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Dairy Reproductive Management Using Artificial Insemination

Michael Looper
Professor and
Department Head -
Animal Science

Introduction

Reproductive efficiency of the dairy herd is important to the economic success of the dairy operation. One of the most important reproductive technologies implemented by the dairy industry is artificial insemination (AI). Artificial insemination reduces the incidence of sexually transmitted diseases among cattle as well as increases the use of genetically superior sires to improve performance of the herd.

Standing estrus or "heat" is the most reliable indication that a cow is going to ovulate and release an ovum or "egg." Estrous behavior is used to determine when a cow should be inseminated. A brief window of opportunity exists for fertilization of the egg and pregnancy of the cow to occur. It is estimated that the U.S. dairy industry loses more than $300 million annually due to failure and/or misdiagnosis of estrous detection. Thus, the efficient and accurate detection of estrus and the proper time of insemination are of utmost importance if dairy producers want to increase reproductive efficiency of the herd.

Estrus or "Heat"

Estrous behavior or heat is due to the actions of the steroid hormone estrogen on the brain of cattle. Early research in the late 1940s found the duration of estrus in dairy cows ranged from 2.5 to 28 hours, with an average of 18 hours in cows visually observed three times daily. With continuous observation of estrus by radiotelemetric systems, duration of estrus averaged 7 hours with a range of 33 minutes to 36 hours (Dransfield et al., 1998). Several managerial factors affect estrus in dairy cattle. Increasing the number of cows penned together increases the intensity (number of mounts) and duration of estrus. Dairy cows observed for estrus on a dirt surface had greater intensity and duration of estrus compared with cows on concrete surfaces. Environmental factors such as increased temperatures decrease estrous activity. Estrous behavior was greatest in dairy cows observed twice daily when ambient temperatures were less than 77°F compared with temperatures above 86°F (Gwazdauskas et al., 1983).

Proper estrous detection is critical to the success of AI. Approximately 75 to 80 percent of cows in estrus will be identified when the herd is visually observed twice daily (30 minutes each time). When estrous detection is increased to three times daily, 85 percent of cows in estrus may be detected, while four daily observations will identify more than 90 percent of cows in estrus. Several aids have been developed to assist producers in estrous detection including pedometers, Kamar® patches, tail paint, chin-ball markers and radiotelemetric systems. A combination of visual observation and one or more of the detection aids will increase the efficiency of estrous detection compared with visual observation or detection aids alone.

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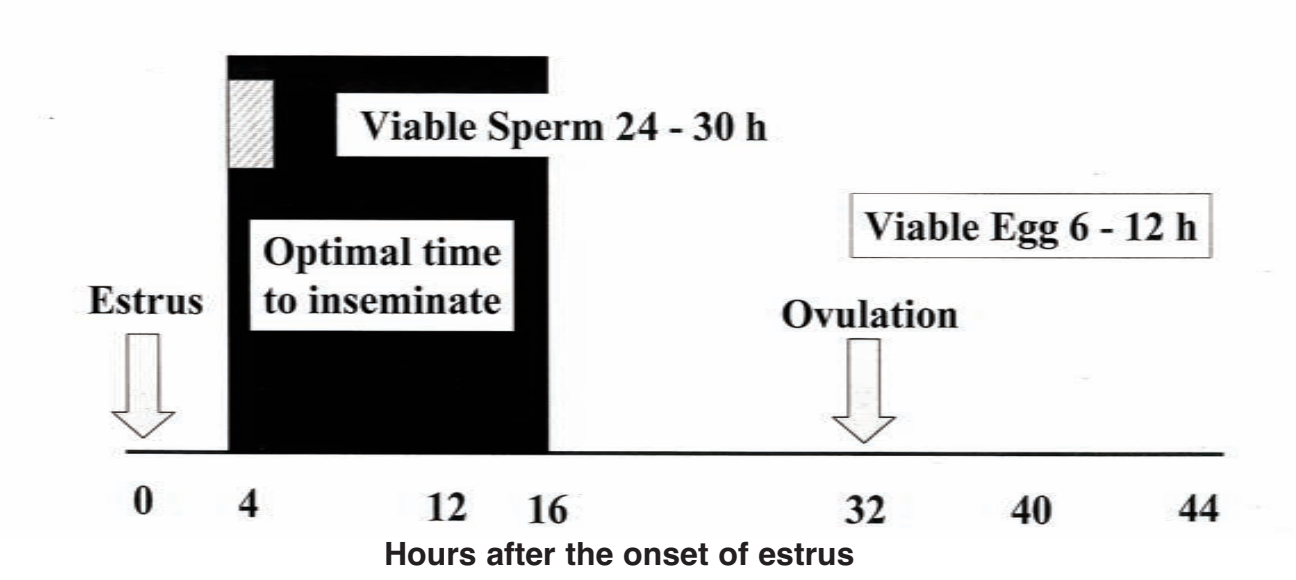
Figure 1. Optimal time to inseminate dairy cows



Ovulation in Dairy Cows

Ovulation is initiated by a surge of the luteinizing hormone (LH) from the brain of cattle. This surge of LH results in the rupture of the follicle and the release of the egg from the ovary. Ovulation usually occurs approximately 28 to 32 hours after the onset of estrus in dairy cows. After ovulation, there is only a short period when the egg is released and has the capability of being fertilized (Figure 1). Optimal fertility of the egg is projected to be between 6 to 12 hours after ovulation. The viable lifespan of sperm in the reproductive tract is estimated at 24 to 30 hours.

Artificial Insemination Relative to Estrus

Researchers have investigated the optimal time at which to inseminate cows relative to the stage of estrus for the past 50 years. Trimberger (1948) found that conception rates were maximal when cows were inseminated between 6 and 24 hours before ovulation. This early work led to the establishment of the "a.m.-p.m." recommendation. This guideline suggests that cows in estrus during the a.m. should be inseminated during the p.m., and cows in estrus in the p.m. should be bred the following a.m. However, research with large numbers of cows has indicated that maximum conception rates may not be achieved using the "a.m.-p.m." rule.

A large field trial (44,707 cows) found no differences in the percentage of nonreturn rates at 150 and 180 days (which would indicate pregnancy) between cows bred either the same morning as observed estrus, cows bred between noon and 6 p.m. on the day of observed estrus or cows bred the following morning after observed estrus the previous evening. This indicates a single mid-morning insemination for all cows observed in estrus the night before or the same morning should give near maximum conception. Similarly, cows bred once daily (between 8 and 11 a.m.) had similar nonreturn rates as cows bred according to the "a.m.-p.m. rule" (Nebel et al., 1994). Research from Virginia suggests that cows be bred earlier than the "a.m.-p.m." rule guidelines. Highest conception rates for AI occurred between 4 and 12 hours after the onset of estrus (Table 1). Cows inseminated 16 hours after the onset of estrus had reduced conception rates compared with cows bred between 4 and 12 hours.

Table 1. Conception rates of dairy cows inseminated at different times after the onset of estrus or "heat" (adapted from Dransfield et al., 1998).

Interval from onset of estrus to AI (hours)[1]	Number of inseminations	Conception rate (%)
0 to 4	327	43.1
> 4 to 8	735	50.9
> 8 to 12	677	51.1
> 12 to 16	459	46.2
> 16 to 20	317	28.1
> 20 to 24	139	31.7
> 24 to 26	7	14.30

[1]Onset of estrus determined by HeathWatch® system (DDx Inc., Denver, CO).

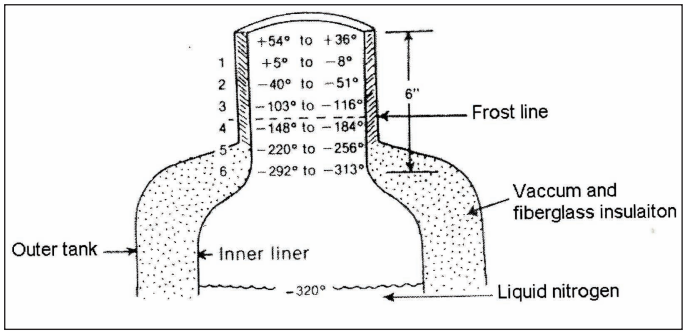
Proper Semen Handling

Improper semen handling can result in low conception rates minimizing the advantages of an artificial insemination program. Semen is most frequently damaged during handling after thawing and prior to insemination of the cow.

Removal of Semen From the Liquid Nitrogen Tank

Time spent removing semen from the liquid nitrogen (LN) tank must be kept to a minimum in order to reduce damage to semen. Temperatures can reach +54°F in the neck of the LN tank (one inch from the top) (Saacke 1974; Figure 2). If the entire canister of semen (10 straws) is withdrawn above the frost line (2 to 3 inches from the top of the tank), all straws of semen can be damaged. When the desired straw of semen cannot be located within 10 seconds of raising the canister, the canister should be lowered back into the LN for 10 to 15 seconds to cool completely. Semen should be removed from the tank with tweezers, not the hands! The location of the semen in the tank should be noted prior to removing the plug from the tank. This can be accomplished by maintaining a tank inventory with a wall chart or inventory wheel. Quantity of semen remaining in the LN tank also can be accounted for with such a system.

Figure 2. Adapted from *Concepts in Semen Packaging and Use.* Proceedings of the Eighth NAAB Conference on Artificial Insemination of Beef Cattle, R. G. Saacke, 1974, pp. 11-19.



Thawing Semen

Unfortunately, recommended procedures for thawing semen are not the same for all artificial insemination companies. Dairy producers usually use semen from several of these companies and only one protocol for thawing semen. The National Association of Animal Breeders (NAAB) recommends thawing semen at about 90° to 95°F for at least 40 seconds. Thawing semen between these temperatures allows more semen to survive the thawing process. Calibrate the thermometers used for monitoring thaw water temperature on a regular basis to ensure accuracy of temperature measurements. Never thaw semen straws in your pocket or in the cow. Thaw rates are too slow and will reduce the number of viable sperm cells. The semen straw should be completely dried with a paper towel after thawing since water is lethal to sperm cells.

It is not uncommon for several cows to exhibit estrus on the same day; therefore, it is likely that numerous straws of semen will be thawed at one time. Research suggests that as many as 15 to 20 straws of semen can be thawed simultaneously in a thermos without reducing semen quality. However, thaw water should be agitated so that multiple straws will not freeze together during thawing. A larger volume of water (≥ 1 quart) is recommended if more than five straws of semen are thawed simultaneously. It is important to remember that the number of semen straws thawed should not exceed the quantity that can be inseminated within 10 to 15 minutes.

Loading the Artificial Insemination Gun

The artificial insemination gun must be prewarmed prior to loading the semen by rubbing it with a paper towel to avoid cold shocking semen. The semen straw must be cut at the crimped end, not at the end with the cotton plug. A plastic sheath is then placed over the semen and gun. Place the semen gun within clothing (i.e., shirt or jacket) close to your body to avoid cold shocking semen. Further research with more cows is needed to confirm effects of time from thawing to insemination on conception rates. It is still recommended that cows be inseminated as soon as possible after thawing semen.

Proper Semen Handling on the Dairy

Dairy personnel not acquainted with artificial insemination techniques are sometimes recruited to help inseminate cows. Only persons who have been adequately trained in artificial insemination should be allowed to breed cows. Untrained personnel will become fatigued, and accuracy of semen deposition will be reduced. General recommendations include thawing semen at 95°F in a water bath, not in the pocket or cow, for at least 30 seconds but not more than 15 minutes. If several straws of semen are thawed at one time, stir the water bath so that straws do not freeze back together. Use the same caution when thawing several straws of semen as you would to thaw a single straw. Finally, do not load too many artificial insemination guns simultaneously. Conception rates could be reduced. Cows should be inseminated as soon as possible after semen is thawed. Artificial insemination techniques of personnel responsible for breeding cows should be evaluated on a regular basis (i.e., monthly or quarterly). It is important to remember that proper AI techniques must not be compromised for convenience.

When Should Dairy Cows Be Inseminated?

Use of the traditional "a.m.-p.m." rule may reduce conception rates since cows probably will be bred several hours after the onset of estrus; therefore, the chance for successful fertilization may be missed. The exact onset of estrus is usually unknown. For example, a cow beginning estrus at 1 a.m. and observed in estrus at 6 a.m. the following morning would be bred approximately 17 to 18 hours after the onset of estrus. Breeding cows at this time would reduce the number of cows that become pregnant (Table 1).

The herd should be observed twice daily, usually 30 minutes each time, to identify a majority (75 to 80 percent) of cows in estrus. Influences of the environment and managerial practices on behavioral estrus must be recognized so that failure or misdiagnosis of estrus is minimized. It is recommended that cows should be inseminated within 4 to 16 hours of observed estrus when the precise onset of estrus is unknown (Figure 1). If estrous detection is conducted twice daily, most cows should be within this time period. A single mid-morning insemination of cows that have been observed in estrus the same morning or the previous evening should give optimal conception rates.

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DR. MICHAEL LOOPER is a professor and department head of the Department of Animal Science, University of Arkansas Division of Agriculture, and is located at the University of Arkansas in Fayetteville.

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