

When Should Dairy Cows Be Inseminated?

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Reproductive efficiency of the dairy herd is important to the economic success of the dairy operation. One of the most important reproductive technologies of the dairy industry is artificial insemination (AI). Artificial insemination reduces the incidence of sexually transmitted diseases among cattle and 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 ovum and pregnancy of the cow to occur. Senger (1994) estimated that the U.S. dairy industry loses more than \$300 million annually due to failure and/or misdiagnosis of estrus. 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 (E_2) on the brain of cattle. Early research by Trimberger (1948) found the duration of estrus in dairy cows ranged from 2.5 to 28 hours with a mean of 18 hours in cows visually observed three times daily. With the recent advent of continuous observation of estrous behavior by radiotelemetric systems (HeatWatch®, DDX, Inc. Denver, CO), duration of estrus averaged 7 hours (range 33 minutes to 36 hours; Dransfield et al. 1998).

Several factors related to dairy management affect estrous behavior in dairy cattle. Increasing

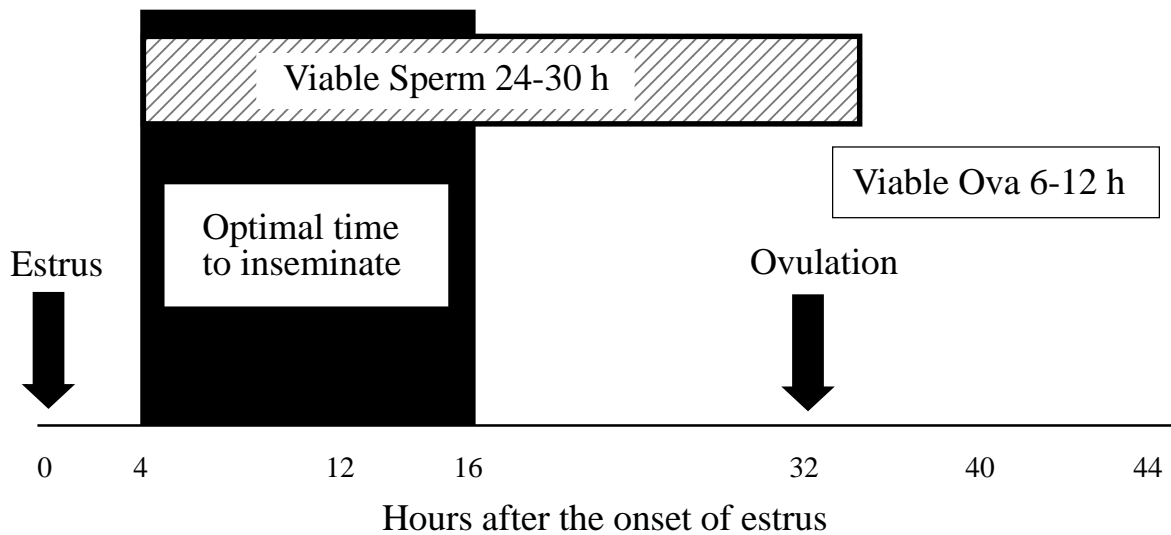
the number of cows penned together increases the intensity (number of mounts) and duration of estrus (Hurnik et al. 1975). Dairy cows observed for estrus on a dirt surface had greater intensity and duration of estrus compared with cows on concrete surfaces (Britt et al. 1986; Vailes and Britt 1990). Environmental factors such as high temperatures decrease estrous activity. Estrous behavior was greatest in dairy cows observed twice daily when ambient temperatures were less than 77°F (25°C) compared with temperatures above 86°F (30°C) (Gwazdauskas et al. 1983; Gwazdauskas 1985).

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 identify more than 90 percent of estrual cows. Several aides have been developed to assist producers in estrous detection, including pedometers, Kamar® patches, tail paint, chin-ball markers, and radiotelemetric systems. A combination of both visual observation and one or more of the detection aides increases the efficiency of estrous detection compared with visual observation or detection aides alone.

OVULATION IN DAIRY COWS

Ovulation is initiated by a surge of luteinizing hormone (LH) from the brain of cattle. This surge of LH results in the rupture of the follicle and the release of the ovum from the ovary (Espey 1994). Ovulation usually occurs approximately 28 to 32 hours after the onset of estrus in dairy cows

Fig. 1. Optimal time to inseminate dairy cows.



(Trimberger 1948; Walker et al. 1996). After ovulation, there is only a short period when ova can be fertilized (fig. 1). Optimal fertility of ova is projected to be between 6 and 12 hours after ovulation (Brackett et al. 1980). The viable life span of sperm in the reproductive tract is estimated at 24 to 30 hours (Trimberger 1948).

ARTIFICIAL INSEMINATION RELATIVE TO ESTRUS

For the past 50 years, researchers have investigated the optimal time at which to inseminate cows relative to the stage of estrus. Trimberger (1948) found that conception rates were highest 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 a.m. hours should be inseminated during the p.m. hours, and cows in estrus in the p.m. should be bred the following a.m. However, research with large numbers of cows indicates that maximum conception rates may *not* be achieved using the a.m.–p.m. rule.

A large field trial (44,707 cows) found no difference 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, between noon and

6 p.m. on the day of observed estrus, or cows bred the following morning after observed estrus the previous evening (Foote 1979). This indicates that a single mid-morning insemination for all cows observed in estrus the night before or the same morning should give near maximum conception. Also, cows bred once daily (between 8 a.m. 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; Dransfield et al. 1998). Cows inseminated 16 hours after the onset of estrus had lower conception rates than cows bred between 4 and 12 hours after the onset of estrus.

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	14.3

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

WHEN SHOULD DAIRY COWS BE INSEMINATED?

Use of the traditional a.m.–p.m. rule may not provide the best conception rates because cows probably will be bred too long after the onset of estrus, so the chance for successful fertilization may be missed. The exact onset of estrus is usually unknown. For example, according to the a.m.–p.m. rule, a cow beginning estrus at 1 a.m. and observed in estrus at 6 a.m. would be bred approximately 17 to 18 hours after the onset of estrus. Breeding cows at this time would limit 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 (75–80 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. Cows should be inseminated within 4 to 16 hours of observed estrus when the precise onset of estrus is unknown (fig. 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 provide the best conception rates.

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