ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 66 63 Number 2, 2018
https://doi.org/10.11118/actaun201866020619

SEVERAL METHODS OF ESTRUS DETECTION IN CATTLE DAMS: A REVIEW

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Abstract

MIČIAKOVÁ MÁRIA, STRAPÁK PETER, SZENCZIOVÁ IVETA, STRAPÁKOVÁ EVA, HANUŠOVSKÝ ONDREJ. 2018. Several Methods of Estrus Detection in Cattle Dams: A Review. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 66(2): 619–625.

The oestrus is defined as a complex of physiological signs and changes of behavior occurring immediately before the ovulation. It is the period of sexual receptivity of the cow and this period characterized by, typical cow behaviour which is standing when mounted by a bull or companion cow. Cow indicates this willingness by a slight arching of the back and immobility when approached. The bovine estrus cycle averages 20 days in heifers and 21 days in cows, but the fluctuations in the cycle length is laying between 18 and 25 days. As a result of this progress often only 50% of the estrus cycles are recognized, and it is extremely hard to find all cows on heat. We state a few methods for estrus detection such as visual observation, locomotion activity and rumination time measurement and other.

Keywords: cows, detection, insemination time, methods, observation, oestrus, problems

INTRODUCTION

Recently, it has been demonstrated that today's cows show for shorter duration and fewer signs of estrus. The results of many new studies from the Netherlands and the USA show fluctuations in the cycle length. Mostly we talk about shorter mating season duration and shorter oestrus intensity in high-performing herds (Brehme *et al.*, 2006). According to Dobson *et al.* (2007) mostly the intensities and durations of behavioral signs are decreased in terms of reduced mounting activity and less of the vulva sniffing, so it is harder for farmers to determine oestrus. Walker *et al.* (1996) demonstrated that the average mating season lasts for about 9.5 hours during which the cow mounts other cows 10.1 times on average, but only six mounts lasted more than 2 seconds.

In other research with 2600 dairy cows in Blacksburg obtained similar results. Here the average oestrus period duration of the Jersey cows were 8.8 hours and of the Holstein cows just 7.3 hours. Nebel (2004) reported that 30% of the Holstein cows showed a toleration reflex for at most only 4 hours. This variation is by Diskin and Sreenan (2000) probably due in part to different criteria used to define estrus in cows.

Senger (1994) said the poor detection of oestrus is the most important problem, that limits the high reproductive efficiency. In 1975, Barr determined that estrus detection efficiency has the biggest correlation with the calving to conception interval and the much greater impact on reproductive

performance. The influence factors, with an adversely influence of the heat intensity, are by Laven (2004) too little place for the mating season activity, seasonal temperature fluctuations, the slippers floor covering in loose barn and the time of day and the work in the stable (milk, feeding, medication of the animals, atc.). By Fetrow and Blanchard (1987) the average oestrus detection rate in dairy herds ranges widely from approximately 50 to 92%.

Nebel *et al.* (1997), Diskin and Sreenan (2000) and Laven (2004) described several technical possibilities of the mating season reconnaissance as, e.g. regular estrus observation, electrical resistance, regular milk progesterone measurement, pressure sensitive mount count devices and pedometers, radio telemetric devices, change from temperature in milk and body or vasectomised bulls heat-mount detectors.

Visual observation and tail-painting

The most common used method of oestrus detection is visual (personal) observation. The highest detection rates can be achieved with between two (Xu *et al.*, 1997) and five (Mee, 2004) 20–30 minutes observation sessions per day. One of most important factor which affect the heat detection efficiency is by Diskin and Sreenan (2000) that a head manager responsible for heat determination should be maximally familiar with all the signs of heat detection and be fully prepared as long time as it is possible. But this method incurs high labor costs and is tedious. Several methods have been used to facilitate detection of estrus; these methods have focused on physiological (Carter and Duffy, 1980), behavioral (Gwazdauskas *et al.*, 1990), and physical (Kiddy, 1977; Liu and Spahr, 1993) signs that are associated with oestrus.

Xu *et al.* (1997) say, that is possible using tail painting, where a strip of paint is applied over the tail head. The paint strip disruption shows possible mounting activity. Foote (1975) and O'Farrell (1980) contended that the paint or chalk application to the tailhead of cows is effective in satisfactorilyindicating cows in estrus. In situations that cows are mounting, it is common that the strip of paint is either partially or totally removed. According to this finding Diskin and Sreenan (2000) recommend a combination of early morning and late evening observations and checks for paint loss during milking times, what should result in 90% success of heat detection.

Progesterone in milk and blood

Progesterone is the hormone of the corpus luteum and if it occurs in a mating season, that the insemination shouldn't be considered (Strapák *et al.*, 2013). Changes in hormone levels especially in progesterone content have a very strong correlation with oestrus. The progesterone level can be easily measured from milk or blood plasma. The content of progesterone in milk depends highly on the level of milk fat. Based on study of Döcke (1994) a sharp decline of progesterone from > 10 to < 3 ng.ml^{-1} in milk indicates when pro-estrus starts. Changes in progesterone levels don't occur at first oestrus after calving. In 1984, Boyd reported that collection and labelling of progesterone samples is difficult to perform. Progesterone measurements were in the past mainly used with various oestrus detection methods (Schofield *et al.*, 1991; Stevenson and Phatak, 1999). But recently, different biochemical methods with sensors have been developed and tested in practice (Koelsch *et al.*, 1994; Delwiche *et al.*, 2001a, 2001b; Mottram *et al.*, 2001). The estrus detection ability of the biosensor and pregnancy in cows was proved by Mottram *et al.* (2001). Delwiche *et al.* (2001a) were able to detect 100% of oestrus by use of a biosensor, while of course some error was found with false detections of oestrus on level of 26.3%.

Ultrasonography

Braun (1997) described, that the practical methods for searching the mating season is also include ultrasonography, which are characterized as a modern noninvasive method using the principle of pulse-echo ultrasound waves. Sonography provides an very objective and immediate information. Ultrasound is used in cows to detect ovarian follicle maturation, for monitoring the physiological changes in the uterine endometrium and the whole cycle and during sexual puerperium, in the diagnosis of early-estate, and the like.

Vaginal (cervical) secretions

Next method of detection of estrus is the measurement of resistance of vaginal or cervical secretions. Most of the hormonal changes directly affect the electrical resistance of vaginal mucus during oestrus. The lowest level of vaginal mucus resistance is 25 hours before ovulation (Boyd, 1984). Vaginal mucus resistance is a parameter well suited for oestrus detection (Eradus *et al.,* 1992) because it indicates strong correlation with the whole oestrus cycle (Boyd, 1984). Leidl and Stolla (1976) stated, that the intravaginal measurement of vaginal resistance and the cervical secretions looks like a useful tool to determine oestrus objectively. The authors reached pregnancy of 82% in 874 dairy cows that were inseminated by the application of a vaginal probe and detection of resistance mucus below 30 ohms. On contrary Brehme *et al.* (2001) and Brehme a Brush (2002) found this device unsatisfactory. Practical application is complicated because of difficult, time-consuming manual measurements with the risk of inflammation (Roth *et al.*, 1987; Eradus *et al.*, 1992). Further reasons for the reduction of electrical resistance measurements are cysts or ulcerous inflammations (Boyd, 1984).

Vasectomised bulls

Active detector or vasectomised teaser bulls are useful for identification cows either coming into or in oestrus. A lot of herds managers are now finding

that teaser bulls are particularly useful after the first 3 weeks of the breeding season when the level of heat-related activity in the herd is reduced and when fewer cows are in heat each day as more cows become pregnant. Among bulls exist considerable variation in libido and they request the same breeding conditions as normal bulls. Normal time for vasectomy of bulls is carried out 40–60 days before to introduction their to the herds. An alternative to vasectomised bulls on can be useful to use a treatment with testosterone or estradiol in cows or heifers (Diskin and Sreenan, 2000).

Locomotion activity during estrus

The most typical sign for an oestrus is the toleration reflex. Brehme *et al.* (2008) reported that the period of time between first and last on-jump is on an average of 7.1 hours. During this time period on an average 8.5 on-jumps in duration of about 4 seconds are tolerated.

The altered behavior patterns of cows during estrus indicate an increased physiological activity as an expression of searching for a compatible mating partner (Kerbrat and Disenhaus, 2004). The movement activity increased and an amplified restlessness resulting from period of estrus are the essential symptoms of the mating season. The average activity rising at the time of the mating season varies from 30 to 93% (Kiddy, 1977; Eradus *et al.*, 1992; Kerbrat and Diesenhaus, 2004).

Heat mount detectors

As the primary and most obvious sign of heat is standing to be mounted. A lot of research laboratories and centers tried to develop pressure sensitive devices that measure standing (mounting) activity. These devices are mostly connected on the top of tail part of the cows and if pressure is applied by the weight of the mounting animal the indicators as intensity or color of the device is changed. The system mingles the location of a pressure sensitive battery powered transmitter on the cows tail head. The device is activated by mounting cow and emits a radio signal which is picked up by either a repeater or receiver and relayed to a personal computer where the information is stored and digitized for use. The time, date and duration of each mount along with the identity of each cows is recorded. From this data the exact time of heat onset is calculated (Diskin and Sreenan, 2000).

HeatWatch is another small device which use digital radio transmitters incorporating a pressure switch which are glued on the tailheads of cows. These transmitters continuously monitor all mounting activity of cattle and transmit the mounting data to computer where advanced software algorithms examine the mounting profile of each animal. The software is looking for mounting criteria known to be indicative of true oestrus (HeatWatch, 1992).

ShowHeat is also a simple but effective mount monitor. The device has only a single light that is activated when the cow receives at least three mounts. The number of light flashes in a can be counted to calculate when the onset of estrus occurred and insemination can be performed accordingly. The light will continue to flash for up to 18 hours after the onset of heat. Rorie *et al.* (2002) stated, that there mount monitors were found to be equally effective in detecting estrus.

According to Stevenson and Phatak (1999) the efficiency of heat detection using these heat mount detectors vary from 56 to 94%. Also the accuracy of estrus detection vary from 36 to 80%.

Pedometers

It is widely known fact that cows in oestrus increase their physical activity rapidly. Kiddy (1977) reported that the number of steps taken by cow per hour in estrus is about two or four times higher like in diestrus. The increased activity of cows can be measured by a pedometer, an special electronic device attached to the animal's neck or leg (Lehrer *et al.*, 1992).

This technology is used very frequently, nowadays. Better improved pedometric technology has now led to improved analytical capabilities and information storage systems which allow the comparison of current and previous physical activity. Integration of internal power supply which operate the electronics, the development of self-contained build pedometers in the milking parlour and information storage in a personal computer are all benefits of this method. Some pedometers have an inbuilt alert system like a bleeper or flashing light which alerts the farmer in case of heat detection (Diskin and Sreenan, 2000).

Special type of pedometer called ALT can measure three parameters (activity, lying time, and temperature) in same time. A real-timewatch and a changeable measuring time interval was also developed. The measured parameters like activity and lying time comparison allow a statement to be made very early and safely which allow us to determine animal illnesses and the time of the oestrus cycle (Brehme *et al.*, 2008).

The ALPRO system uses a radio link to collect the activity information once an hour (DeLaval, 2001a). To have as much as possible heat indications, the ALPRO system provides the herd manager data about the activity, expected heat date, individual feed consumption, individual milk yield development (DeLaval, 2001b). The comparison of these two systems is reported in Brehme *et al.* (2008).

Combined with other methods, using a pedometer accompanied with constant scrutiny can lead to accuracy of estrus detection close to 100% (Lehrer *et al.*, 1992).

Accelometers

Accelerometers are devices used in activity monitors. This type of monitoring was first developed for the military, automobile industries or aerospace. Accelerometers have the capacity

to detect motion in all 3 spatial planes. Increase in physical activity of the cow provided 70 to 80% accuracy of detected estrus (Roelofs *et al*., 2010). Cows housed in freestalls were approximately 2.75 times more active during estrus like in diestrus; therefore relatively little within-cow variation in activity occurred from day to day when cows were not in estrus. So, activity monitors may be acceptable predictors of sexual and other behaviors associated with estrus (López-Gatius *et al*., 2005; Roelofs *et al*., 2005).

The Heatime system consists of animal tags, a small control terminal and an identification transceiver. The animal tags monitor individual cow activity levels and 24 hour cumulated activity. Every animal movement and movement intensity is provided using a three-dimensional accelerometer. The result is a dimensionless activity index that is stored in twelve 2-hour memory cells (SCR, 2011).

Feeding and rumination time

Oestrus induces by the alterations in feeding and rumination. The effects of estrus on feeding behavior vary in different studies, for example Maltz *et al.* (1997) and Reith *et al.* (2014) described a decrease in daily matter intake (DMI), Lukas *et al.* (2008) observed an increased in DMI during estrus, and de Silva *et al.* (1981) found no effect on DMI.

The cows produces specific sounds during chewing what is recorded by the acoustic sensor (Burfeind *et al*., 2011). The system evaluates this type of chewing and is able to separate it from other sounds related to food fed and intake (Adin *et al*., 2009). Schirmann *et al.* (2009) confirmed the accuracy of recording sounds of this system of recorded chewing for the purpose of monitoring the survival of dairy cows, which is benefital for research, but also for commercial applications.

For the automatic sensor-based detection of rumination time, the Heatime RuminAct-Tag can be used. This tag is placed on left side of each cow's neck. For a RT records data in blocks of 2 hours was used a microphone enclosed within a plastic. The output data consist, chewing rhythm, from cow RT and the interval between feed boluses (SCR, 2011). The data are analyzed by algorithms inside of the tag. The newest measured data are automatically compared with the stored pattern micro-processor. HR-Tags are storing data of RT regularly like average every from 2–h intervals up to 24 h. Based on the validation study's by Schirmann *et al.* (2009), Burfeind *et al.* (2011) and other, the HR-Tag works accurately for recording RT in dairy cows.

The CowManager SensOor, other system for RT recording, is located in the left ear, based on the fundamentals a 3-axis accelerometer to classify each minute into 1 of 6 behaviors like are rumination, feeding, low activity, regular activity, high activity or resting, and reported hourly percentage of time associated with each behavior. Additionally, the CowManager SensOor used a digital surface temperature monitor to evaluate mean hourly ear surface temperature. The behavioral portion of the CowManager SensOor, but not the temperature monitor, was previously validated by Bikker *et al.* (2014) in dairy cows.

Both mentioned sensor techniques measure the decreasing rumination time during estrus compared with nonestrus in study published by Dolecheck *et al.* (2015). The percent change in rumination time between nonestrus and estrus for the CowManager SensOor and the HR Tag were –43.8 and –37.9%, respectively. Reith and Hoy (2012) evaluated 265 estrus events, finding that rumination on the day of estrus decreased 17% (74 min), but with large variation between herds (14 to 24%). In a follow-up study that looked at 453 estrous cycles, rumination time decreased 19.6% (83 min) on the day of estrus (Reith *et al*., 2014). Pahl *et al.* (2015) also found a decrease in rumination on the day of (19.3%) and the day before (19.8%) inseminations leading to pregnancy.

CONCLUSIONS

The low level of mating season detection is a relatively serious problem that significantly reduces reproductive performance of breeding ones and thus the usefulness and overall efficiency of breeding establishments for milk production. Uncaptured right mating season has resulted in significant economic losses. An interim extension of the dairy cows is not used at the potential for milk production and calves, which makes increasing the cost of breeding. For these reasons, it is necessary on the basis of knowledge of reproductive physiology refine the search of the mating season in cows. The visual search is the oldest search method of the mating season, but it does require quite a lot of time and a high degree of practical experience workers. At present, however, since many breeders who have invested funds in modern technologies for automated searching mating season that allow relatively high reliability of detecting oestrus and determine the optimal time of insemination pregnancy rates increase the rate of breeding ones in the herd.

The electronic identification of the animals and technology systems that allow identifying oestrus breeding ones is a key technology for progressive automation in modern livestock farms. In addition, they are essential in order to properly and objectively ensure the smooth running of farms,

identification of animals easier to quickly and safely identify animal diseases, normal sexual cycle, quiet oestrus or stress in animals.

Acknowledgements

The article was supported by the project VEGA [1/0724/16].

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