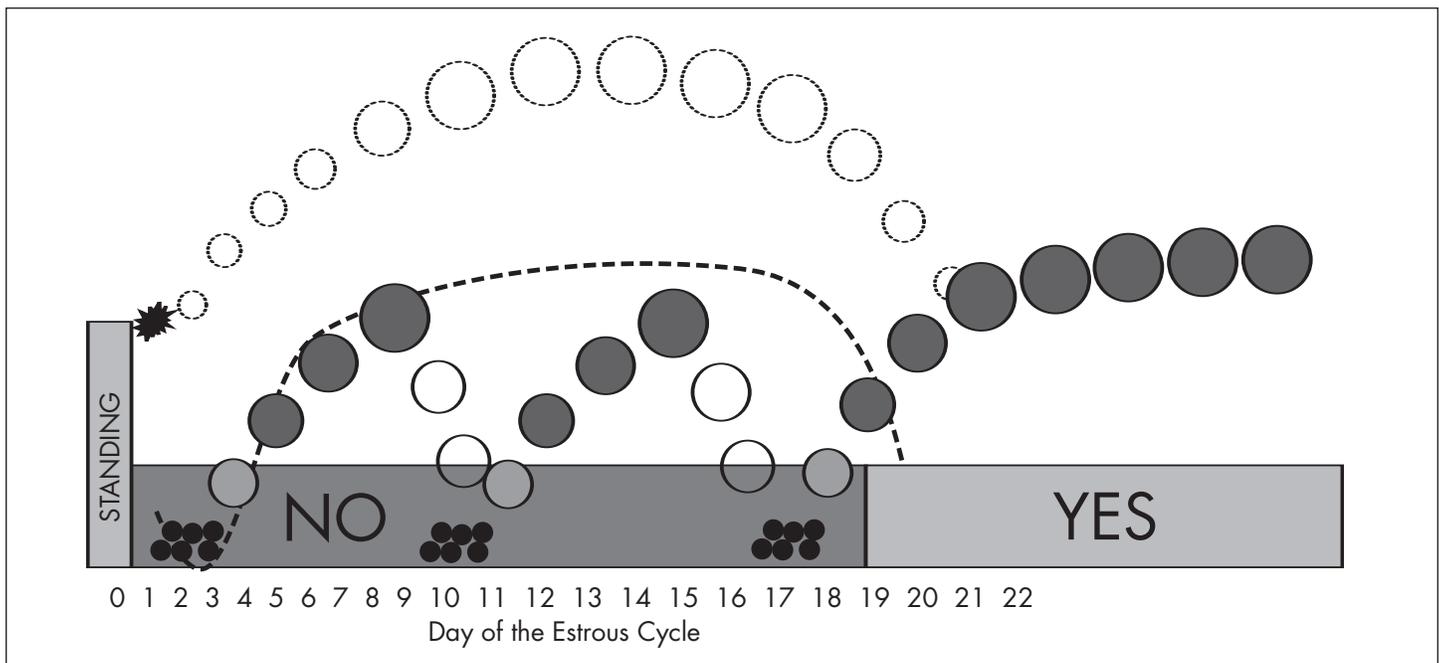
If an animal does not have a CL present (a cow in the postpartum anestrus period or a heifer that have not reached puberty), she will



**Figure 2.** Normal growth and regression of the CL (dotted circles) during the estrous cycle along with the changes in concentration of progesterone (dotted line) that occur. From day 0 to 5 and from 17 to 21 (indicated with the NO) the CL will not respond to an injection of PG. From day 5 to 17 (YES) the CL will regress following an injection of PG.



**Figure 3.** Three follicular waves (indicated by the groups of small, medium, and large circles) occurring during the estrous cycle along with the growth and regression of the CL (dotted circles) and the changes in concentration of progesterone (dotted line). When a dominant follicle is present, an injection of GnRH is capable of inducing ovulation and initiating a new follicular wave (indicated with a YES). When a follicular wave is developing and a dominant follicle is not present, an injection of GnRH will have no effect (NO).



**Figure 4.** Three follicular waves (groups of small, medium, and large circles) occurring during the estrous cycle along with the growth and regression of the CL (dotted circles) and the changes in concentration of progesterone (dotted line). While a CL is present and progesterone concentrations are high, a progestin will have no influence, but when a CL regresses and progesterone concentrations are low, a progestin will inhibit standing estrus and ovulation.

not respond to an injection of PG. An animal must be cycling and be between days 5-17 of the estrous cycle to respond to an injection of PG.

## 2. Gonadotropin releasing hormone (GnRH)-based protocols

**Gonadotropin releasing hormone (GnRH)** controls the follicular phase of the estrous cycle. Follicles grow in wave-like patterns, with each estrous cycle consisting of two or three follicular waves. The dominant follicle of each of these waves is capable of ovulating (releasing an egg) and having good fertility. However, when progesterone is present it inhibits a dominant follicle from ovulating.

Gonadotropin releasing hormone is a naturally occurring hormone that induces a **luteinizing hormone (LH)** surge, which causes ovulation of the dominant follicle even in the presence of progesterone. During an estrous cycle with three follicular waves, there are three time periods when a dominant follicle is present and can be induced to ovulate with an injection of GnRH. When a follicular wave is developing and a dominant follicle is not present an injection of GnRH will have no effect (Figure 3).

Following the induced ovulation of a dominant follicle by an injection of GnRH, a CL will form and a new follicular wave will be initiated.

## 3. Progestin-based protocols

During the estrous cycle when a CL is present and progesterone concentrations are high, standing estrus and ovulation are inhibited, but when the CL shrinks in size and the progesterone concentra-

tions decrease, the animal then returns to standing estrus.

**Progestins**, however, mimic the progesterone produced by the CL and inhibit ovulation, controlling the estrous cycle by extending the luteal phase of the cycle. Instead of the animal exhibiting standing estrus and ovulating after natural regression of the CL, the introduced progestin will cause the follicle to continue growing. Ovulation will be inhibited (Figure 4).

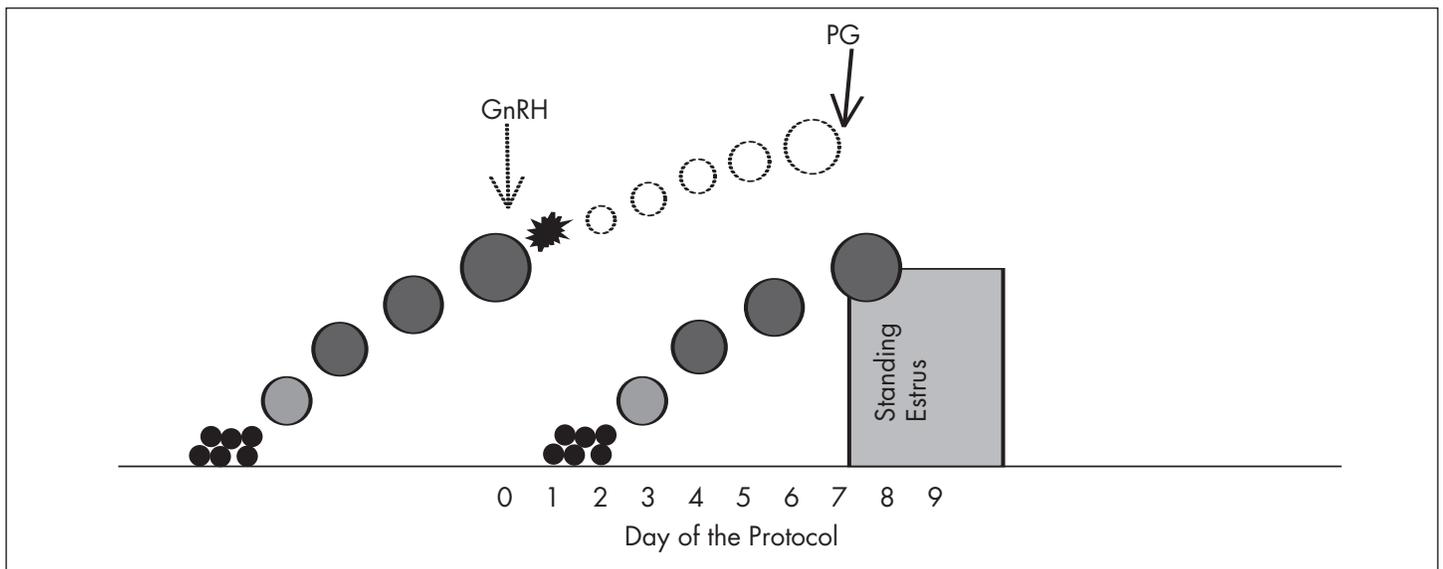
Following the removal of the progestin, progesterone concentrations will be low and standing estrus and ovulation will occur. However, when a CL regresses and cows are exposed to a progestin to inhibit ovulation of the dominant follicle, the follicle will continue to grow and will become a persistent follicle. Breeding animals at the first estrus after exposure for more than 7 days to a progestin will have decreased fertility, but subsequent ovulations will have normal fertility.

## 4. Combination protocols

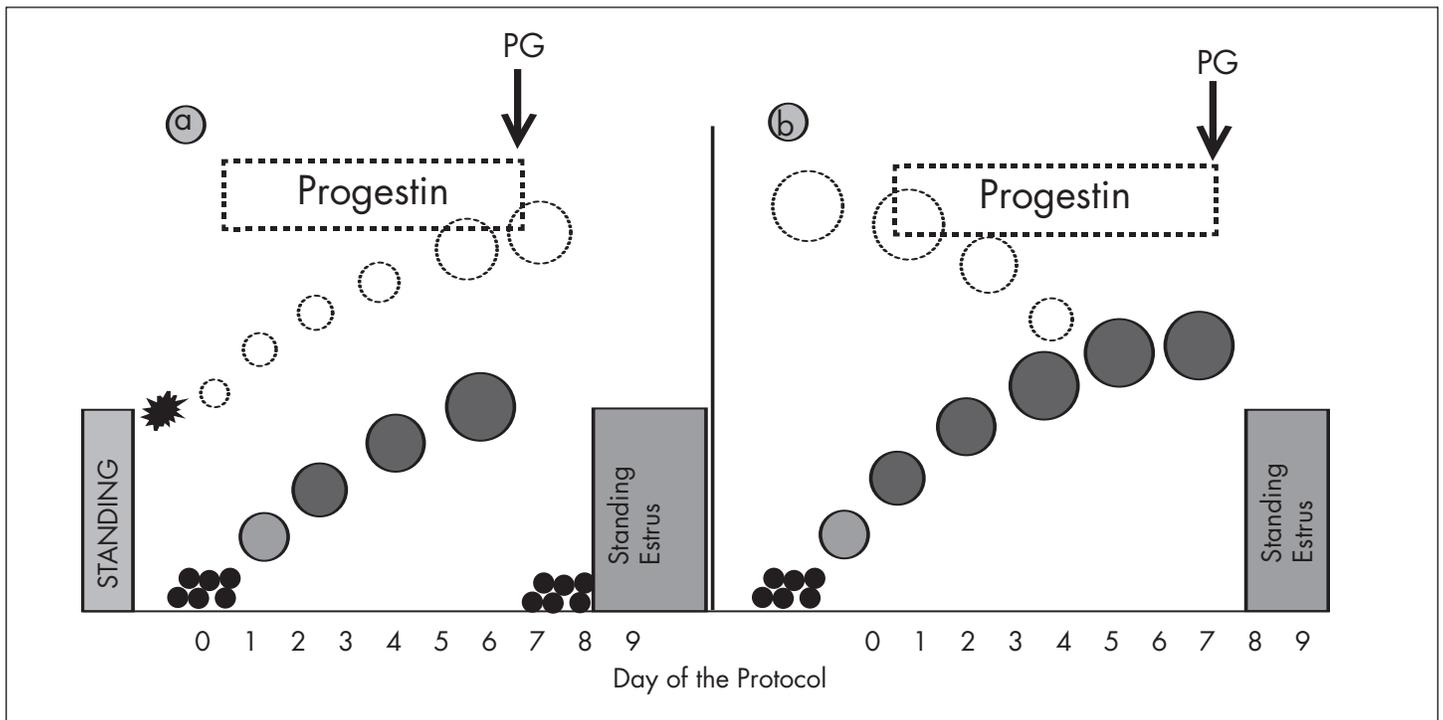
When PG, GnRH, or progestins are used alone, they will only synchronize either the luteal or follicular phases of the estrous cycle. Therefore, most estrous synchronization protocols combine the above methods to control both phases of the estrous cycle.

### GnRH-PG

As previously mentioned, GnRH is a naturally occurring hormone that, when injected, induces an LH surge and causes ovulation of a dominant follicle even in the presence of progesterone. Following the induced ovulation of the dominant follicle, a CL will form and a new follicular wave will be initiated. The CL that forms following this induced ovulation can be stopped (regressed) 7 days later by an injection of PG.



**Figure 5.** Follicular waves (groups of small, medium, and large circles) occurring during the estrous cycle. When an injection of GnRH (dotted arrow) is given, it will induce ovulation of a dominant follicle, causing the formation of a CL (dotted circles) and the initiation of a new follicular wave. Seven days after the GnRH injection an injection of PG (solid arrow) is given to regress the newly formed CL. At this time the new follicular wave should have a dominant follicle present that will cause standing estrus around the time of the PG injection.



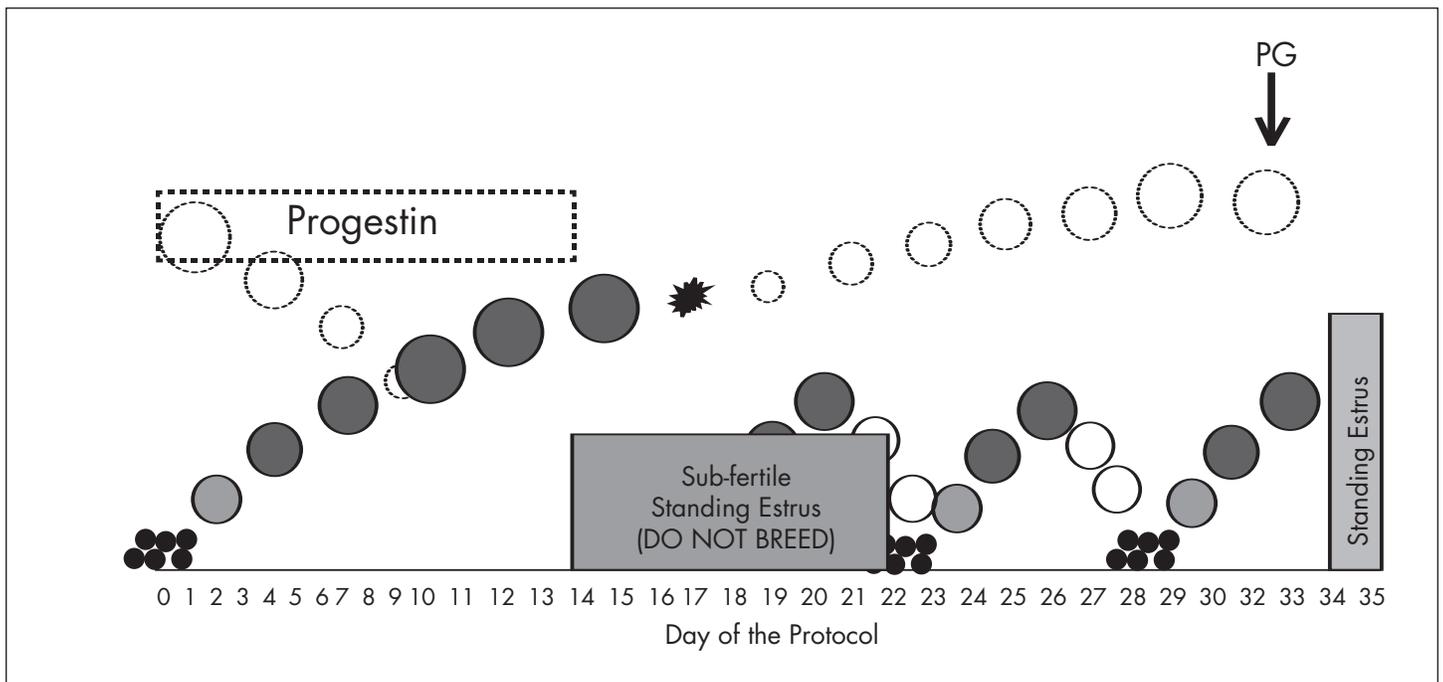
**Figure 6a.** Initiation of progestin treatment (indicated by the box) at the beginning of an estrous cycle (a new follicular wave emerges as indicated by the group of small, medium, and large circles, and a new CL is developing as indicated by the dotted circles). At time of the PG injection the CL is at least 7 days old and able to regress.

**Figure 6b.** Initiation of progestin treatment (indicated by the box) at the end of the estrus cycle and ovulation being inhibited after the CL regresses (dotted circles). The follicular wave (groups of small, medium, and large circles) will continue to grow until the time that the progestin is removed and standing estrus occurs.

The new follicular wave that was initiated by the induced ovulation by GnRH will develop normally and around day 7, a new dominant follicle will be present and ready to ovulate following regression of the CL by PG (Figure 5). However, animals that do not have a dominant follicle present at the time of the GnRH injection will not be induced to ovulate. Depending on the stage of the estrous cycle, these animals can exhibit standing estrus before the time of the PG injection.

### Progestin-PG

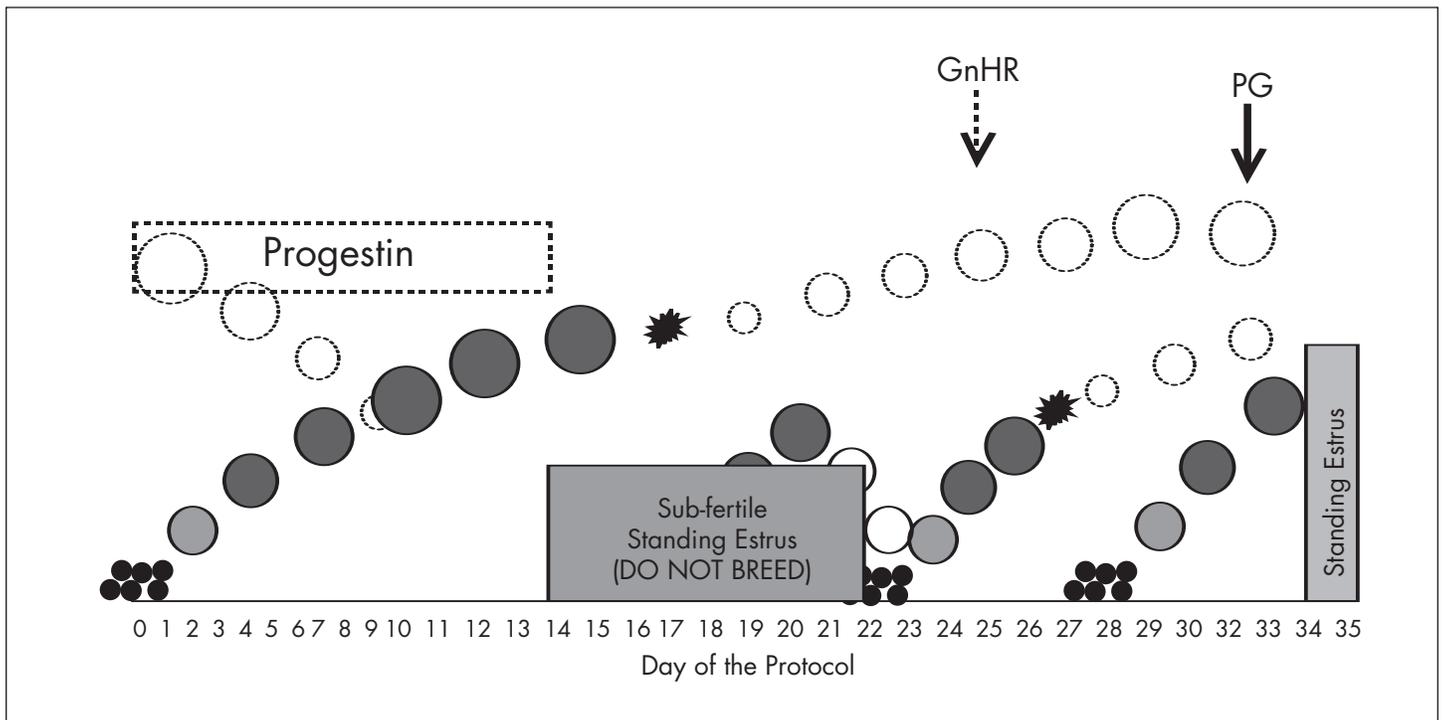
**7-day exposure.** As previously mentioned, progestins mimic the progesterone produced by the CL and inhibit ovulation. When ovulation is inhibited for 7 days, all animals will have a CL that is at least 7 days old at the time of PG injection (Figure 6a). Therefore, all animals with a CL will respond to the PG. Animals in which a CL had regressed during the 7-day period will show standing estrus following removal of the progestin (Figure 6b).



**Figure 7.** Corpus luteum regression (dotted circles) during the 14 days of progestin treatment (box). Following removal of the progestin, standing estrus and ovulation will occur within 7 days; this is a sub-fertile estrus (DO NOT BREED). Following ovulation, follicular waves (indicated by the group of small, medium, and large circles) will occur, and the CL will develop (dotted circles). Nineteen days after ending the progestin treatment, a fully mature CL is present to be regressed by an injection of PG.

**14-day exposure.** As previously mentioned, progestins mimic the progesterone produced by the CL and inhibit ovulation. Therefore, when a CL regresses, instead of the animal exhibiting standing estrus and ovulating, follicular growth will continue and ovulation will be inhibited. When the progestin is removed, animals will usually show standing estrus within 7 days.

Since ovulation was inhibited for up to 14 days, the follicle that ovulates following this standing estrus is aged (termed a persistent follicle) and has reduced fertility. Therefore, PG is usually given 19 days following progestin removal. This injection of PG will regress the CL that forms after the ovulation of a persistent follicle, and an estrus with good fertility will occur (Figure 7).



**Figure 8.** Corpus luteum regression (dotted circles) during the 14 days of progestin treatment (box). Following removal of the progestin, standing estrus and ovulation will occur within 7 days; this is a sub-fertile estrus (DO NOT BREED). Following ovulation, follicular waves (small, medium, and large circles) will occur and the CL will develop (dotted circles). Since ovulation can occur over a 7-day period, follicular waves are not synchronized. Twelve days after ending the progestin treatment an injection of GnRH is given to induce ovulation of the dominant follicle and synchronize follicular waves. Seven days after the GnRH injection (19 days after ending the progestin treatment) a fully mature CL is present to be regressed by an injection of PG.

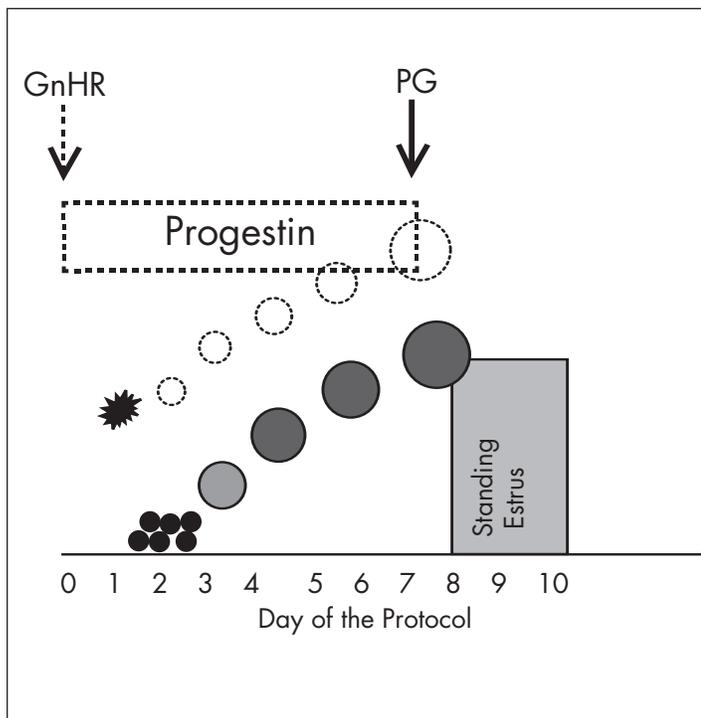
## Progestin-GnRH-PG

Since animals can show signs of standing estrus over a 7-day period following a 14-day progestin exposure, follicular waves are not synchronized. The addition of an injection of GnRH 7 days before an injection of PG will result in the induced ovulation of a dominant follicle, formation of a CL, and initiation of a new follicular wave. The CL that forms following this induced ovulation can be regressed 7 days later by an injection of PG (Figure 8).

## GnRH-Progestin-PG

Since progestin exposure will not synchronize follicular waves and animals that regress their CL during a 7-day period of progestin treatment can form a persistent follicle, the addition of a GnRH injection at the start of progestin exposure will synchronize follicular waves (Figure 9).

The normal duration of a follicular wave is between 7 and 10 days; therefore, the initiation of a new follicular wave at the beginning of progestin exposure will reduce the occurrence of a persistent follicle forming. Furthermore, the progestin that is present between the GnRH and PG injections will eliminate the chance of animals exhibiting signs of standing estrus before the PG injection.



**Figure 9.** Injecting GnRH at the time progestin treatment is begun. This will induce the formation of a CL (dotted circles) and the initiation of a new follicular wave (small, medium, and large circles). The progestin (box) will inhibit any animals from ovulating, and a fully mature CL will be present at time of PG injection on day 7.

## Conclusion

Estrous synchronization is manipulation of the bovine estrous cycle to result in the majority of animals exhibiting standing estrus in a short period of time. It is a very effective method to increase the proportion of animals that are bred at the beginning of the breeding season.

For an estrous synchronization protocol to be successful it needs to synchronize follicular waves and/or luteal regression and result in the majority of animals showing standing estrus at the beginning of the breeding season. Prostaglandin F<sub>2</sub> $\alpha$  induces regression of a CL, progestins inhibit ovulation, and GnRH induces ovulation. The use of these naturally occurring hormones can result in the majority of cows exhibiting standing estrus at the beginning of the breeding season, and they will have an extra chance to get pregnant during a defined breeding season.

Any one of many estrous synchronization protocols can be used to achieve good synchrony of estrus in your herd. To determine which synchronization protocol will work the best in your operation contact your local livestock educator or state livestock specialist.