Practical application of estrus synchronization and fixed-time artificial insemination in cattle

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Abstract

Despite the genetic benefits provided by artificial insemination (AI), relatively few Southeastern cattlemen and women utilize this technology. According to the February 2009 USDA National Animal Health Monitoring System (NAHMS) Beef Report, only about 5.5% of beef cattle farms in the Southeastern United States utilize AI, compared to almost 15% in the Western United States. This represents a tremendous opportunity for genetic improvement of economically important traits if more Southeastern cattle producers adopted AI as part of their routine reproductive management. However, the majority of Southeastern cattle producers are employed outside the farm, and effective estrus (heat) detection has historically been a critical component of a successful AI program. Effective estrus detection requires observation for standing heat at least 30 minutes twice a day, if not three times a day, and even then, standing heats are often not detected. Therefore, it has been difficult for part-time cattle producers in the Southeastern United States to adopt successful AI programs. The situation has changed somewhat over the past 10 years with the introduction of fixed-time artificial insemination (FTAI) protocols, in which insemination occurs at a predetermined date and time following an appropriate synchronization program. FTAI eliminates the need for estrus detection, and allows for a more regimented schedule conducive to implementing an AI program for Southeastern cattle producers. This also represents an opportunity for veterinarians to provide artificial insemination services by appointment.

Keywords: cattle, artificial insemination, estrus synchronization

Artificial insemination (AI) is a reproductive management tool that allows cattle producers to use proven sires of superior genetic merit at an affordable price. Incorporating superior genetics into a herd provides for more rapid improvement in economically important attributes such as growth, maternal, and carcass traits, while simultaneously increasing calving ease. Improvement in these traits is accelerated when heifers from these sires are retained in the breeding herd.

Estrus synchronization typically involves administering a series of hormones to induce a group of cows or heifers to be fertile at a chosen time period, which facilitates heat detection and AI. Estrus synchronization with AI in beef cattle offers several advantages over entirely natural mating systems or AI without estrus synchronization:

1. Heat detection is made easier with estrus synchronization by reducing the number of days necessary to observe the herd for signs of estrus (i.e. standing to be mounted), which ultimately contributes to closer observation. The administration of hormones can also result in stronger heats with more noticeable signs of estrus.
2. Estrus synchronization results in a shorter, more concentrated, breeding season, which allows for more efficient labor management during the breeding season and ultimately during the resulting calving season.
3. Artificial insemination can result in less stressful calving seasons by allowing the use of high accuracy, calving ease sires and subsequently fewer cases of dystocia.
4. The end result of a successful estrus synchronization and AI program is a more consistent, uniform calf crop that is older and heavier at weaning.

The hormones used for estrus synchronization protocols mimic what occurs during a cow or heifer's normal estrous cycle. Therefore, understanding the physiology of the normal estrous cycle is critical to understanding estrus synchronization programs.

The Normal Estrous Cycle

The average estrous cycle, from one standing heat to the next, is 21 days in the cow (Figure 1) with a range of 18-24 days. The cycle begins on Day 1 when the egg is ovulated from a follicle on the ovary. The egg moves into the oviduct where, if viable sperm from the bull are present, it is fertilized and moves into the uterus. Regardless of whether the egg is fertilized, by approximately Day 5-7, the site of ovulation on the ovary develops into a corpus luteum (CL) that produces the hormone progesterone. While the CL is secreting progesterone, the cow does not display estrus.

Figure 1 placeholder. Illustration provided courtesy of the Alabama Cooperative Extension System.

Around Day 17, if the cow is not pregnant, the uterus releases the hormone prostaglandin F2 alpha (PGF2α) that causes the CL to regress in about 3-5 days. While the CL is regressing, a new egg-containing follicle is developing that secretes the hormone estrogen, causing the cow to come into standing heat on about Day 20 or 21 of the estrous cycle. Cows should be inseminated near the end of standing heat (see section on Timing of Artificial Insemination for Maximum Conception) to provide enough time for the sperm to undergo a process called capacitation

before they encounter the egg. Capacitation gives sperm the ability to fertilize the egg. Cows ovulate approximately 30 hours after the onset of estrus.

If the cow becomes pregnant, the embryo in the uterus prevents the release of PGF2α, and therefore progesterone secretion by the CL continues, cycling ceases, and the pregnancy is maintained. If no problems occur during pregnancy, the embryo develops into a fetus that is born about 283 days after the egg was fertilized.

Estrus Synchronization Protocols

The majority of estrus synchronization protocols use one or a combination of three basic methods that work with the physiology of the cow's normal estrous cycle.

1. Prostaglandin (PGF2α) injections cause CL regression and standing heat in 1 to 5 days, unless the cow or heifer is in the first 5 to 7 days of her estrous cycle when her CL is not responsive PGF2α.
2. Progesterone or progestins, released from Controlled Internal Drug Release (EAZI-BREED™ CIDR®) inserts or ingested in feed by feeding melengesterol acetate (MGA®), mimic the effects of the cow’s natural progesterone by preventing estrus from occurring as long as they are present in the body. Once removed, the cow or heifer typically comes into heat in 1 to 3 days. However, a heifer is subfertile during the first heat following long term progesterone treatment (i.e. MGA® or 14-day CIDR®) due to ovulation of an older oocyte, so the heifer should be bred on a subsequent, synchronized estrus.

3. Gonadotropin Releasing Hormone (GnRH) injections promote and synchronize follicle growth and induce ovulation. A GnRH injection administered approximately 48 hours after a prostaglandin injection provides a more concise synchrony of ovulation.

Some things to remember when working with reproductive hormones:

- Federal law restricts the majority of reproductive hormones to use by or on the order of a licensed veterinarian.
- Always be careful when handling reproductive hormones because they can be absorbed through the skin and affect humans.
- Women of childbearing age, asthmatics, and persons with bronchial or other respiratory problems should exercise extreme caution when handling reproductive hormones.
- Always follow label directions and adhere to all other Beef Quality Assurance guidelines.

Resources that aid in the planning of an estrus synchronization program

To review recommended estrus synchronization protocols for both cows and heifers, please refer to the Beef Reproduction Task Force, a multi-state extension activity in cooperation with the North Central Agriculture and Natural Resources Program Leaders Committee and the Cooperative State Research, Education and Extension Service, at http://beefrepro.unl.edu/resources.html. Recommended protocols are updated frequently and provide a comparison of both cost and labor resources as an aid in selecting an appropriate estrus synchronization protocol. Also available through the Beef Reproduction Task Force website is a free, downloadable estrus synchronization planner. Another great resource for scheduling an estrus synchronization program can be found at http://estrussynch.com/, which is a collaborative

effort between the Southeast Cattle Advisor, the Iowa Beef Center, and the Beef Reproduction Task Force.

Why do Estrus Synchronization Programs Fail?

There are two main reasons why estrus synchronization programs fail:

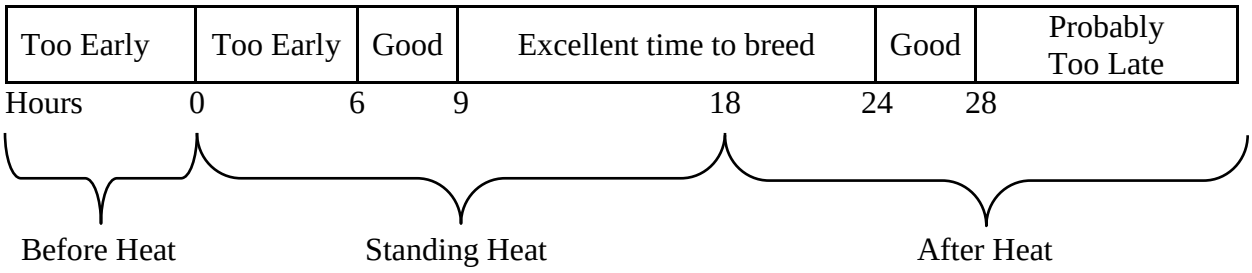
1. The animals were not cycling.
    a. Cows must be in sufficient body condition at calving, have had sufficient days postpartum, and have adequate nutrition available to return to reproductive cyclicity postpartum.
    b. Heifers may not have reached puberty. Heifers should be approximately 65 percent of their mature body weight at first breeding.
2. The animals were cycling, but estrus was not detected after injection of PGF2α and/or removal of progesterone/progestin.
    a. The signs of heat may have been present, but just not detected. Cows are usually in estrus for only 12 to 24 hours, and may only show signs of standing heat a few times. Observe for standing heat at least 30 minutes twice a day. Early morning and late afternoon are the best times for heat detection.
    b. The cow or heifer did not respond to the PGF2α injection because she was in the first 5-7 days of her estrous cycle when her CL is not responsive to PGF2α.

Timing of Artificial Insemination for Maximum Conception

The following illustration (Figure 2) offers general guidelines for timing of artificial insemination based on observed estrus. Actual times will vary depending on the length of

standing heat, but the goal is to inseminate near the end of a heat period. Cows ovulate approximately 30 hours after the onset of standing estrus. Inseminating approximately 12 hours after standing estrus was first observed provides time for the sperm to undergo a process called capacitation before they encounter the egg. Capacitation gives sperm the ability to fertilize the egg. In general, it is better to have the sperm waiting on the egg, rather than the egg waiting on the sperm, because the egg has a shorter lifespan.

Figure 2. Timing of artificial insemination for maximum conception



Some things to consider when timing artificial insemination:

- Good heat detection is critical for successful artificial insemination if fixed-time artificial insemination (FTAI) protocols are not implemented. Observe for standing heat at least 30 minutes twice a day. Early morning, late afternoon, and evening are the best times for heat detection.
- Maximum conception rates for artificial insemination occur if animals are bred near the end of standing heat, or approximately 12 hours after standing estrus is first observed. Traditional artificial insemination has therefore followed the AM-PM rule. An animal first observed in heat in the AM should be inseminated that PM. An animal first observed in heat in the PM should be inseminated the next AM.

- Some producers may desire the use of FTAI, in which insemination occurs at a predetermined time following an appropriate synchronization program. FTAI allows for a more regimented schedule. Recent improvements in FTAI and estrus synchronization protocols have increased pregnancy rates, while allowing for easier scheduling of labor resources and less cattle handling. If a FTAI program is used with estrus synchronization, the need for heat detection can be eliminated. Furthermore, a FTAI program allows for insemination of the entire herd, regardless of estrous expression. Therefore, all animals have the opportunity to become pregnant to AI.
- Another method is to combine AI and natural service with the use of clean up bulls to boost overall pregnancy rates and reduce the amount of estrus detection and drug expense. Commonly, estrus synchronization and AI are used for one AI service, and then clean up bulls are introduced 10-14 days later for the remainder of the breeding season.

Conclusion

Estrus synchronization and AI are reproductive tools that, when used properly, ultimately enhance the profitability of a well-managed beef cattle operation. The most common failure of estrus synchronization and AI programs is poor attention to detail. Neglecting crucial management practices, such as nutrition, record keeping, AI technician proficiency, accurate estrus detection, and proper implementation of estrus synchronization protocols generates poor results. Therefore, attention to detail is the key to a successful estrus synchronization and AI program.