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Advanced Heat Detection Aids and Its Applications in Dairy Farm

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Abstract: The heat detection is the key issue to be considered on priority basis. Inadequate heat detection is one of the major factor limiting reproductive performances in herds; therefore, it is an area of farm activity where increased effort or investment is likely to be profitable. Proper heat detection to achieve appropriate timing of insemination is the biggest restriction in attaining high conception rate in dairy herd. For improving efficiency of heat detection visual observation is best method, if it is done three times a day for at least 30 minutes every time, however heat detection aids, if used in combination give better results. The use of synchronization and heat-detection aids can greatly shorten the time spent in heat detection but will not benefit a non- cycling herd. It is already established that, estrus detection alone contributes considerably to reproductive status of the herd, therefore the need of the our is critical observation of dairy herd to reduce incidence of unnoticed estrus.
Keywords: Heat detection aids, Dairy farm

INTRODUCTION

Management of reproduction is an important economic component in the success of a dairy enterprise. Inadequate heat detection has been identified as a major limit to herd reproductive performance over many years. Each missed heat represents the loss of a complete oestrus cycle of approximately 21 days that in a seasonally calving herd represents 21 days of lost potential production, so each missed heat has a significant financial consequence.

Heat detection is the key in the success of an effective breeding program. This was achieved by close observation, timed A.I. and sound record keeping [1]. As heat detection is labour intensive and time consuming method, its success depends on the abilities, skill, approach and attitude of dairy farm labour. The problem of heat detection is more prevalent in buffaloes. The situation more worsen due to delayed sexual maturity, postpartum involution and silent oestrus. The reproductive efficiency depends on, how soon after calving, the cow come into heat and success of first or subsequent insemination. The goal of a good oestrus detection program is to identify oestrus positively and accurately in all cycling animals and consequently to identify the animals not cycling. The ultimate goal of heat detection is to predict actual time of ovulation. Heat detection efficiency (rate) is the percentage of eligible cows seen or detected in heat. A heat detection rate of 80 to 85 per cent should be attainable.

Estrus

The origin of word estrus is from a Latin adapted Greek word “Oistros”, which means gad fly, sting, frenzy or rage to describe “period of sexual desire in female” [34]. In female cow the estrus behavior comprised of attractiveness, proceptivity and receptivity. Estrus is the period during reproductive cycle when female animals become sexually accessible. During estrus cow show clear cut behavioral signs especially firm footing and allowing herd mate to mount on her, the condition is known as “standing heat”. The duration and intensity of estrus, varies between and within breeds of cattle [3, 4]. Estrus in European breeds of dairy cattle is more intense than beef or zebu cattle. Particular estrus sign like reddening of vulva, mounting on herd mate are well correlated with the ovulation time [5]. If behavior sign are lacking or not prominent it is obvious that estrus may pass unnoticed, condition described as silent heat. Silent heat is a common problem in buffaloes. Generally in buffaloes, estrus commences towards late evening and the peak sexual activity occurs during hours of darkness [33].

Estrous behaviour in cattle

Cow is non seasonal polyestrous animal. The estrous cycle is of, average 21±3 days. The different stages are, pro-estrus (18th to 20th day), estrus (0 day), met-estrus (1st to 5th day) and di-estrus (6th to 17th day of cycle) of estrous cycle.

Three distinct patterns are observed during estrus includes male like mounting, rise in spontaneous activity and mating responses. Receptive animal may

perhaps be identified in herd by sexual attractiveness and receptivity. The female stands immobile for mounting on her, indicates that she is definitely in heat [6]. Pug mark on back and dirt on flank is also a clear cut indication of animal in heat. Hair on tail head is ruffled or missing due to frequent mounting by herd mates. Standing to be mounted is yet the best sign of heat, although it is displayed only in limited cases. Therefore mounting on herd mate is better option [7]. Secondary behavioral sign observed before real "standing heat" includes frequent urination, separation from herd, chin resting, back rubbing, nervousness, restlessness, walking along fences, bawling, aggression, arching of back, loss of appetite and sudden drop in milk production. Other supportive sign include licking, sniffing, head lift up, lip curling and flehman's reaction (up curling of lips by female or male after touching the genitalia of raged animal). Physical sign of estrus include the tumefaction of vulva, reddening of vulva (bright cherry pink color), excess mucus discharge [8] and tone in uterus. Closeness in animals coming into heat usually congregates and form small groups of three to five animals called sexually active group (SAG). It is easy to detect heat if sexually active group exist in herd. The period of receptivity lasts for 18-24 hrs. A bloody discharge at cessation of behavioral estrus usually indicates a missed heat. A careful monitoring required for such animal with bloody discharge for returning to heat [9].

The sign of heat is clear cut and prominent when activities like milking and feeding are minimal, i.e. heat detection should be avoided at milking and feeding time. Failure to watch critically for long time is most common cause of poor heat detection. During copulation the female may display postural alteration to facilitate mating, called sexual presentation. The cow may exhibit an orgasm like reaction, since some females maintains a typical posture for several seconds after copulation. At the time of ejaculation the electrical resistance of skin dropped suddenly.

Estrous behaviour in buffalo:

Buffaloes are shy or poor breeder. They are seasonally poly estrous; the estrous behaviors are shown during September to January, with a peak during October to November. The onset of the breeding season is associated with a higher intake of energy and a lower intake of protein. Low blood glucose level with high serum urea concentration in summer, associated with sub fertility. Behavioral sign in buffaloes are less obvious than those in cattle; therefore less than one third of buffaloes in heat might be detected by homosexual behavior [10]. Unlike cattle obvious and raged sign in buffaloes are not pronounced. Hetero sexual behavior, particularly standing to be mounted by a bull, is most reliable sign of estrus in buffaloes, where as homosexual behavior observed only occasionally. Sign such as swelling of vulva, clear transparent mucus discharge, spontaneous milk letdown, bellowing, restlessness [11], frequent urination and raised tail vary in intensity from animal to animal, and in relation to standing estrus. Generally in buffaloes, estrus commences towards late evening and the peak sexual activity occurs during hours of darkness. The cases of silent estrus higher in herd using A.I. rather adopting natural service and this may often indicate that the problem may lie with the heat detection rather than animal itself. Copulation in buffaloes lasts for 20-30 seconds. Bio-stimulation favors behavior sign of estrus clearly.

Protocol for successful heat detection: [9]

- Tracking of individual animal throughout their life using permanent numbering system.
- A sound record keeping system should be supplemented with frequent information updates.
- Standard operating procedure (SOP) should be established. Punctual staff should be selected for the heat detection program and recording information like animal identification, time of onset of heat with respect to different sign and estimating ovulation time.
- Morning hours are crucial for heat detection as heat detection rate were higher during morning hours [12]. Cow in heat is the first cow to rise in morning in herd.
- Any interruption to cattle such as feeding or milking should be avoided during monitoring.
- Special surveillance required for detecting animal grouping activity i.e., SAG. Cattle approaching heat usually congregate together.
- Duration of heat may change with respect floor surface, as activity rises 3-15 times greater on soil surface than on concrete. There is sudden drop in mounting activity on slippery surface.
- Heat detection aids should be used wisely and efficiently. Heat detector should be used only as a supplement to visual observation rather replacement.
- The herd may synchronize with hormones or its combination to increase the probability of detecting estrus at appropriate time.
- To catch every in heat a balance programme should be formulated keeping in view that animal return to estrus 18-24 days later.
- Hoof problems and sore feet should be treated immediately as lame cattle will not mount or permit to ride on, which decreases the chances of detecting animal in heat.
- Standard protocol should be followed and all activities are documented.

HEAT DETECTION AIDS

Different signs are studied carefully for detection of heat. Heat detection aids are very important tools for efficient reproductive management if used in combination with expert eye. Cows with detector (KaMaR) plus CHALK marking on tail were more

efficient than detector alone. Visual observation with tail paint is 98 % efficient as compared to heat watch alone i.e. 91 %.

- **Vaginal pH:**
  pH is good indicator of animal in estrus. The pH falls from 7.0 to 6.72 one day before estrus which further fall to a level of 6.45 immediately before ovulation.

- **Measurement of vaginal conductivity using probe:**
  Vaginal resistance varies with stage of cycle. The decrease in electrical resistance or rise in conductivity of the vaginal tissues and discharges during estrus were well reported. Vaginal probe approach also includes intra-vaginal or implantable resistance devices with transponder to send the information directly to computer. Measurement of vaginal conductivity require repeated insertion and repeated measurement can produces inflammation which may affects the reading. Vaginal resistance can vary with site of probe in animal i.e., measurement of resistance in posterior vagina is less reliable than anterior vagina.

Fig.1: Vaginal Conductivity Measurement

- **Fern pattern of cervical mucus discharge:**
  The cervical mucus is collected from cow suspected of heat; it is smeared on slide and dried naturally in air. If fern pattern appears in slide in microscope indicates animal in estrus. This pattern appears 84 hours before estrus and starts declining before ovulation [14]. If fern pattern show more branching, it shows appropriate time for insemination. Viscosity of mucus decreases at the time of estrus i.e., it become very thin liquid.

- **Endometrial biopsy**:
  It shows rise in phosphate activity around estrus.

- **Cervical mucus glucose content:**
  The glucose test is more positive on day of estrus than on the other day.

- **Uterine tone:**
  The maximum tone in uterine horn remains on day of estrus. The conception was directly proportional to the degree of tonicity of uterus [11]. Yet it is one of the most reliable indications, although it requires expert hand for the purpose.

- **Change in parlor behavior:**
  Cow in estrus may be less regular in parlor behavior like entry habits, restless in milking chute, kicking during teat cup fitting and milk yield drop. It requires careful observation and more practical experience with cow in parlor.

- **Milk yield fluctuation:**
  Sudden drop in milk (75% of its usual yield) on estrus followed by recovery at next milking is good indication of estrus. Such drop in milk is due to concentration of estradiol in blood. So far it is good indicator but it requires milk yield recording.

- **Temperature measurement:**
  The temperature of skin, deep body, vagina and milk is measured as means of detecting estrus in cattle. Radio telemetry based vaginal temperature measurement was also used with reliable result. The ruminal temperature also raised during time of estrus measured by sensor based intra ruminal electronic radio-telemetric bolus [15]. On the other hand estrus detection rates by temperature monitoring rarely exceed 70-80 percent.

- **Heat expectancy charts:**
  This simple management aids allow heat to be recorded and the time of next heat to be predicted so that cow can be viewed more closely at the time of the next expected heat. Both manual and computer based system are developed which assist in easy detection of heat [16].

- **Tail painting:**
  Tail painting/chalking is easy method of heat detection; it is commonly used in combination with visual observation. Fluorescent paint provision of electric lamp. The result is not good in buffaloes due to wallowing activity and false positive reading can occur if smearing occurs from false contact with low tree branches or from lying in free stalls. A detection rate of 94 percent was shown to be possible.

- **Use of Androgenized cow**:
  This cow is just like male for estrus detection. The chin ball device may be fitted on the cow [17]. Such system would be cheap as well as there would be little risk of introducing venereal

disease in herd. The efficiency varies from 39 to 74 percent.

- **Chin ball device:**

The device placed under the chin of the bull, causes paint to be smeared on back of the cow if mounting takes place. It works on the principle of "ball point pen" i.e., if chin is pressed on rump it will mark animal in estrus. A buffalo bull fitted with chin ball detects heat efficiently if used at least twice daily. The efficiency of estrus detection is around 50 percent if used once daily.

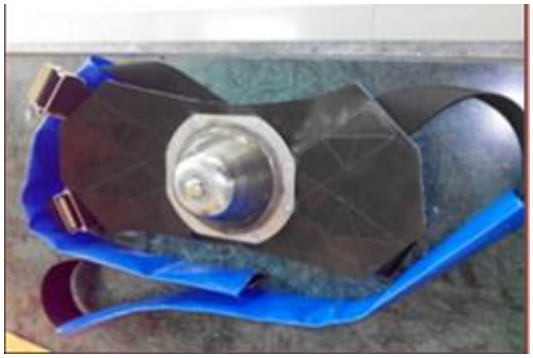

Fig.2: Chin Ball Device

- **Use of marker animals and bull parading:**

Teaser animals are used for heat detection, especially in close housing system. Marking device such as chin ball may be fitted to teaser bull for proficient heat detection.

- **Gomer bull:** The bulls are altered, so that they cannot make sexual contact with female. If the bull mounts, it shows that the female must be in heat.

- **Bio-stimulation:**

Presence of male in the vicinity of the females, will improve expression of estrus to be detected. It is used commonly as curative measure for silent heat problems especially in buffalo.

- **Pressure sensitive KaMaR or BeaCon heat detector:**

It is fitted on sacrum of cow. It shows good result in cattle, Moreover in buffaloes the method is not satisfactory. Wallowing might interferes with the efficiency of heat detection in buffaloes [2]. Such detectors were significantly more efficient than chin- ball-harnessed steers. The mistake can be made with these aids if they are not utilized in conjunction with heat detection records and good judgment. Proper fixation is also important to avoid loss of device. The efficiency is 80-90 percent.

Fig. 3: KaMaR heat detector

- **Electronic heat mount detector:**

Electronic heat mount detector also known as heat watch system, is a radio-telemetric system that sense the mounting activity. The data recoded is transmitted to a receiver then recorded by computer for subsequent retrieval [18]. A cow declared to be in heat if she shows mounting 3 times within 4 hours. Asimilar instrument the "mount count" is pressure sensitive estrous detector glued at sacral area of cow. The mount count signals through LED lamp which gives exact time of mounting. The efficiency of this system is around 91 percent.

- **Heat patch with visible colour change:**

The heat patch applied on tail head with fixing device, after mounting the colour of dye changes.

- **Pedometer and activity meters:**

The cows in heat are more mobile and walk two to four times as compared to non-estrous animals. Activity meters used at the neck or a leg of cow and they may be read by receiver and pass on to computer for retrieval. Some pedometer emits signal in form of light when cows showed increased activity. Careful observation required to remove high false positive reading. Data of cow activity recoded with the help of pedometer has good correlation with estrus [19]. ALT (activity, lying time and temperature) pedometer is a real time watch used for measuring time interval for activity rise [20]. The lack of acceptance has been due to initial cost and expense of replacing lost device. Efficiency of heat detection is 90 to 96 percent.

Fig. 4: Pedometer and activity Meters

- **Video camera and recording using CCTV:**

This system of recording is unique for round the clock observation and data recording of herd. Using time- lapse and fast play back, the estrous activity of the night can be viewed in half an hour. It is applicable in intensive system of housing (close housing), however the range of camera may either miss cows because they are not within view of the camera. This method may not applied in loose house and range system.

Fig. 5: CCTV Camera

- **Electronic odour detector:**

Principle of the device is based on detection of pheromones related to heat. The pheromones are the natural olfactory signal for bull that cow is in heat. Trained dogs were having the ability to detect estrus odour correctly in approximately 80 percent of estrus cow. Dog can detect estrus by urine and milk, after being trained with vaginal fluid samples [21]. The odour is not emitted by vaginal mucus or urine was also reported.

The BOVINOSE (pheromone based sensor system) for estrus detection. It is based on the principle of detection of sex pheromones that are secreted by the cows, exclusively during estrus. Sex-pheromones are associated with estrus [22]. The pheromones are actually released by the dung of cow in estrus. Pheromones are volatile fatty acids i.e., Acetic acid (AA), Propionic acid (PA) and 1- iodo undecane [23]. The synthetic compounds (volatile fatty acids) were rubbed on to dummy cows, and bulls has shown similar response, however only two volatile chemical i.e., AA and PAisolated later in faeces estrous cow [22]. It is up to 90 percent efficient. Still the project is running in future if successful, further development steps are anticipated.

- **Milk progesterone Detection:**

Cattle and buffalo can be bred on the day of lowest progesterone (P_4) to achieve adequate fertility [24]. The C.L. (corpus luteum) on ovary is source of P_4 in milk. As the C.L. lacks the enzymes to convert P_4 into other steroids. -++++Therefore it diffuses to the plasma and milk. The P4 level in milk is four to five times higher than in plasma. Yet it is not a practical procedure for large numbers of cows if it is conducted manually. This may offers a potential future method of estrus detection using automatic Kit based system. Developing a programmed/automatic biosensor that includes the ELISA as transduction mechanism. So far it involve a high cost, but this system capable of checking progesterone at every milking, could be extremely valuable for progesterone profiling as well as estrus detection in cows or buffaloes.

- **Infra red spectroscopy and magnetic resonance spectra:**

Infrared spectroscopy and nuclear magnetic resonance spectra are carried out to detect estrus related change (inflammatory reaction) in vaginal mucus, vulva and vestibule.

- **Synchronization of estrus:**

It is one of the important methods for easy detection of heat and timed A.I. Synchronization of heat is a process by which group of animal are managed in such a way that they will come in heat on same day. As estrus is controlled and harmonized on a particular day. Different protocols are used for estrus synchronization like ovsynch [25, 26], pre synch, co-synch, select synch, double synch and heat synch [27, 28] in both cattle and buffaloes. By manipulating the level of endogenous estrogen pre- ovulatory estrus behavior expressed optimally. Use of estradiol benzoate with or without inclusion of equine chorionic gonadotropin in cow [29]. This method is highly efficient for both cyclic and non cyclic animals; however it require expert supervision for good result.

- **Laparoscopic technique:**

It is used for study genital organs in general and ovary in particular. Although the technique used for heat detection timely and accurately, it is not economical to be used by farmers in field condition.

- **Use of ultra-sonography for monitoring of ovarian status:**

Monitoring the ovarian function with the help of ultrasound in bovine has improved the knowledge and understanding of follicular dynamics and number of developing follicles. Ultrasongraphy can also be used to detect ovulation time with respect to different sign of heat [5]. An-ovulation is also diagnosed by ultrasonography [13]. Measurement of endometrial thickness before and during estrus indicates conception and fertility status [30]. Ultrasonography accurately guides the estrus detection and ovulation time in cow but it require expert person to understand the scan image

and instrument needs careful handling and maintenance. The efficiency of ultrasonography is around 85 to 95 percent.

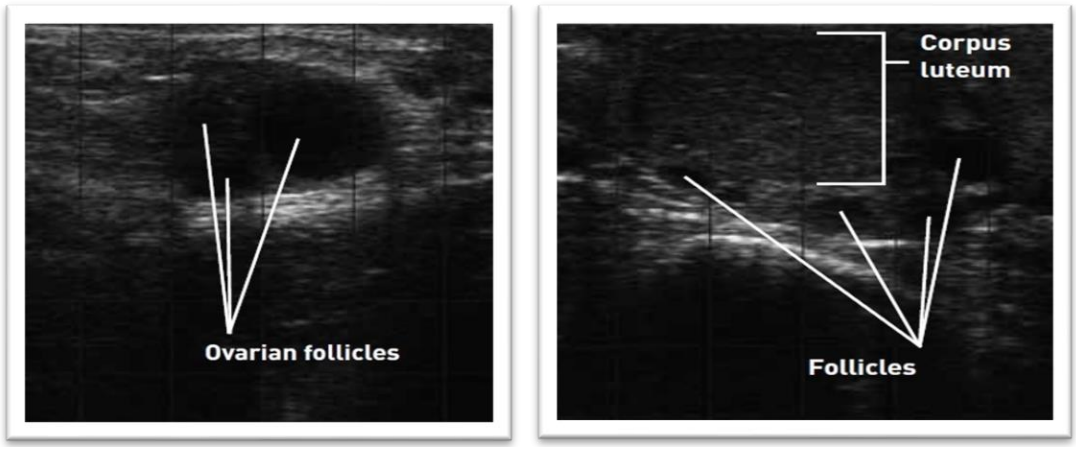

Fig. 6: Ultrasonography of Ovarian structure

- **Improving estrus detection rate using sensor based fuzzy logic system:**

Fuzzy function can be used for automatic detection of estrus using fuzzy logic. For input data the system uses previous estrus cases information with data of pedometer for rise in activities. The outputs were organized in three categories: i.e. "in estrus", "may be in estrus" and "not in estrus". The sensitivity was found around ninety percent [31]. Heat can be detected by vaginal fluids using specific sensor [32]. This method focuses on solving the problems rather than modeling the system mathematically, however it requires a sufficient expert knowledge for formulation of rule base, fuzzification and defuzzification. The sensitivity is found 84.2 percent, indicating that the system may improve automatic estrus detection.

a. **Use of "Nanotechnology" for motion sensing:** Assist in the detection of raised physical activity in cow. The activity data is collected every hour for the cows. The data were analyzed using nanotechnology based intelligence, the software then filters the data against usual activity of herd mate to recognize the cows in estrus and ready to breed. The system is compatible with ear tag identification system, e.g. "Select detect technologies" and "Moo monitor system" device. The message for estrus alert may be received on mobile phone. This method of heat detection is recent updated and advance except the cost of initial investment is high. Accuracy of the system is more than 82 percent.

Advantages of heat detection aid/heat detector:

- ✓ It identifies more cows in heat.
- ✓ Greater accuracy of detection means fewer wasted insemination, saving time and keep away from 21 day of loss in production.
- ✓ The technology is easy to use, cost effective and easy to interpret.
- ✓ It improves the submission rate and more accurate timing of A. I., which ultimately increases the profit.
- ✓ Detector can identifies cows even with short heat and cow that sows sign in night.
- ✓ It also works well for differentiating the stages of estrus like pro-estrus, estrus and return to normal however it works well with visual observation rather alone.

CONCLUSION

The combination of heat detection techniques should be used to increase heat detection efficiency to 100 percent. Cattle come into oestrus at all times of the day, moreover she may not be very active in hot weather and remain in heat for only a short period of time (roughly 12-18 hours), making it difficult to observe. Allowing animal to interact in small group (three to five) with two to three visual observations per day will increase the chances of catching cycling animals. The use of synchronization and heat-detection aids can greatly shorten the time spent in heat detection but will not benefit a non- cycling herd.

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