Repro Tracks

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Timing of AI for maximum conception rates

Proper timing is one of several factors that determine the success rate following artificial insemination (AI). The optimum timing of insemination following heat detection is based on events that occur between the beginning of standing heat and ovulation. The same events must be controlled for timed-AI following estrous synchronization to be successful.

Introduction

The timing of insemination is an important factor in determining the conception rate following AI. The recommended time of insemination following detection of a cow in heat is based on the estimated timing of ovulation relative to the onset of standing heat. Although biological variation exists in the timing of estrus (heat) and ovulation, a depiction of the timing of events in an "average cow" is shown in Fig. 1.

Angus cows and heifers normally exhibit standing heat for six to 18 hours, with an average duration of about 12 hours. While the length of standing heat varies considerably, the interval from the beginning of standing heat to ovulation is more consistent, usually around 30 hours as depicted in Fig. 1. The trigger that causes ovulation is the release of luteinizing hormone (LH) from the pituitary gland in the brain of a cow at the beginning of standing heat.

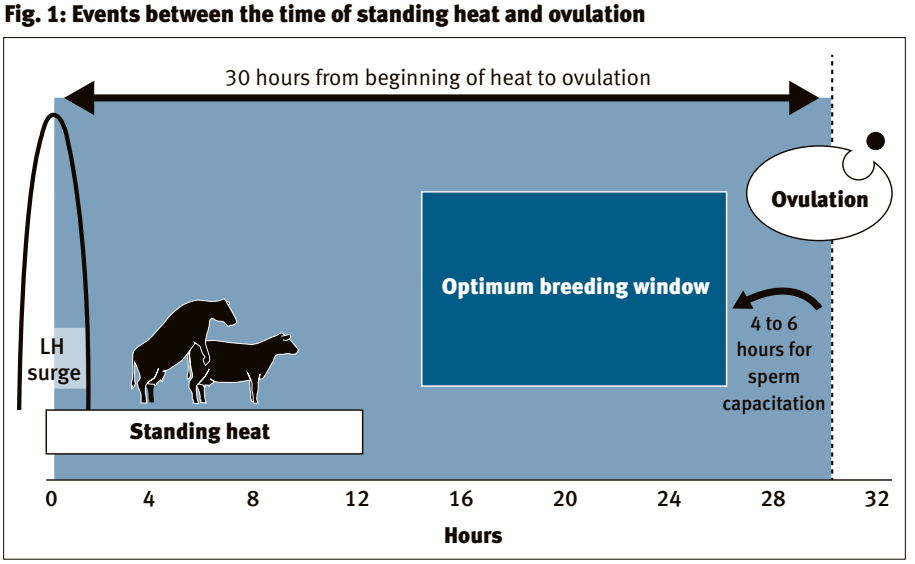
For maximum conception following AI, sperm should be deposited in the uterus of the cow in heat at least four to six hours prior to ovulation. This allows time for sperm to undergo changes while in the female tract, referred to as capacitation, that are necessary for fertilization of the egg.

There is no exact limit to the time prior to ovulation that sperm can be deposited in the female tract and still achieve fertilization. However, the longer the interval between insemination and the time of ovulation, the more likely it is for sperm inseminated to die before the time of ovulation. Based on these relationships, the optimum breeding window appears to be from four to 16 hours prior to the time of ovulation.

Long before we had ultrasound units to document the timing of ovulation or could perform hormone assays, AI companies and university scientists determined by trial-and-error that waiting approximately 12 hours after heat detection to inseminate cows (the so-called "a.m.-p.m. rule") resulted in the highest conception rates. Using today's technology, it has become apparent that the 12-hour waiting period after heat detection was important because it moved the timing of insemination into the optimum breeding window — long enough prior to ovulation to allow capacitation of sperm, but not so long as to reduce the number of live sperm too much.

Whenever beef cattle breeders pose questions related to the timing of insemination in cows that show natural heats or that are treated to synchronize estrus, referring back to the relationships in Fig. 1 is useful to explain "why" certain insemination protocols work better than others.

Fig. 1: Events between the time of standing heat and ovulation



Breeder question No. 1

I am having trouble understanding why the recommended time for AI is 12 hours after a cow is detected in heat and not as soon as you see the cow in heat. When a bull breeds the cow by natural service, the breeding occurs while the cow is still in standing heat. Why wait 12 hours for AI?

Response: The biggest difference between natural service by a bull and AI of cows with frozen semen is the number of sperm that are deposited in the reproductive tract. A bull ejaculates about 8 billion sperm each time he services a cow in heat. The standard AI dose varies, but is usually between 20 and 40 million sperm per insemination straw. That means in one natural-service mating, a bull is depositing at least 200 times more sperm than the standard AI dose. By depositing so many more sperm during natural service, there are enough sperm still alive at the time the egg is ovulated (18 to 30 hours later) to achieve high fertilization rates.

Given the difference in the number of sperm deposited by AI vs. natural service, you might say, "It's a wonder AI works at all." Three thoughts come to mind in regard to this.

First, it is apparent Mother Nature has endowed the bull with remarkable sperm-delivery potential as an insurance policy to eliminate the chance too few sperm would reach the site of fertilization. Second is the fact that AI technicians have an advantage by depositing semen in the reproductive tract beyond the cervix (closer to the site of fertilization), rather than in the vagina. Third,

AI technicians wait 12 hours after detection of estrus before performing inseminations (allowing a higher proportion of sperm to survive until ovulation). Therefore, even though many fewer sperm are deposited during AI, conception rates are similar to those following natural service.

There is no exact limit to the time prior to ovulation that sperm can be deposited in the female tract and still achieve fertilization.

Breeder question No. 2

The Beef Reproduction Task Force recommends several estrous synchronization protocols that include fixed-time AI without any heat detection. I use the 7-day CO-Synch + CIDR® protocol and breed all my cows at 66 hours after the end of the synchronization treatment. Each cow receives an injection of gonadotropin-releasing hormone (GnRH) at the timed-AI breeding. How can a cow that has not shown estrus prior to the GnRH injection and timed AI have any chance of becoming pregnant?

Response: The results of timed AI protocols are pretty amazing. You would expect the fertility following timed breeding of cows that have been in standing heat before the timed AI to be very good, but the fact that a cow that has not shown heat has a good chance of becoming pregnant after being injected with GnRH and timed-inseminated is remarkable. In some ways it defies the logic of the optimum breeding window (Fig. 1). Therefore, it is understandable to ask, "How is it possible?"

The success of timed-insemination protocols recommended today depends on the programmed development of a large ovulatory follicle that will be ready to ovulate two to three days after the end of the synchronization treatment. When the ovulatory follicle is present and the estrous cycle of the cow is artificially ended by the synchronization treatment, a GnRH injection administered to the synchronized cow (at the time of AI) will induce ovulation.

This induced ovulation is achieved the same way a natural ovulation is controlled in a cow that has exhibited standing heat. In the case of the synchronized cow that has not shown signs of heat, ovulation is induced 30 hours after the GnRH injection causes a surge in LH, the hormone that triggers ovulation (Fig. 1).

When cows treated for estrous synchronization do not show heat and are simultaneously inseminated and injected with GnRH, ovulation is induced to occur 30 hours after insemination. Perhaps the most amazing thing we have learned from the results of synchronization and timed-AI trials is that semen deposited at the timed AI can sustain sperm numbers in the reproductive tract for longer (30 hours) than we may have estimated in the past. This suggests that while the optimum breeding window for achieving high conception rates may be four to 16 hours prior to the time of ovulation, satisfactory conception rates can be achieved when semen is deposited much longer prior to ovulation.

Editor's Note: *Bill Beal is a beef cattle reproductive physiologist and professor emeritus at Virginia Tech. He conducts research involving estrous synchronization, artificial insemination, embryo transfer and the use of ultrasound technology. This column is designed to provide answers to questions about reproductive management commonly posed by commercial and purebred breeders. If you have questions or comments related to the reproductive management of cows or bulls, e-mail them to him at wbeal@vt.edu.*