# HEAT DETECTION METHODS FOR THE YEAR 2000


**Ray Nebel**
**Department of Dairy Science**
**Virginia Polytechnic Institute and State University**
**Blacksburg, Virginia**


A major factor limiting optimum reproductive performance on many farms today is the failure to detect estrus in a timely and accurate manner. Using the January 1998 Dairy Herd Improvement summary from 11883 dairy farms (approximately 1.32 million cows) that process their records at the DRMS in Raleigh, NC the average days to first breeding was 95 days compared to the stated goal of 65 days (voluntary waiting period plus 10 days). Thus, 30 days or approximately 1 1/2 estrous cycles (time interval between two consecutive estrus periods) are loss presumably due to failure to detect estrus.

Increases in herd size and milk yield have been implicated as contributors to the decreased reproductive efficiency experienced today by many U.S. dairy farms. For example, during the past ten years the average Virginia DHI dairy herd has experienced a 33% increase in milking cows and a 20% increase in milk yield per cow without the same increase in additional labor force. During this same time period the average calving interval has increased from 13 to 14 months. This decrease in reproductive efficiency conservatively cost $7,700 per year per herd if one assumes a $2 loss per day open without additional losses of fewer replacements, increased labor, fewer cull cows, and increased drug and veterinary expenditures. Farms located in Florida have additional climate constraints that effect the expression of estrus and increase fertilization failure and early embryonic loss.

Without a doubt the number one reason for extended calving intervals is poor heat detection. A heat detection program needs to be established and adhered to similar to the feeding program. All too often visual observations are not performed or the location and timing reduces the efficiency and accuracy of the results obtained. Accurate and efficient heat detection is the key management factor determining the successful use of AI and obtaining acceptable reproductive performance in the dairy herd. Humans are not well equipped to detect estrus in cattle, which is a major source of frustration. Requirements of the "IDEAL" heat detection system are debatable. However, the "IDEAL" heat detection system should provide year round 24-hour surveillance, eliminate or at lease minimize labor, and be at least 90% efficient and accurate in identifying cows in heat. Heat detection can be one of the most boring daily management chores, and motivation of individuals performing the task is a key to success. Visual observation of "standing" while mounted by a herdmate is the gold standard that determines if a cow is actually in heat. Both the efficiency and accuracy of visual detection is very variable from farm to farm because of the numerous factors that may interact with the expression of behavioral indicators of estrus. It is frequently reported that the efficiency of visual detection is approximately 50% with an accuracy rate of 80 to 95%.


Presented At The 35th Florida Dairy Production Conference, Gainesville May 5th, 1998

## Vaginal Probes

The recognition that changes in electrical resistance occurred in the tissues as well as the mucus secretions of the reproductive tract led to the initial approach of measuring these changes using probes that were inserted into the lumen of the vagina. When carefully performed, electrical resistance changes measured by vaginal probes provide a tool for attempting to predict the time of ovulation. However, variation both among and within cows has produced a frustrating high rate of false positives and false negatives. This characteristic combined with a high labor requirement has greatly limited the practicality of the vaginal probe.

Recognizing that the vaginal impedance probe had marked limitations, Feldmann, et al., (1978) proposed continual monitoring of vulvar impedance utilizing implantable electrodes coupled to a telemetric system which could transmit information to a remote receiver. As a final step, they implanted electrodes into the vaginal tissues of cows and repeatedly monitored changes in impedance using a direct electrical connection between the probes and an exterior recording device. During recording periods of between 20 and 38 days, these researchers observed that electrical conductivity increased predictably during estrus.

Changes in electrical resistance within the vulva tissue are critically related to changes in ovarian hormone levels (Lewis, et al., 1989). Using telemetrically-coupled electrodes implanted into the vulvar tissue, those researchers demonstrated a strong relationship between ovarian steriods and electrical resistance values of the vulvar tissue. Reduction in vulvar resistance is related to the period of estrus. Development of a cost-effective telemetric system coupled with an implantable electrical resistance device would be a worthy endeavor but not likely to be here by the year 2000.

## Pedometry

Almost 70 years elapsed between the first published recognition that female mammals display a predicable increase in physical activity when in estrus and the first potentially useful field application of pedometry. The first critical description of the relationship between physical activity and stage of the estrous cycle in dairy cows was made by Farris in 1954. Cows equipped with mechanically activated pedometers were characterized as having significantly higher physical activity during estrus than during late diestrus and proestrus or during metestrus. More than 20 years elapsed after the report of Farris (1954), before research by Kiddy (1977) revived interest and provided for the development of pedometry as a practical tool for heat detection of dairy cows. Cows in heat were about four times as active as cows not in heat when housed in a free stall barn (Kiddy, 1977). When cows were housed in comfort stalls, cows in heat were about 2.7 times more active than those not in heat, indicating that type of housing influences the magnitude of physical activity change.

Lehrer et al. (1992) reviewed the effectiveness of pedometry-aided estrus detection. In this review it was reported that the efficiency of pedometer technology compared with that of visual observation was quite variable and ranged from 60 to 100%, depending on the study. The accuracy of estrus detection using pedometry usually determined by comparison with progesterone profiles also was highly variable ranging from 22 to 100%. However, averaging results from studies reported in scientific journals, the efficiency of pedometer systems average 83% and the accuracy of declaring cows in estrus were 85%.

Recently (Maatje, et al., 1997) reported the optimal time of AI was predicted using mathematical models based on pedometer readings and rectal palpation of 171 cows. Chance of pregnancy was highest between 6 and 17 hours after increased pedometer activity, and the calculated optimum time of AI was 11.8 hours. The advantage of pedometer based system is reduced labor cost and continuous 24 hour monitoring; however, disadvantages maybe the effects of environment and housing which affect the efficiency and accuracy because of their influence on walking activity which is only a secondary indicator of estrus and initial cost.

Three milking equipment companies (Afikim, Bou-Matic, and Westfalia) have pedometer technology integrated with the milking system at various stages either in the milking parlor with an alarm system are downloaded into a central computer for list report generation. Pedometer technology commercially available today has improved greatly since its earlier use in most studies published in research journals. Analytical capability whereby the pedometer can compare activity that has occurred in the present time period to a pre-set baseline time period (previous 10 days) allows comparison of activity within individual cows and thus increases the specificity of the system. All pedometer systems available today are integrated with the milking equipment. If you are considering a new milking system or a milking system up-grade that is the time to invest in a pedometer system for heat detection.

## Electronic Pressure Sensing for Determination Standing Behavior (HeatWatch®)

The primary behavioral signal for sexual receptivity in the cow is standing to be mounted. Observing standing behavior is a challenging management problem. Standing behavior represents less than 1% of the period of estrus (Senger, 1990) and thus, is exceptionally difficult to detect unless significant time is devoted to direct observation of cows eligible for breeding.

The HeatWatch® estrus detection system is the first system that has continuous 24-h surveillance to monitor behavioral events associated with estrus. Radio frequency data communications is the base technology employed by the HeatWatch® system. A radiotelemetric device is attached to each cow and consists of a miniaturized radiowave transmitter, powered by a lithium 3-V battery and linked to a pressure sensor enclosed in a hard plastic case. Each device is secured in a water- resistant pouch, attached to a saddle-shaped nylon mesh patch that is glued with contact-type adhesive to the hair in the tailhead region. Activation of the pressure sensor by weight of a mounting herdmate for a minimum of 2 seconds produces a radiowave transmission (0.4-km range). Transmitted data consisted of sensor identification, date (month, day, and year), time (hour and minute), and duration of sensor activation. Transmitted signals are sent to a microcomputer via a fixed radio antenna. The remote signal receiver should be centrally located on the farm to minimize transmission interference. Transmitted data from remote receiver is chronologically stored in a buffer external to the microcomputer and transferred to a microcomputer at request of the HeatWatch® software. The HeatWatch® software generates both fixed management reports and individual cow files that can be viewed, printed or sorted by each cow into individual periods of estrus activity. The HeatWatch® software classifies a standing estrus as a cow having three standing events in any 4-h period; fewer standing events are noted as a suspect estrus, and visual observation for secondary signs of estrus prior to the decision to AI is recommended.

Optimal time of artificial insemination (AI) was determined from services (n = 2661) performed in herds (n = 17) utilizing the HeatWatch® system (Dransfield et al. 1998). Each farm selected a 3-hour interval to AI cows identified in estrus during the previous 24 hours. Pregnancy status was determined by data for return to estrus and palpation of the uterus 35 to 75 days following AI. Standing events during estrus averaged (± SD) 8.5 ± 6.6 per cow, and mean (± SD) number of events per estrus across herds ranged from 6.2 ± 5.1 to 12.8 ± 9.9 per cow. Duration of estrus ranged from 5.1 ± 3.8 to 10.6 ± 6.8 hours across herds with a mean of 7.1 ± 5.4 hours. Time from first standing event to AI affected the probability of pregnancy; highest conception rates for AI occurred between 4 and 12 hours after the onset of standing activity. A higher probability of pregnancy was revealed for cows >100 days in milk, exhibiting >2 standing events during estrus, and inseminated during March, April, or May.

Distribution of estrus periods by duration and intensity were as follows: 1) low intensity defined as an estrus containing <1.5 standing events per hour; 2) short duration as lasted <7 hours from first to last standing event; 3) High intensity defined as an estrus containing ≥1.5 standing events per hour and; 4) short duration as lasted for ≥7 hours from first to last standing event. The proportions of total estrus periods were as follow: low intensity and short duration, 24.1%; high intensity and long duration, 8.4%; high intensity and short duration, 34.3%; and low intensity and long duration, 33.2%. Distribution of estrus periods by intensity and duration was similar for cows that conceived (n = 1102) and for cows that either returned to estrus or were diagnosed not pregnant during palpation by herd veterinarian (n = 1299). Conception rates did not differ in intensity and duration across the four categories of estrus periods. Conception rates ranged from 45.5% for cows that had estrus periods of low intensity and long duration to 49.8% for estrus periods classified as consisting of high intensity and long duration. This distribution of estrus periods by duration and intensity reinforces the importance of both the frequency of visual observation and proficiency of individuals performing visual examination in the detection of estrus.

The efficiency and accuracy of estrus detection using the HeatWatch® system was evaluated in two New Zealand seasonal grazing herds (Xu et al. 1998). The efficiency and accuracy was determined using three times weekly milk sampling for progesterone profile construction. Efficiency and accuracy of detection was similar to the best results achievable with visual observation and tailpaint (Table 1). It was interesting that estrus characteristics of cows (intensity and duration of standing activity) were similar to that reported for cows in confinement housing environments.

## Conclusions

Clearly the development of new technology for the reproductive management of dairy cows is taking place. In the final analysis, the success of any new technology will depend on the following:

The technology must have a high rate of effectiveness.

The technology must be cost-effective and contribute to increased profitability of the dairy enterprise.

The technology makes life easier for the management team.

Technology that satisfies these three requirements will make a long-term, positive impact at the world-wide level weather this technology be in the area of heat detection or in some other area of dairy production.

## References


1. Dransfield, M. B. G., R. L. Nebel, R. E. Pearson and L. D. Warnick. 1998. Timing of insemination for dairy cows identified in estrus by a radiotelemetric estrus detection system. J. Dairy Sci. 81:(Accepted).

2. Farris, E. J. 1954. Activity of dairy cows during estrus. J. Amer. Vet. Med. Assoc. 125:117.

3. Feldmann, F., E. Aizinbud, H. Schindler and H. Broda. 1978. The electrical conductivity inside the bovine vaginal wall. Anim. Prod. 26:61.

4. Kiddy, C. A. 1977. Variation in physical activity as an indication of estrus in dairy cows. J. Dairy Sci. 60:235.

5. Lehrer, A. R., G. S. Lewis, and E. Aizinbud. 1992. Oestrus detection in cattle:recent developments. Page 355 Clinical Trends and Basic Research in Animal Reproduction Science. S.J. Dieleman, B. Colenbrader, P. Booman and T. Van Der Lende, ed., Elsevier Sci. Publ., Amsterdam, Netherlands.

6. Lewis, G. S., E. Aizinbud and A.R. Lehrer. 1989. Changes in electrical resistance of vulvar tissue in Holstein cows during ovarian cycles and after treatment of Prostaglandin $F_2$ alpha. Anim. Reprod. Sci. 18:183.

7. Maatje, K., S. H. Loeffler, and B. Engel. 1997. Optimal time of insemination in cows that show visual signs of estrus by estimating onset of estrus with pedometers. J. Dairy Sci. 80:1098-1105.

8. Senger, P. L. 1990. Heat detection - some little known facts and problems. Some possible solutions. Page 196 *in* Proc. 1990 Lower Columbia and Northwest Dairy

shortcourse. Washington State Univesity, Pullman, WA.

9. Xu, Z. Z., D. J. McKnight, R. Vishwanath, C. J. Pitt, and L. J. Burton. 1998. Estrus detection using radiotelemetry or visual observation and tailpainting in seasonal dairy cows on pasture. J. Dairy Sci. (Submitted).