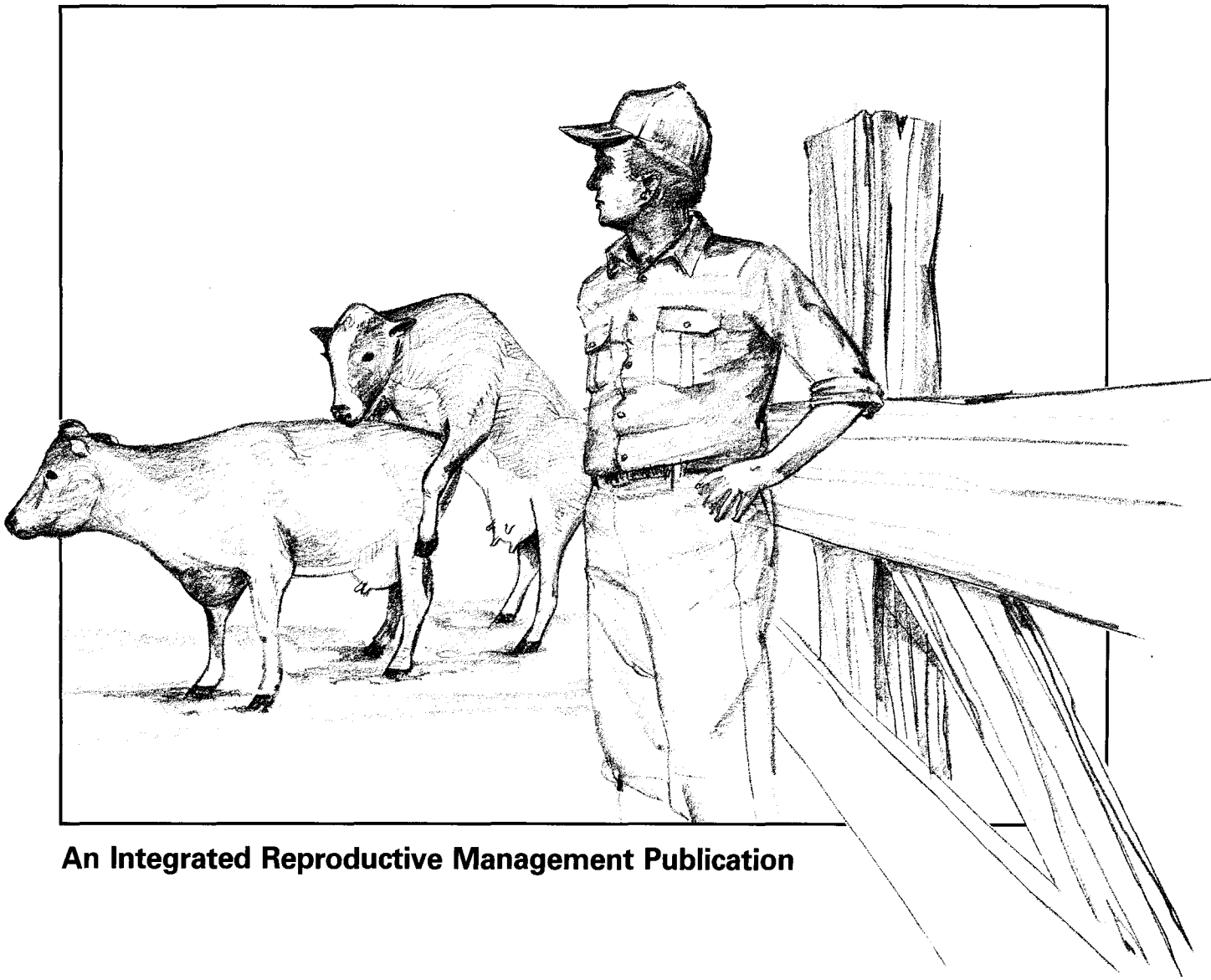
AG-FO-2018
1983

Detection of Heat in Dairy Cows

Norm Williamson
Associate Professor and Extension Veterinarian
University of Minnesota □ Agricultural Extension Service



An Integrated Reproductive Management Publication

Introduction

Inadequate detection of heat in cows is one of the major factors limiting reproductive performance in Minnesota dairy herds. The problem is well recognized: 49 percent of farmers in a Dairy Herd Improvement Association (D.H.I.A.) survey acknowledged heat detection as a management problem. This made it the highest ranking problem perceived by the dairymen who were surveyed. Inadequate heat detection affects herd profitability in a number of ways:

1. When heats are not detected and therefore cows are not bred, calving intervals are extended, resulting in lower lifetime milk production and fewer calves.
2. Conception rates are depressed and semen, which can be costly, is wasted when cows unsuitable for insemination are bred.
3. The combination of unrecognized estrus and low conception rates may lead to culling of normal cows before they achieve peak production levels and peak production efficiency.
4. Insemination of pregnant cows mistakenly identified as in estrus may cause abortion.

While artificial insemination can produce rapid genetic progress in a herd, it also places greater responsibility for heat detection on farm personnel. However as herd size increases and the number of cows each person handles increases, due to increased automation, each cow receives proportionately less attention. Consequently, inadequate or inaccurate estrus detection has become a factor that limits the reproductive performance and resulting profitability of many herds.

However, it is possible to improve heat detection and reproductive performance in most herds, using techniques that require some effort, but little money.

Determining Whether Heat Detection in Your Herd can be Improved

1. To accurately evaluate how well heats are detected in your herd, you need: adequate identification of cows; good records; records of *all* heats, and regular veterinary examinations.
   If you lack the above information, it is still possible to estimate heat detection efficiency if you keep records of all breedings.
2. It can be useful to compare heat detection indexes in your herd with target indexes based on other herds that have adequate heat detection.

Heat Detection Indexes

1. The proportion of cows in heat by 60 days after calving.

This should be 85 percent or better. If not, there is room for improvement. Managers of some herds can maintain a consistent detection rate of more than 90 percent of cows in heat by 60 days after calving. To accurately determine this index, all heats must be recorded, even those observed before the intended breeding time.

2. The average interval from calving to the first heat.

Over recent years there has been an increasing realization that ovulation and estrus occur relatively early after calving. In well-fed herds, the first ovulation commonly occurs 20 to 25 days after calving, with an average interval to first observed heat of 40 days or less. In some herds with excellent estrus detection, this interval can be even less than 25 days, but averages this low are uncommon. If the average interval is more than 40 days, there is room for improvement.

Real or apparent delays in return to estrus may be due to a failure of cows to undergo ovarian cycling or to a farmer's failure to note estrus in cows. A veterinary exam can usually detect the presence of infections and abnormalities that may prevent ovarian cycling. If no such conditions are found, estrus detection can usually be improved. This is true in most situations when anestrus appears to be a problem. Minnesota studies have revealed that 90 percent of apparent anestrus is due to a failure to observe estrus; only 10 percent is due to abnormality of the cows.

3. The proportion of cows found to be pregnant at pregnancy diagnosis.

If regular veterinary visits are a part of your herd's reproductive health program, your cows are generally examined for pregnancy. Cows are generally first presented for pregnancy diagnosis five to seven weeks after they are served, but only if no return to service has been observed. Thus if cows are not found pregnant upon examination, this implies that their return to estrus after service has not been observed. In herds where pregnancy diagnosis is done 7 to 11 weeks after service, 95 percent or more of cows presented for pregnancy diagnosis should be pregnant. Where pregnancy diagnosis is first conducted 35 days after service, 85 percent or more of cows examined for pregnancy on the basis of no return to service should be pregnant. A lower proportion of pregnant cows generally reflects inadequate detection of heat.

4. Intervals between heats.

These can be used to measure heat detection efficiency if all observed heats [and/or services] are recorded. The number of days between heats [and services] of individual cows can be calculated using a calendar and the pooled cow intervals analyzed in a number of ways to assess performance.

a. Average intervals between heats

By adding days of all of the intervals and dividing by the number of intervals, the average interval between heats can be calculated. In herds with excellent estrus cycling and detection, this interval is less than 25 days. When the interval is more than 30 days long, there is considerable scope for improvement in heat detection.

b. Heat detection rate

If all cows are assumed to have heat cycles of 21 days, then dividing 21 by the average interval between heats gives an estimate of the proportion of heats detected. This, expressed as a percentage, is called the "heat detection rate". For example, if the average interval between heats is 30 days, then the heat detection rate is $\frac{21}{30} \times 100 = 70\%$

c. Distribution of cycle lengths

The proportion of cycles occurring at less than 18, 18 to 24, and more than 24 days is used to assess heat detection efficiency. It is sometimes suggested that 85 percent of the intervals between heats should be between 18 and 24 days long. However, in a large population of herds with very good heat detection, 10 to 15 percent of cycles were less than 18 days, 55 to 60 percent were 18 to 24 days, and 26 to 33 percent were more than 24 days.

d. Ratio of single to double interestral intervals

Where all heats are recorded in herds of 80 or more cows, the ratio of single (18- to 24-day) to double (39- to 45-day) interestral intervals gives an excellent indication of heat detection efficiency. This index is independent of nutritional effects or early embryonic mortality, because there is no reason why returns to estrus due to these causes are more likely to occur at 39 to 45 days. However, if heats are occurring but detection is poor, there is likely to be an increased number of 39- to 45-day cycles. If there are six or more times as many single as double cycles, estrus detection is satisfactory. If there are less than five times as many, heat detection can be improved.

5. Submission Rate.

In herds in which a compact seasonal calving is desired, a simple index of the occurrence and detection of estrus (and also of service) is the submission rate. The submission rate is the percentage of the herd bred during the first four weeks of mating. Submission rates of more than 90 percent can be achieved in well-managed, well-fed herds.

Strategies for Improving Heat Detection

Become Familiar With Heat Signs and Behavior

A primary requirement for improved detection of heat in cows on any farm is a thorough familiarity with the signs of heat and estrous behavior.

During estrus, copious quantities of clear, elastic mucus may be seen flowing from the vulva (figure 1). In some cows the vulva becomes swollen with a reddened lining, and the pelvis may be rotated so that the back is depressed. As these are the only visible signs of estrus, farmers need to rely heavily on behavioral patterns to detect estrus.

Estrous cows in the stalls become active and restless and tend to remain standing when others lie down. They may also bellow, urinate frequently, and switch their tails. Free-stall or pastured cows in estrus roam and display seeking activity such as nudging, sniffing, and rubbing their chins on other cows, especially around the vulvar and rump areas. Estrous cows will mount other cows and stand to be mounted; the latter is the definitive sign of heat. Cows in estrus are also commonly reported to have a depressed appetite and depressed milk production.

Dependability of Various Signs as Selection Criteria for Estrus

1. Standing to be mounted

This is the definitive sign of heat and is probably the most useful sign in selecting cows suitable for breeding. However, this behavior will not occur unless cows are allowed adequate opportunity to interact. Turning cows out from stanchion barns is an important prerequisite to accurate heat detection. Cows in heat stand firmly when mounted by other cows or stagger forward a little under the weight of the mounting cow. Cows not in heat walk quickly away if an attempt is made to mount them or turn and butt the cow attempting to mount them.

Although standing to be mounted is the definitive sign of heat, it still does not provide either a perfect method of heat detection or of predicting suitability for insemination. In an intensive study of heat detection and behavior in 165 cows, 7.3 percent of heats in one three-week period occurred in pregnant cows, with 13 percent of the pregnant cows showing heat. Cows with ovarian problems (e.g., cystic ovaries) may also show heat but be unsuitable for insemination. On the other hand, many cows that are suitable for insemination may go through estrus without detection if standing to be mounted is the sole selection criterion. Even on pasture, with 24 hours per day observation for estrus, only 80 percent of cows suitable for insemination were detected in estrus by observation of them standing to be mounted.

The mounting of one cow by another may produce secondary signs that can help in detecting heats. The hair over the base of the tail and rump of mounted cows may become very ruffled and matted. Prolonged and vigorous "riding" of cows may also lead to removal of the hair and abrasion of the skin, producing raw, red and bleeding areas. If the rubbed areas are bleeding at the time of observation, the cow is probably in estrus; if dry scabs are present, cows may either still be in standing estrus or may be up to six days past it.

If cows are turned into yards or paddocks or held in free stall pens, smears of mud or faeces on the sides of the legs or flanks can indicate that they have been recently ridden by other cows and therefore are in heat.

2. Mounting other cows

Many mounts are made by cows in estrus, but mounts are also made by cows approaching heat, going out of heat, or, in fact, nowhere near heat. In a herd of 165 cows, 150 were seen mounting other cows in a three-week period. So, although mounting other cows is a sign suggestive of heat, it cannot be used as an accurate selection criterion. However, English research in free-stall barns showed that cows mounting the heads of other cows were invariably in heat.

3. Relaxation, moistness, and redness of the vulva

At estrus, the vulva may become swollen and relaxed. The lips of the vulva separate easily to reveal a red, moist lining. Between heats however, the lining is paler and stickier, which makes the vulvar lips more difficult to separate. Although these changes do occur within the cycles of cows, it is difficult to pinpoint the proper time of estrus using these signs even when they are obvious, since the signs start to appear before true heat and may persist for a day or two after heat. The variations between cows in the color, shape, and size of the vulva are generally too great to permit ready observation of changes at estrus.

4. Mucus from the vulva

Mucus may be expelled from the vulva of cows throughout the estrus cycle and even in pregnancy. However, long strands of *sticky* and *crystal clear* mucus indicate that the cow is in, or very close to, heat. When a sample of the mucus is touched to two objects and then pulled apart, it should stretch for more than four inches if the cow is in heat. When cows are in heat, the mucus may be seen hanging from the vulva or from the tail, or smeared on the buttocks. A day or two after estrus, the mucus may be blood-streaked (figure 2), indicating that estrus occurred one or two days earlier.

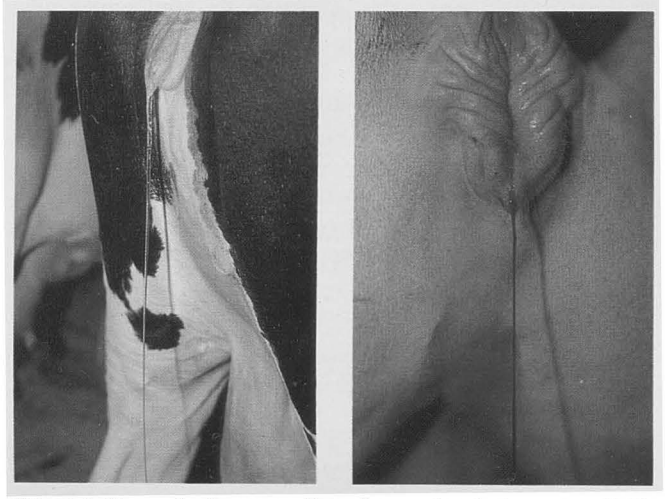


Figure 1. Clear, elastic mucus flows from vulva during estrus (left); Blood-streaked mucus indicates estrus passed one or two days earlier (right).

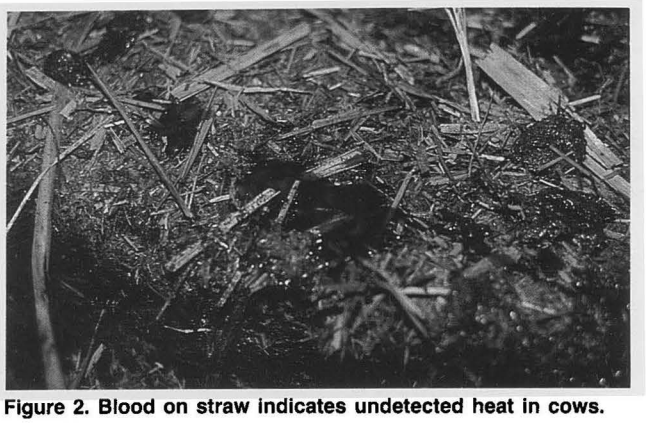


Figure 2. Blood on straw indicates undetected heat in cows.

5. Response to Rubbing

It has been claimed that a cow's reaction to firm rubbing of the rump or rubbing near the vulva can help detect heats. Cows in heat supposedly depress their backs and elevate their tails. However, although a few estrous cows respond in this way, most fidget and appear to resent the procedure. Therefore rubbing is at best an unreliable method of estrus detection.

Behavior of Cows in Heat

The behavior of cows in heat is dependent on their type of housing. Since the behavioral signs of heat are related largely to interactions between animals, they can only express these interactive signs when they are together and able to interact and move freely. Tied or stanchioned cows show a restricted range of behavioral traits, since they cannot interact.

1. Signs relying on freedom and interaction

Group activity is pronounced in sexually active cows with the group including those coming in heat, in standing heat, or just past heat and also nymphomaniac cows. Only some animals in the groups are prepared to stand for mounting and truly in heat. Identification of the sexually active group is very helpful as a first step in identifying cows in heat. Sexually active cows associate together and are active in sniffing vulvae of other cows, nudging them, rubbing chins on rumps, and mounting. Cows in the sexually active group are more mobile than the remainder of the herd. Members of the sexually active group stand closer together than cows normally do. They also tend to stand up more than cows that are not sexually active.

In large herds, sexually active groups of more than eight cows may subdivide into smaller groups. Cows tend to join the sexually active group a day or two before heat, stay with it throughout heat and for a day or two later, and then abandon it.

Mounting activity and standing for mounting has been dealt with above, but understanding the following behavioral signs associated with heat may help you in heat detection in your herd.

a. Sniffing and licking of the vulva

Sexually active cows will approach other cows and sniff their vulvae. If the cow approached is not near heat, the active cow will move on. If the cow approached is about to come in heat or is in heat, the active cow will stay and may possibly nudge the vulva or rub her chin on the rump of the cow approached. If the cow approached is in estrus, the active cow may sometimes stretch her neck and curl her upper lip like a bull, especially if the cow being investigated urinates. However, cows being investigated frequently urinate whether or not they are in estrus.

b. Chin resting and rubbing

A sexually active cow frequently rests and rubs her chin on the rump of another cow as a prelude to mounting (figure 4). Before mounting, cows appear to test the sexual receptivity of the other cow by applying pressure to the rump and loins with their chins. The cows being tested give negative signals by rapidly walking away or by turning and butting the testing cow. A positive signal is given if the cow being tested stands quietly and sometimes raises her tail to one side.

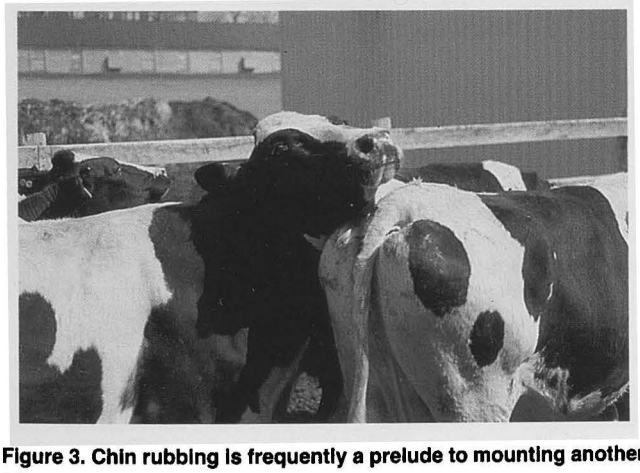


Figure 3. Chin rubbing is frequently a prelude to mounting another cow.

2. Signs shown by isolated individual cows

When their housing system restricts the interactions of cows, the opportunity to display signs of estrus are limited. However, some behavioral changes in such cows have been associated with estrus.

a. Standing time

Canadian and Minnesota studies of stanchioned and free-stall cows show that cows in estrus spend more time standing than herdmates. Thus, if the majority of the herd is resting and a few cows remain standing, the standing cows should be closely examined for further signs of estrus and can be tested for standing heat by letting them interact with sexually active cows or other teaser animals.

b. Alertness, bellowing

Cows in estrus tend to be more alert and interested in their surroundings than nonestrous cows. Some cows also bellow noticeably more when they are in estrus. Cows showing these signs should be investigated further for evidence of heat, since these signs in themselves are not definitive.

c. Tail raising, switching, and urination

It has been reported that cows in estrus raise their tails more than nonestrous cows. However, although this may happen when cows interact, it is difficult to observe in tied stanchioned cows. The same is true of tail switching and increased frequency of urination. Although these behavioral signs have been described as increasing in estrus, the changes generally cannot be recognized by simple observation.

d. Feed consumption and milk production

Farmers have long reported that cows in estrus tend to eat less and studies confirm that estrous cows spend less time eating. So, if cows that normally eat well do not do so, they should be observed more closely for other signs indicating heat. Similarly, cows eating more slowly than usual should be observed for further signs of estrus.

Cows in estrus have been reported to produce less milk due to both a decrease in actual production and of inadequate milk letdown. Consequently, cows should be further examined if their milk production suddenly decreases as they may either be in estrus or affected by a disease. In either case, further examination is desirable.

Environmental Factors Influencing Heat Signs

A number of environmental factors influence the occurrence and signs of estrus. It has been pointed out above that the *type of housing* of cows influences their ability to interact and the estrous signs they display. The type of housing is reported to influence the length of estrus as well as the farmer's ability to observe signs. Studies show that cows in tie-stall barns are actually in estrus for only one-half to two-thirds the length of time that free-stall housed cows are, although the ovarian cycling of the two groups was similar. The ability of cows to interact in a free-stall or pasture situation extends estrus if more than one cow is in heat. This does not occur in tie stalls.

Management activities such as feeding, cleaning, and milking can also disrupt the normal behavior of cows. Moving cows for parlor milking may stimulate mounting activity; however, it is difficult to identify standing cows if they are at the center of the group when they are mounted. Feeding schedules may modify the time at which estrous cows display signs. Observations of cows in pasture show that sexual activity is most markedly displayed when the majority of the herd has finished grazing and settles down to ruminate. In housed cattle too, it may be best to specifically examine cows for signs such as alertness

and standing when the majority of the herd has settled to ruminate. When, for the purpose of estrus detection, cows are turned out from barns and fed in corrals, observation should not start until after the feed has been consumed. If the aim of the observation is estrus detection, there is little point in watching cows eat. It is better to turn the cows out, leave, and return when most cows are ruminating, since estrous cows are likely to be demonstrating behavioral signs then.

Comfort may be an important factor modifying the behavior of cows and it therefore may influence the detection of heat. If cows can lie down and ruminate in comfort, alert, standing cows will be more easily evident. However if cows are not comfortably housed and have inadequate lounging space, they may be forced to stand regardless of their estrus status.

Inclement weather and cold can cause cows to "turn off" their estral behavior, at least for short periods. It has been observed that cows show stronger signs of heat when they are warm than when they are cold; however, high temperatures also depress both the expression of estrus and fertility. These observations emphasize the need for adequate shelter from extreme weather of any type in the interests of cow comfort.

Aids to Heat Detection

1. Heat detection patches

There are two types of device available that are effective in aiding heat detection. They are the KaMaR* heat mount detector, and the Matemaster† detector manufactured in New Zealand. Heat detection efficiency may be improved by 50 percent by using these devices. These devices are more effective used where cows may interact freely than in crowded situations where cows' interactions are restricted.

Crowding also increases the number of mistaken positive detections made by the device. Despite this, these detectors have been used successfully to improve the detection of estrus and to reduce calving intervals under varied management conditions throughout the world. Apart from their cost, these devices have other reported disadvantages in addition to the false positive reactions previously mentioned. Incomplete triggering of the devices must be interpreted by farm personnel and false positive or false negative detections can result from incorrect interpretations. Interpretation problems may also occur if the devices are missing from cows fitted with them. However, if the cows are free of external parasites and have not scratched themselves on objects, it may generally be assumed that the lost detectors have been rubbed off by mounting activity. The use of detection aids has been associated with a decrease in the observation of standing estrus. If they become a substitute for instead of a supplement to careful observation, their advantages may be offset. In addition, cows must be allowed to interact for these devices to be of use.

2. Chalk and paint marks

As an alternative to these heat detectors, chalk or paint can be applied to base of cows' tails (figure 5). Paint can be applied to the midline, from where the tail hangs down, forward to between the pin bones. When the paint dries, it forms a skin that is rubbed off when cows are mounted. Chalk or crayon marks can also be used, but they must be applied daily, whereas paint must be replaced only every one to three weeks. Both oil-based paint and water-soluble latex or acrylic paint can be used. Although specially formulated paint is available in some countries, most paint is suitable. Cows need to be able to interact freely to allow the mounting activity that will rub off the paint. Cows should be checked at least twice a day to determine if the paint-line has been rubbed or broken over bony prominences.

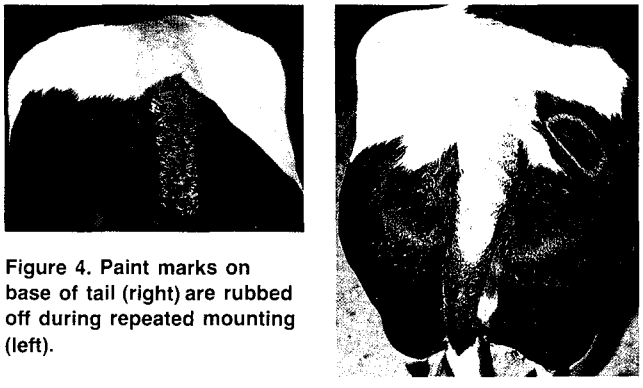


Figure 4. Paint marks on base of tail (right) are rubbed off during repeated mounting (left).

3. The use of teaser animals

Heat detection may be improved by the use of teaser animals because the expression and duration of estrus are enhanced if more than one sexually active animal is present. Teasers may be vasectomized bulls, bulls with their penises fixed, nymphomaniac cows, and testosterone-primed steers or cows. The use of chin-ball markers, which mark mounted cows with ink, enables detection without constant observation, and so increases the usefulness of teaser animals. Teasers may be highly suitable for some farm situations. Teasers should be closely observed and well managed to ensure a high efficiency of heat detection. It is desirable to remove cows identified as in estrus so that teasers do not stay with one estrous cow alone, but keep seeking out others.

4. Increased anticipation of estrus

Heat expectancy calendars, with days arranged in 21-day rows or columns, can aid estrus detection by increasing awareness of the next expected estrus.

*KaMaR Inc. Steamboat Springs, Colorado.
†Delta Plastics Ltd., Palmerston North, New Zealand.

Cows can then be more critically observed for signs of estrus at the likely time. The calendars can also be used to note the discharge of blood-stained mucus that occurs a day or two after estrus. If this discharge is noted, heat usually will occur in 18 to 20 days.

Skilled veterinarians can also predict the likely time of the next estrus through examination. These predictions are based on changes in the uterus and ovaries detectable by rectal palpation. The accuracy of prediction and range of anticipated time until expected estrus varies depending on what stage of the estrous cycle the cow is in when she is examined. Examinations, when used in a regular reproductive health program, can considerably improve estrus detection and resolve apparent anestrus. In studies conducted in Minnesota in the 1960s this was the most effective means of dealing with anestrous cows.

5. Automated estrus detection

A number of devices, generally involving computer monitoring of records, are being developed to measure the performance of cows in areas discussed above. These include devices for the automatic detection of cows with depressed milk production, decreased appetite, increased activity, and increased standing time. Some of these are already commercially available and others will be going into production. These devices are unlikely to have an immediate place in the average Minnesota dairy farm, but they may gain a larger role in the future.

6. The Evaluation of Vaginal Secretions

A number of tests have been advocated to help detect heat, based on the chemical and physical properties of vaginal mucus. These tests generally require special equipment and skills that are rather time consuming. Also, while results of such tests may indicate that a cow is close to estrus, they do not accurately predict optimal breeding time. Therefore, these techniques cannot be recommended for practical use on farms at this time.

Develop a Management Plan and Monitor Performance

Using the above information about heat detection and estrous behavior, you can set detection aims for your herd. You can monitor the detection of heat in your cows to see if you are achieving your aims. Heat detection is a function with important economic consequences on modern dairy farms, and it deserves a specific management plan. Suitable plans will obviously vary from farm to farm.

Every management plan should include the monitoring of detection performance. This can be done by regularly (each month) calculating some or all of the indexes of estrous performance described previously. If your herd's performance achieves the target levels, you can continue the excellent management in your herd. However, if it doesn't, you should aim to identify the factors limiting performance and modify and improve farm management to remove the limits, if it is economically possible. Your veterinarian is the person best qualified to help you to do this. It can be useful to make a graph of the performance of the herd to give a pictorially obvious account of trends in improvement or decline in performance. A graph can be constructed to demonstrate whether or not a cow is detected in estrus by a certain time after calving. The time needs to be selected with regard to the normal occurrence and observation of estrus in the herd, so that the normal proportion of cows detected by the specified day is approximately 50 percent. This may be 60 days in some herds. The graph starts at the left hand margin of a sheet of graph paper, half way up the page. The results for each cow may be entered to the sheet at day 60 after calving. Each time a cow shows heat by 60 days after calving, a mark is made one square to the right and one square up. Each time one fails to achieve the aim, a mark is made one square to the right and one down. This is a simple way to monitor the occurrence and detection of heat after calving.

Members of the D.H.I.A. can use the several heat detection monitors provided on the monthly herd summary sheet. The estrous detection rate, as described previously, can be recorded and also graphed to determine trends. It is important to record all breeding dates so that the estrous detection rate is as accurate as possible. Another way to assess the occurrence and detection of estrus from the monthly D.H.I.A. summary is to look at the distribution of cycle lengths between breedings. Problems with heat detection are generally present when the proportion of 18 to 24 day cycles is less than 50 percent.

Adequate, accurate, and complete records are essential to the management of estrous detection in herds. To be useful, these records must be analyzed and regularly monitored to detect unsatisfactory or declining performance.

If this occurs, new management strategies should be introduced to improve performance.

Conclusion

Inadequate detection of heat is a major limit to reproductive efficiency of dairy herds in Minnesota. However there are methods available to monitor the efficiency of estrus detection and inadequate detection rates can invariable be improved if farm managers are prepared to: become familiar with the signs of estrus, regard estrus detection as a specific management task, devote adequate and appropriate time to estrus detection, and employ and utilize estrus detection aids.

By doing this, farmers will not only improve the biological efficiency of their herds, but they will usually increase their profits.

Calculating Heat Detection Indexes

Example of Cow Histories:

115 Calved 11/22/82, Heat, too early 12/25/82, AI-410. 1/14/83, Vet Preg 2/26/83

120 Calved 11/18/82, Heat, too early 12/17/82, AI-303 1/6/83, Vet Preg 2/26/83

155 Calved 8/26/82, Heat, too early 9/29/82, AI-301 11/9/82, AI-301 1/8/83, Vet Preg 2/26/83

100 Calved 7/29/82, AI-POE 9/16/82, AI-EAR 10/11/82, AI-TRX 12/18/82, AI-TOP 1/10/83, AI-TOP 2/3/83, NB-TOM 2/27/83, Vet Preg 3/31/83

107 Calved 8/10/82, Heat, too early 9/2/82, Heat, too early 9/23/82, NS-HAR 10/15/82, AI 410 11/6/82, AI-NOB 12/18/82, Vet Preg 2/26/83

162 Calved 11/13/82, AI-SAM 1/24/83, Vet Not Preg 2/26/83, AI-MER 3/3/83, AI-MER 3/24/83, Vet Preg 4/30/83

Sample Calculations of Some Heat Detection Indexes:

A. Define the period to be evaluated, e.g., 1 month, 3 months or 1 year.

B. Gather records for *all* cows in the herd at that time.

C. Calculate performance indexes as follows:

1. The Proportion of Cows in Heat by 60 Days After Calving

- NB—all heats must be recorded for this index to be accurate and useful.
- A low index may reflect poor estrus detection *or* cows that are not coming into heat. Veterinary palpation or progesterone profiles are needed to determine if cows are cycling.
- The index may be calculated for cows calving in any interval ending 60 or more days before it is calculated, e.g., on June 1st, the index could be calculated for cows calved up to April 2nd.

Looking at our example herd of 6 cows:

- #115 had 8 days in November and 25 days in December before showing heat, i.e., a total of 33 days.
- #120 had 12 days in November and 17 days in December, i.e., 29 days.
- #155 had 5 (August) + 29 (September) = 34 days
- #100 had 2 (July) + 31 (August) + 16 (September) = 49 days
- #107 had 21 (August) + 2 (September) = 23 days
- #162 had 17 (November) + 31 (December) + 24 (January) = 72 days

Thus $^{5}/_{6}$ or 83 percent of cows showed heat by 60 days after calving. In a well-managed herd in which heat detection is very good more than 90 percent of cows should be detected in heat by 60 days after calving.

2. The Average Interval from Calving to First Heat

- All observed heats should be recorded for this index to accurately reflect the performance of the cows and herdsmen.
- A long interval may reflect poor estrus detection, a failure to record early heats or a failure of the occurrence of heat.
- The index may be calculated for cows calving in any defined period or for cows showing their first heat in any defined period. The definition of the intervals to be analyzed by calving date is more useful in identifying possible influences on the interval from calving to first heat.

Information from the calculation of the previous index can be used to determine the average interval from calving to first heat, which is simply the sum of the intervals from calving to first heat of each cow divided by the number of first heats.

e.g., 33 + 29 + 34 + 49 + 23 + 72 ÷ 6 = 240 ÷ 6 = 40 days.

3. The Proportion of Cows Found Pregnant at Pregnancy Diagnosis

- Both non-pregnancies and pregnancies at pregnancy examination must be recorded.
- This requires herd visits by a veterinarian for pregnancy diagnosis, either on a regular or ad hoc basis.
- The index is calculated for cows presented for pregnancy diagnosis at a visit or in a period.
- A low proportion generally reflects inadequate heat detection, but certain abnormalities may contribute to a failure to return to estrus after breeding.

Five cows were examined for pregnancy on 2/26/83 and 4 were pregnant. Thus there were 4 ÷ 5 × 100 or 80 percent pregnant at pregnancy diagnosis.

4. Intervals Between Heats

- The number of days between observed heats and breedings can be used in a number of indexes to measure heat detection efficiency.
- All observed heats and breedings should be recorded to calculate these indexes

a. Average Interval Between Heats

- #115 There are 20 days between the heat on 12/25/82 and the breeding on 1/14/83.
- #120 There are 20 days between the heat on 12/17/82 and the breeding on 1/6/83.
- #155 There are 43 days and 63 days between heats or breedings.
- #100 There are 25, 68, 23, 24, and 24 days between breedings.
- #107 There are 21, 23, 22 and 42 days between heats and breedings.
- #162 There are 38 and 21 days between breedings.

The average interval between heats is:

20 + 20 + 43 + 63 + 25 + 68 + 23 + 24 + 24 + 21 + 23 + 22 + 42 + 38 + 21 divided by the number of between heat intervals (15), which equals 31.8 days.

b. Heat Detection Rate

$$\frac{21}{\text{Average interval between heats (31.8)}} \times 100 = 66\%$$

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Agricultural Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, creed, color, sex, national origin, or handicap.

The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Minnesota Agricultural Extension Service is implied.