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# Estrus Synchronization for Heifers

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Developing replacement heifers is the most expensive enterprise in the cow-calf operation. You can increase returns to heifer development if the heifers calve at 24 months of age and calve early in the calving season. In addition, heifers that calve early in the breeding season have greater lifetime production and longevity compared to heifers calving late in their first calving season (Lesmiester *et al*., 1973). The days to estrus after calving are reduced, and longevity is increased if heifers do not experience dystocia (Bellows *et al*., 1982). By using estrus synchronization and artificial insemination, you can increase the number of heifers calving early in the calving season, reduce dystocia, use superior sires, and increase calf weaning weights.

## Basic reproductive physiology of heifers

Beef heifers normally have their first estrous cycle between 12 and 15 months of age. The major factors delaying onset of puberty are poor nutrition or a genetic predisposition for late maturity. In order for heifers to calve at 24 months they must conceive by 15 months of age.

As heifers mature, increasing amounts of the luteinizing hormone (LH) and follicle-stimulating hormone (FSH) are released from the brain. The increase in LH and FSH stimulates ovarian follicular development. Ovarian follicles produce estrogen and contain the developing ovum (egg). In prepuberal heifers these follicles grow and regress without ovulating. Puberty occurs when the heifer responds to the estrogen from the growing follicle by expressing estrus (heat) and producing an LH surge. The LH surge causes ovulation, which begins the heifer's first cycle.

Heifers must exhibit two to three cycles for fertility to be maximized. Conception rates are 20 percent greater in heifers that are bred on the third rather than puberal (first) estrus (Byerley *et al*., 1987). The increase in fertility is a result of enhanced uterine acceptance of the embryo or maternal recognition of pregnancy. Exposure to low levels of progesterone for seven to ten days can induce puberty in heifers. The mechanism appears to be related to a hastening of the normal changes in hormone receptors and hormone release by the brain (Kinder *et al*., 1996). Progestins can reduce age at puberty by about 1 month. Therefore, synchronization systems that "jump start" heifers and allow more heifers to have several cycles before breeding improve pregnancy rates as well as the percentage of heifers bred early in the breeding season.

## Estrus synchronization tools

The approved drugs for estrus synchronization in the U.S. elicit one of the following actions:

1. Keep animals out of heat and extend the estrous cycle (Progestins).
2. Bring females into heat and shorten the estrous cycle (Prostaglandins).
3. Cause ovulation or start development of a new follicular wave (GnRH).

Estrus synchronization systems often use two or three of these tools to synchronize estrus and ovulation.

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## Progestins

Progestins keep animals from coming into heat. They mimic the natural progesterone produced by the corpus luteum (CL) after ovulation. The progesterone from the CL prepares the uterus for pregnancy and keeps the heifer from coming back into heat. Melengestrol Acetate (MGA) and Controlled Intervaginal Drug Release devices (CIDR) are the two progestins approved for use in heifers. Both compounds can induce puberty in prepuberal heifers.

Melengestrol Acetate (MGA) is an oral progesterone analog approved as a synchronizing agent for heifers. It has been used in the feedlot industry for many years to suppress estrus in finishing heifers. You feed melengestrol acetate to heifers at a rate of 0.5 mg per head per day. Mix the MGA with ground corn so that 3 to 5 pounds of the corn-MGA mix will supply each animal with 0.5 mg of MGA per day. You usually feed MGA for 14 days. Feed the heifers at the same time every day. All heifers must get their share, so ensure that you have adequate bunk space. Any animal not getting enough MGA will "break-through" and show heat and not be synchronized with the rest of the group. Heifers will have a subfertile estrus three to five days after stopping MGA feeding. Females **should NOT** be inseminated at this estrus.

The CIDR is a T-shaped rubber device that contains progesterone. Insert the CIDR into the vagina of the heifers using a special applicator. The lining of the vagina absorbs the progesterone from the CIDR. Properly disinfect the applicator and CIDR before inserting the CIDR into the animal. Take care to clean the vulva and not introduce any manure into the vagina. The CIDR is usually left in place for seven days, but a few estrus synchronization systems leave the CIDR in place for 14 days.

## Prostaglandin

Prostaglandin $F_{2\alpha}$ (PGF2a) is the hormone produced by the uterus of the cow that causes luteolysis (death of the CL), which allows the animal to come back into heat. Products that contain $PGF_{2\alpha}$ are Lutalyse®, In-Synch®, and ProstaMate®. Cloprostenol is a synthetic analog to $PGF_{2\alpha}$ and it is available as Estrumate® and estroPLAN®. Prostaglandin $F_{2\alpha}$ and its analog have been used to synchronize cattle since the mid-1970s. Because prostaglandins rely on the endogenous progesterone produced by the CL as part of the synchronizing system, cows must be cycling in order for PGs to be effective. In addition, injection of prostaglandins to anestrous cows or prepuberal heifers will NOT induce cyclicity.

## GnRH

Gonadotropin Releasing Hormone (GnRH) is the 10-amino-acid polypeptide secreted by the brain to release LH. An injection of GnRH causes an LH surge, which causes ovulation or synchronizes follicular growth. Products available include Factrel®, Fertagyl®, Cystorelin®, and OvaCyst®.

# Estrus synchronization systems for artificial insemination

The estrus synchronization systems for heifers recommended by the Beef Reproductive Task Force are illustrated in Figure 1 on page 6. These protocols are proven to be successful by research conducted at numerous universities. The Beef Reproductive Task Force is a consortium of reproductive physiologists and reproductive technicians from land-grant universities, the AI industry, and animal health providers. The task force reviews research on estrus synchronization protocols annually and recommends only those systems that are most effective.

## Heat Detection Systems

These systems group heifers into expressing estrus over a three- to ten-day period, thereby reducing the amount of time devoted to estrus detection (See diagrams of protocols at end of this publication). Heifers are inseminated approximately 12 hours after observed estrus (a.m./p.m. rule). Because these systems only inseminate heifers that are observed in heat, pregnancy rates of heifers inseminated is high (60 percent to 80 percent). However, overall success depends on the number of heifers cycling and the accuracy and efficiency of estrus detection. Overall pregnancy rates for these systems are usually 45 percent to 70 percent, with an average of about 50 percent.

You, the producer, must commit considerable time and labor to estrus detection, which can drive up the cost of heat detection systems, but keep drug costs relatively low. In addition, you must be able to inseminate heifers over several days. This usually requires an on-the-farm technician. Since only animals that are in heat are inseminated, these systems are a good choice if semen cost is high. The relative advantages of the three systems are indicated in Table 1.

**Table 1. Comparison of synchronization systems requiring estrus detection.**

| System | Advantages | Disadvantages | Number of trips through the chute |
|---|---|---|---|
| **1-Shot PG** | • Lowest drug cost<br>• Allows go/no-go option | • Most days of estrus detection<br>• Only works in cycling heifers<br>• Will not induce puberty | 1 to 2 |
| **CIDR-PG** | • Can induce puberty<br>• Fewer days of estrus detection | • Most trips down the chute<br>• Highest drug cost | 3 |
| **MGA-PG** | • Can induce puberty<br>• Fewer days of estrus detection | • Requires daily feeding of MGA<br>• Consumption may be erratic | 2 |

## Heat Detection and Timed AI Systems

These two systems are modifications of the heat detection systems, resulting in fewer days of estrus detection and AI. All heifers detected in heat are inseminated approximately 12 hours after the observed estrus (a.m./p.m. rule). At 72 to 84 hours after PG injection, any heifers not detected in heat are given a dose of GnRH and inseminated. (See diagrams of protocols at end of this publication).

Less labor is dedicated to estrus detection and AI in these systems, and all heifers are inseminated. However, an AI technician must be available morning and evening for three days. Pregnancy rates in heifers detected in estrus is normal (65 percent to 75 percent), but pregnancy rate for timed-insemination heifers with no observed estrus is 25 percent to 40 percent. Even though the pregnancy rates for timed-insemination heifers are lower, the overall pregnancy rate of these systems is higher than the heat detection only systems because all heifers are inseminated. Pregnancy rates for these systems are usually 50 percent to 68 percent, with an average of 56 percent.

If most heifers are puberal and cycling normally, then 60 percent to 70 percent of the heifers will exhibit estrus. However, if a low percentage of heifers have exhibited estrus by the 72 to 84 hours, then you may opt to continue estrus detection and not breed heifers by fixed-time AI. This can avoid costly wrecks by not breeding a large number of nonresponsive heifers. Therefore, they may be the best systems for producers beginning estrus synchronization and AI.

Both systems can induce puberty in heifers and only involve three to four days of estrus detection. Other major differences between the two systems are indicated in Table 2.

## Fixed-Time AI Systems

These systems are designed to control the timing of ovulation. They eliminate the need for estrus detection, and allow insemination of all heifers on a single day (See diagrams of protocols at end of this publication). In general, they have higher drug costs and more trips through the chute than the other systems discussed previously. However, they allow an AI technician to breed all animals on a single day, so these systems work well for small as well as large herds. These are the only practical systems if you are not trained in AI.

Because there is no estrus detection, there is not an option for a go/no-go decision. In addition, some heifers will be in estrus over 24 hours before the fixed-time AI (FTAI). Therefore, there is greater risk with these systems. The decreased pregnancy rate in heifers that are in heat early tends to be offset by the insemination and induced ovulation of all heifers. Pregnancy rates with these systems are variable, and pregnancy rates generally run between 45 percent and 65 percent. The average pregnancy rate with FTAI systems is about 53 percent.

**Table 2. Comparison of heat detection plus fixed-time AI estrus synchronization systems.**

| System | Advantages | Disadvantages | Number of trips through the chute |
|---|---|---|---|
| **Select-Synch + CIDR and TAI** | • Only takes 10 days<br>• Better synchrony of follicular waves | • Most trips down the chute<br>• Highest drug cost | 3 |
| **MGA-PG and TAI** | • Fewer trips down the chute | • Requires daily feeding of MGA<br>• Takes over 36 days | 2 |

All of these systems employ progestin, so they will induce puberty in heifers. The MGA-PG FTAI and CIDR-Select systems include long-term exposure to progestin far in advance of AI. Therefore, these two systems allow "jump started" heifers to have an additional cycle before AI. The disadvantage of MGA-PG FTAI and CIDR-Select is that they take 33 to 36 days to complete. Other differences are listed in Table 3.

Considerable research has focused on the timing of AI relative to injection of PG in these systems. You should adhere to the recommended interval from PG to FTAI as closely as possible. In general, you should inseminate all heifers in a four-hour period. Proper planning on the time of day PG is administered is important to prevent heifers from requiring insemination in the middle of the night.

One challenge to FTAI in heifers is controlling follicular wave growth and development. For reasons that are not clear, follicles in heifers are less likely to be turned over in response to a GnRH injection. As a result, follicular growth in heifers is not as tightly synchronized as in FTAI systems used in postpartum cows.

## Comparison of different types of estrus synchronization systems

It is difficult to compare the impact of the various estrus synchronization systems on pregnancy rates because not all systems can be used in a single study. In addition, over 200 heifers are needed per system to detect a statistically significant difference of 10 percent for pregnancy rate. Therefore, it is important that you only consider information that was the result of research conducted over a large number of farms and states, and that these results were reported in the scientific literature.

Sandy Johnson, a member of the Beef Reproductive Task Force, recently summarized the pregnancy rate results from multiple studies reported in the scientific

**Table 3. Comparison of fixed-time AI estrus synchronization systems.**

| System | Advantages | Disadvantages | Number of trips through the chute |
|---|---|---|---|
| **CO-Synch + CIDR** | • Shortest system<br>• Moderate drug cost | • Most variable results | 3 |
| **MGA-PG FTAI** | • Fewest trips through the chute<br>• Lowest drug cost | • High labor for daily feeding of MGA | 2 |
| **CIDR-Select** | • Highest average pregnancy rate | • Most trips through the chute<br>• Variable results<br>• Highest drug cost | 5 |

**Table 4. Summary of pregnancy rates in beef heifers to different estrus synchronization systems as reported in the literature.**

| System | Cost | Labor | Reports[a] | No. of Heifers | Pregnancy rate[b] Range | Average |
|---|---|---|---|---|---|---|
| **Heat Detection** | | | | | | |
| 1 Shot PG | Low | High | 1(18 herds) | 2700 | | 45 |
| CIDR® - PG | Medium | Medium | 1 | 147 | 41-59 | 51 |
| CIDR® - PG (3 days of heat detection) | Medium | Medium | 2 | 745 | 33-61 | 46 |
| MGA® - PG | Low | Low/Medium | 6 | 2746 | 40-71 | 60 |
| **Heat Detect & TAI** | | | | | | |
| Select Synch + CIDR® & TAI | High | Medium | 2 | 748 | 31-67 | 56 |
| MGA® - PG & TAI | Medium | Medium | 4 | 1826 | 48-64 | 56 |
| **Fixed-Time AI** | | | | | | |
| Co-Synch + CIDR® | High | Medium | 4 | 735 | 24-68 | 53 |
| MGA® - PG | Medium | Medium | 2 | 246 | 47-49 | 48 |
| CIDR® - Select | High | Medium/High | - | 853[c] | 26-78 | 61 |

[a]*Number of reports in published literature*
[b]*Number pregnant to AI / total number treated*
[c]*Field data from 13 herds in Missouri*

literature (Table 4). These results indicate the type of variation in pregnancy rates that occurs. In addition, the average reported pregnancy rate is an indication of what producers can reasonably expect when using these estrus synchronization systems. The cost column refers to cost of estrus synchronization drugs with a range of about $5/female (low) to almost $20/female (high).

## Estrus Synchronization and Natural Mating

The estrus synchronization systems discussed above result in a majority of females in heat during a 48-hour period. This high degree of synchrony, while desirable with AI, would be disastrous with natural mating. The combination of estrus synchronization and natural mating works best when cows and heifers are in estrus over a five-day period.

The primary strategy for estrus synchronization with natural mating is to synchronize females the cycle *before* the bull is introduced. By waiting to the next cycle, the natural variations in individual estrous cycle length will cause the synchrony of the group to be more relaxed. As a result, fewer females are in estrus on any given day compared to synchronized estrus, and the group will be spread over five to six days which allows for a shorter breeding season without exhausting the bull.

Reducing the number of females per bull will increase the success of estrous synchronization with natural mating. Mature bulls should be limited to 20 cows/heifers. Yearling bulls should be allowed only 15 females per bull.

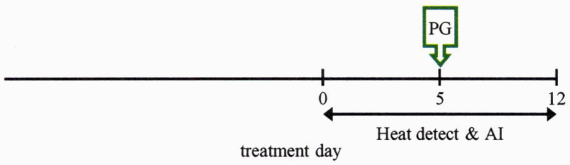
Almost any synchronization system can be used in a natural mating situation if the bulls are not turned out until 13 days after the synchronized estrus. A system that has worked well in heifers is MGA for 14 days and

**Figure 1. Beef Heifer Protocols**

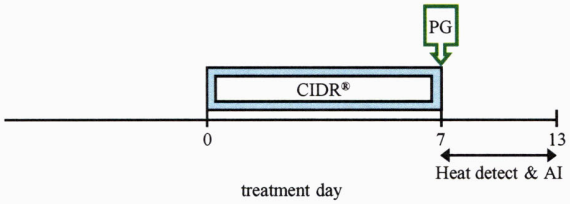
# Beef Heifer Protocols

## HEAT DETECTION

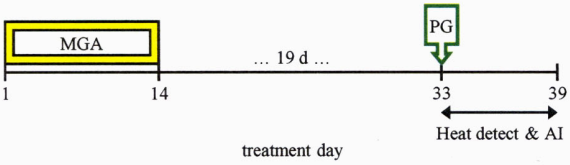
### 1 Shot PG




### CIDR®-PG



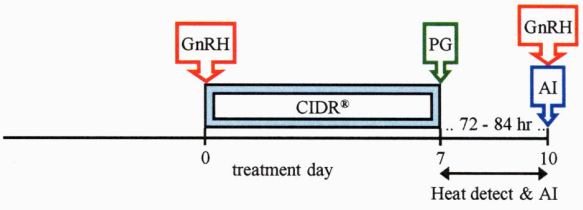

### MGA®-PG




## HEAT DETECT & TIME AI (TAI)

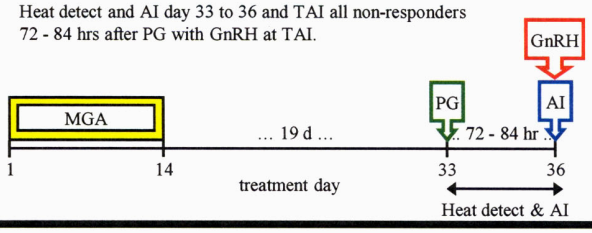
### Select Synch + CIDR® & TAI

Heat detect and AI day 7 to 10 and TAI all non-responders
72 - 84 hr after PG with GnRH at TAI.




### MGA®-PG & TAI

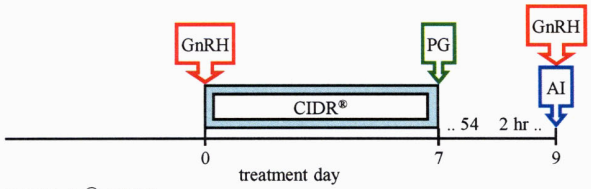
Heat detect and AI day 33 to 36 and TAI all non-responders
72 - 84 hrs after PG with GnRH at TAI.




## FIXED-TIME AI (TAI)*

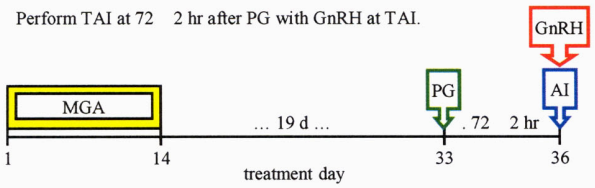
### CO-Synch + CIDR®

Perform TAI at 54 2 hr after PG with GnRH at TAI.



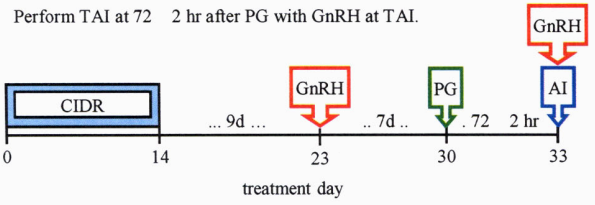

### MGA®-PG

Perform TAI at 72 2 hr after PG with GnRH at TAI.




### CIDR® Select

Perform TAI at 72 2 hr after PG with GnRH at TAI.




**COMPARISON OF PROTOCOLS FOR BEEF HEIFERS**

| HEAT DETECTION | COST | LABOR |
|---|---|---|
| 1 Shot PG | Low | High |
| CIDR®-PG | Medium | Medium |
| MGA®-PG | Low | Low/Medium |
| **HEAT DETECT & TAI** | | |
| Select Synch + CIDR® (TAI non-responders 72-84 hr after PG) | High | Medium |
| MGA®-PG (TAI non-responders 72-84 hr after PG) | Medium | Medium |
| **FIXED-TIME AI (TAI)** | | |
| CO-Synch + CIDR® (TAI 54 2 hr after PG with GnRH at TAI) | High | Medium |
| MGA®-PG (TAI 72 2 hr after PG with GnRH at TAI) | Medium | Medium |
| CIDR® Select (TAI 72 2 hr after PG with GnRH at TAI) | High | Medium |

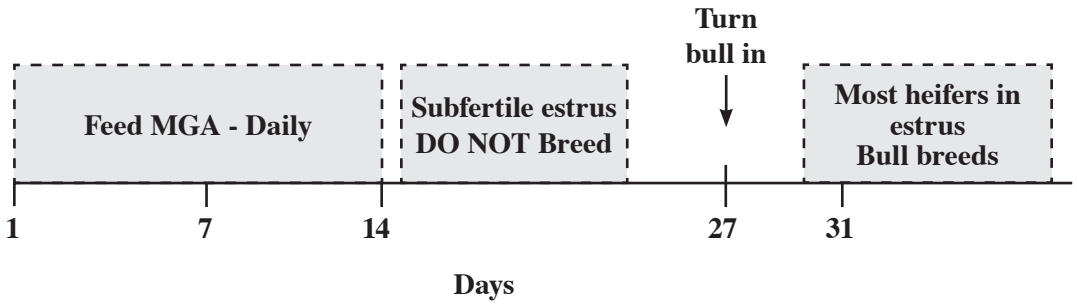
• The times listed for "Fixed-time AI" should be considered as the approximate average time of insemination. This should be based on the number of heifers to inseminate, labor, and facilities.

GnRH Cystorelin®, Factrel®, Fertagyl®, OvaCyst®

PG Estrumate®, In-Synch®, Lutalyse®, ProstaMate®, estroPLAN®

***Beef Reproduction Task Force***

**Figure 2. MGA Synchronization System for Natural Service**




then turn the bulls out 13 days after the last feeding of MGA (Figure 2). No prostaglandin is used. In on-farm trials in Kentucky (601 heifers in 12 herds, conception rates in heifers synchronized by this method and exposed to a bull averaged 69 percent (83 percent of the heifers conceived in the first 30 days).

## Summary

Estrus synchronization protocols presented in this publication are highly proven protocols under both experimental and farm conditions. Selection of the right system for the operation will be based on available labor, technical expertise, and experience. In general, fixed time AI systems are a good choice for small herds. Whereas operations with large numbers of heifers may realize greater pregnancy rates by incorporating a system that uses estrus detection.

## Additional information

Some additional information on estrus synchronization systems for beef heifers and cows can be accessed at the Beef Reproduction Task Force website, *westcentral.unl.edu/beefrepro/resources.html*.

Information includes:

- The most up-to-date versions of recommend estrus synchronization protocols
- An Estrus Synchronization Planner that produces recommended protocols and procedural calendars
- Review of estrus detection aids and procedures
- Tips for successful AI

## References

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