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Automated Heat Detection: AI with No Observation and No Injections?

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Introduction

Over the last 30 years, people have searched for alternatives to traditional observation of cows to detect estrus. Injections to synchronize estrus/ovulation have replaced observations and are now a common tool in many dairy farms. A major benefit of controlling ovulation with injections is that with little or no observation the number of cows inseminated is high. However, injections may not be so popular with some dairy producers and employees and are especially unpopular with the cows. Getting cows pregnant is critical to subsequently initiate lactation and for revenue generation in commercial dairies. To get cows inseminated are there alternatives to observation and injections?

This article provides a general description of alternatives to hormone injections to manage reproduction in dairy cows. It is not meant to judge programs for ovulation synchronization or to compare programs or systems.

Reproduction and Cow Behavior

Almost 100 years ago and before we knew about hormones, physical activity of rats was linked to functional status of ovaries. Since those early studies, status of ovaries was linked to physical activity in virtually every mammal.

When animals experience estrus, ovaries secrete mostly estrogen and little or no progesterone. This hormonal environment -- high estrogen and low progesterone -- makes the brain stimulate physical activity of the animal. In females there are three phases of the complex behavior associated with estrus: *attractivity*, *proceptivity*, and *receptivity*.

Attractivity occurs early in estrus and includes changes in posture, vocalizations, pheromones that attract males through smell, and increased physical activity. Increased activity or locomotion includes seemingly random milling around, exploration, and aggressive action to other females. Collectively, these behaviors during attractivity are interpreted to occur for one purpose, to attract a mate. Unfortunately, many people do not observe cows enough to detect these earliest signs of estrus.

Proceptivity phase is behavior of females that stimulates males to mate. This includes head butting, females mounting other females, various courtship behaviors, and diverse touching and contact. Mounting or standing to be mounted usually is an obvious behavior. Receptivity phase of estrus is actual mating.

Increased activity. As cows approach estrus and ovulation, a profound increase in physical activity occurs before the overt mounting and standing. However, people encounter several problems in detecting estrus of cows. Even among healthy cows, duration and intensity of estrus vary widely. Note that activity can vary due to number of cows in estrus, hot or cold ambient temperature, stocking rate, number of non-pregnant cows, lameness or illness. If visual observations for estrus are twice daily, successful estrus detection is typically less than 50%. This is not acceptable and has led to extensive use of synchronization programs.

Note that time from beginning of estrus to ovulation is quite consistent --- about 24 hours. Detecting the beginning of standing estrus best predicts when ovulation will occur and leads to highest accuracy of when to time AI. Artificial insemination should always occur before ovulation. This means that AI should occur about 12 to 16 hours after onset of estrus. There are two challenges: detecting estrus to have opportunity for AI and detecting the start of estrus to best schedule AI.

Systems to Monitor Cow Activity

Can monitoring physical activity of cows help detect estrus and be used to schedule AI? In fact, in 1977, pedometers were first used to detect estrus in dairy cows. Technology to detect motion and software to analyze data have progressed enormously in the last 30 years. Currently at least four systems have been designed to detect variations in physical activities of cows. Below is a brief description of each with website addresses for additional information.

Heatwatch II™ (www.cowchips.net) monitors when a cow is mounted. Heatwatch involves gluing a radiotransmitter to the tailhead which is activated with pressure of mounting. This system depends on classic mounting behavior of cows in estrus (during the proceptivity phase). Heatwatch provides continuous monitoring of mounting behavior. Duration and intensity of mounting vary widely among cows. This system does not work well when cows are not mounted. In concert with the software, managers must decide the number and duration of mounts that designate estrus for individual cows.

Afimilk™ (www.afimilk.com) monitors general movement of cows with a pedometer. A baseline of activity for each cow is established. Then, deviations above or below the baseline indicate events like estrus, illness, or lameness. Pedometers accumulate information and are read at milking.

ai24™ (www.semex.com, click the ai24 link) or **Heatime system™** (www.healthycow24.com) monitors movement with a motion detector in a collar. This system counts number of steps and other motions associated with estrus. Activity can be recorded every 2 hr. But, as availability of antennae decreases, activity is recorded fewer times per day. As cows approach an antenna, data are transferred to a Control Box with infrared technology. The system will handle up to 600 cows with four antennae.

SelectDetect™ (www.selectsires.com/select-detect.aspx) is the most recent system available. All SelectDetect® systems include three basic components: monitors, base station, and a computer. Monitors or accelerometers are attached to cows with neck collars and detect movement in three different planes: up and down, front to back, and side to side. Monitors collect data continuously. The monitor on each cow transmits data to one or more Base Stations located in the barn. Base Stations merely receive data from cows and transfer to the computer usually in an office. Depending on distances, Base Stations can connect to the computer with a cable or Bluetooth wireless. Overall the software examines mathematically the data from each cow to identify high or low activity relative to her baseline. Herd managers determine how often to collect and review the data.

General Discussion

After detecting increased physical activity, the best time to inseminate is still under review and may vary among systems and herds. However, it appears that about 16 hours after the system detects onset of estrus is the best time for AI. Frequent examination of data increases success to detect onset of estrus. Except for Heatwatch, these systems detect the attractivity phase of estrus. This is earlier than mounting occurs. Therefore after detection of increased activity, scheduling of AI will occur later to coincide with ovulation. Depending on availability of data, consider at least four different insemination periods during a day to really maximize accuracy to time insemination for maximal fertilization. This idea may appear not practical but will increase pregnancy rate compared with just one or even two AI periods per day.

The data from these systems are available for individual cows and lead to three possible conclusions: cows in estrus, cows need examination directly, or no action needed.

There is a cost to install any of these systems to monitor changes in activity. However, consider this as an investment to improve heat detection, enhance accuracy to time insemination, reduce or eliminate injections for synchronization, and reduce costs for hormones and labor. Systems to monitor physical activity of cows allow people to assess cows constantly without visual observation. For many dairy managers these systems will reestablish the priority to detect estrus and inseminate accordingly.

Before you actually purchase a system to monitor activity, you need to answer these questions.

- How frequently do I need to collect data from cows to detect onset of estrus?
- What is the total equipment required for cows, collection of data, transfer to office, and for analysis of data?
- What type of computer, if any, is required?
- How many cows will the system accommodate?
- What are the features of the software; highly technical or user-friendly?
- What is the opportunity to interface with other software used for herd management? Does this affect the computer selected?

The Big Question

The big question is: will these systems improve reproductive performance of dairy cows? The answer is unknown because results of controlled studies are not published in the scientific literature. Thus, a partial budget is not really constructive. However, for every system there certainly are positive testimonials.

Consider a worst case in which systems to monitor activity have similar reproductive success as traditional observation or synchronization. Benefits of monitoring activity are that cows do not have to be injected or observed. Thus, there are savings in costs for hormones and labor. With increased accuracy to detect onset of estrus at various times of day, timing AI should occur according to onset of estrus for each cow. Note that the "AM-PM Rule" is based on twice daily observations for estrus so there are only two daily periods for AI. So, with monitoring activity there should be multiple times for AI per day not just morning and evening. Alternatively, it is likely that these systems will increase detection of estrus, increase conception rates, increase service rates, and consequently increase pregnancy rates of dairy cows with vastly reduced observations or injections. If true, that certainly will be a win-win.

Author notes: There may be additional systems that monitor activity of cows. Omission here is simply failure to identify them during the search process and is not intentional. Much information regarding these technologies is proprietary. Thus, details of how these systems work and actual impacts on reproductive success in controlled studies are not available in the scientific literature.