Box 3523 Burnie
Tasmania 7320 Australia
Telephone + 61 3 6430 4953
Facsimile + 61 3 6430 4959
www.tiar.tas.edu.au

tiar
TASMANIAN INSTITUTE OF AGRICULTURAL RESEARCH

UTAS

Mr Mark Smith
Executive Officer
DairyTas
PO Box 1352
Burnie 7320

22 October 2010

Dear Mark,

This is the final report for the project "Preliminary evaluation of remote-sensing technologies for the detection of oestrus in dairy cows".

This project was completed on 30th September, 2010.

The aim of the project was to highlight the potential for GPS tracking and Proximity logger technologies to cost effectively detect which cows are ready for artificially insemination.

The methodologies and project outcomes are described in detail in the appended publication that was presented at the 10th International Conference on Precision Agriculture, Colorado USA,18th - 21st July 2010 (Appendix 1). Results were also presented at the Australian Society of Animal Production Scientific Conference, Armidale, July 2010. Both papers were presented by the Project leader, Dr David McNeill, and funds to support attendance at the conference were provided by the University of Queensland. Dr McNeill left the position of Research Leader, TIAR Dairy Centre, to take up the position of Senior Lecturer in Animal Health and Production, School of Veterinary Science, University of Queensland, in January 2010.

The targeted and actual outcomes of the project are as follows:

1. **Evidence to support the on-going development of cheaper and more effective Proximity loggers.**

   We concluded that the proximity loggers do have the potential to predict timing of oestrus and so further development of this technology is strongly advised. CSIRO are now proceeding with the development of a proximity logger prototype that is not only cheaper but can communicate wirelessly in real-time back to a base station computer. A priority will also be to develop better ways to screen the raw data collected by the proximity loggers to reduce the number of "false positives" i.e. suggestions by the loggers that oestrus has occurred when it actually has not. The devices proved to be very good at detecting oestrus but for every successful detection there was at least another "detection" that was false. We are confident that it is simply a matter of refining the analytical equations applied to the raw data collected by the devices to reduce the number of false positives and CSIRO will be pursuing further research funding to allow this.

2. TIAR staff trained in the use of GPS and Proximity logger technologies

TIAR Dairy Advisors Mr Mark Freeman and Ms Lesley Irvine were trained in the use of the equipment by CSIRO staff and did all the data collection and collation from the devices and day to day troubleshooting through the course of the project. Dr McNeill conducted final collations, analysis, and interpretation of the data leading to the conference publications mentioned below.

3. Through the current extension mechanisms of TIAR (Tassie Dairy news, Elliott Field days, Dairy Smart Extension project) create producer awareness that such technologies are in development.

Public seminars:

- ABC radio interview live on-farm at the TIAR Dairy Research Facility to launch the project. The interview originally broadcast through ABC Tasmania but went National soon after.(Presenter: D. McNeill)
- Presentation to the Vic DPI Dairy extension and research team and University of Melbourne scientists, Ellinbank, Vic, Dec 2009 to scope opportunities for collaboration.(Presenter: D McNeill).
- Presentation to King Island dairy and beef producers, King Island Research Updates, September 2009 (Presenter: D McNeill and L. Irvine).
- Presentation at the Elliott Open Day, 1st of June 2010 (about 50 farmers present) (Presenter: M. Freeman and L. Irvine).
- Presentation to a group 21 farmers from NSW ACT and northern Vic on the 8th of September 2010. (M. Freeman and L. Irvine).

Scientific papers:

- McNeill, D.M., Bishop-Hurley, G.J., Irvine, L. M., Freeman, M. (2010). Use of Proximity Loggers for the Detection of Oestrus Behaviour in Grazing Dairy Cows. Proceedings of the 28th Biennial Conference, University of New England, Armidale, New South Wales, 11 - 15 July 2010, p 123. (Presenter: D McNeill).

- McNeill, D.M., Bishop-Hurley, G.J., Irvine, L. M., Freeman, M. (2010). A preliminary evaluation of proximity loggers to detect oestrus behaviour in grazing dairy cows. Proceedings of the 10th International Conference on Precision Agriculture, Colorado, 18th - 21st July 2010. (Presenter: D McNeill).

4. A larger research proposal will be developed in collaboration with CSIRO aimed at extending the use GPS and Proximity logger technologies to the integration of wider dairy farm management issues such as improved animal health and welfare, feedbase and supplement utilisation, pasture growth and water use efficiency, and genetic selection

A larger research proposal (Total budget requested, $670,966) entitled "Large herd suppliers support program in Victoria and Tasmania" was written by Dr Marion Titterton (Project Leader) and Dr David McNeill, in collaboration with CSIRO and the Vic DPI. It was submitted to the Gardiner Foundation in March 2010. The remote-sensing component of the trial was part of the stated aim to "To undertake participatory on-farm trials in cutting- edge technology and areas of animal welfare which will improve time and labour saving farm practice and which will reduce issues related to animal welfare". The application was well received but not funded in the first instance. However, the Gardiner Foundation committee was positive about working with the TIAR team to develop and resubmit the proposal for the 2011 round of funding.

Further development of the remote-sensing research direction at TIAR is now in the hands of TIAR Dairy Advisor, Mr Mark Freeman, to whom any further queries regarding this area of research should be directed.

TIAR thanks DairyTas for supporting the current project.

Yours sincerely,

Dr David. M. McNeill
Project Leader

APPENDIX 1. Paper presented at the 10th International Conference - Precision Agriculture - Colorado - 18th - 21st July 2010

A PRELIMINARY EVALUATION OF PROXIMITY LOGGERS TO DETECT OESTRUS BEHAVIOUR IN GRAZING DAIRY COWS

D.M. McNeill

School of Veterinary Science
University of Queensland
Gatton, Queensland, Australia

G.J. Bishop-Hurley

Livestock Systems Group
CSIRO
Pullenvale, Queensland, Australia

L.D. Irvine, and M.J. Freeman

TIAR Dairy Research Facility
University of Tasmania
Burnie, Tasmania, Australia

ABSTRACT

This trial was conducted to determine the potential for using proximity loggers to aid in the detection of oestrus in dairy cows in a pasture-based system. The trial was conducted on a herd of 48 dairy cows over a 90 day period during late spring/summer, 2009. Each cow was fitted with a proximity logger mounted on a neck-collar for the duration of the trial. Tail paint combined with direct observation of cows allowing other cows to mount them (standing heat) was used as the standard method of oestrus detection, to which the proximity data, downloaded periodically throughout the trial, was compared. Increases in proximity, that is, sum of time spent by at least one other herd mate within 4-5 m of the focus cow, that exceeded a set time-threshold for at least two consecutive time periods was used as proximity logger indication of oestrus. Detection rates ranged from 74% to 32% for 15 minutes and 45 minute thresholds, respectively. An optimised detection and error rate, determined by customising the time threshold per cow was estimated at 68% and 51%, respectively. At this preliminary stage of algorithm development, these data are sufficiently encouraging to warrant further investigation into a role for proximity loggers in the detection of oestrus. This further investigation will seek to confirm oestrus detection rates using a more reliable technique to monitor oestrus - changes in milk progesterone concentration rather than tail paint and standing heat, and incorporate a monitoring technique based on real-time delivery of data to allow timely artificial insemination.

Keywords: Remote sensing, Oestrus detection, Mating, Dairy cows

INTRODUCTION

Remote-sensing devices could reduce the cost of labour on dairy farms by removing the need for visual checks on cows during critical periods such as mating. Proximity loggers, if placed on individual cows, record the amount of time that a cow comes, and stays, within a set distance of another cow. Proximity loggers have been used to quantify animal interactions, for example, which cow is the dam of which calf in extensive beef herds (Swain and Bishop-Hurley, 2007). The purpose of this study was to develop a preliminary algorithm to test whether proximity loggers can be similarly effective in the more intensive situation of a pasture-based dairy herd where the behavioural data will be more complex. In this study, the capacity of proximity loggers to detect oestrus in dairy cows was tested by using the proximity loggers to define time-periods where cows stayed close to one another, a behaviour pattern consistent with oestrus, and compared these to a standard technique for oestrus detection – the Tail paint technique combined with visual assessment of standing heat (Firk et al., 2002).

METHOD

The trial was conducted at the TIAR Dairy Research Facility at Elliott in Northwest Tasmania (Lat., -41.082072, Long., 145.779628). A herd of 48 Holstein-Friesian (HF) and HF cross cows were selected from a 300 cow commercial herd of spring-calving cows to reflect the larger herd's age structure. Average age of the cows was 4 years (± 1.8 years) and average days since calved was 40 (± 14.8 days). The cows were managed as one herd from September 22 to December 23, 2009 and, throughout, grazed a fresh area of a predominately perennial ryegrass pasture (12-15 kg DM allocated/cow/day) after each of two daily milkings (6-9am; 3-6pm).

Each cow was fitted with a proximity logger mounted on a neck-collar (Sirtrack Ltd., Havelock North, New Zealand) for the duration of the trial. Pre-mating heat checks began on September 23, a month prior to mating start date. Tail paint was applied to the tail head of each cow to provide the standard for heat detection. Tail paint was checked at each milking and if it had been removed, a record was made of the cow number and the tail head was re-painted. Mating of the cows using artificial insemination (AI) began on October 19. The tail paint was checked at each milking and cows that had paint removed were submitted to AI at the next morning milking, had the tail paint re-applied and were returned to the herd. AI finished on November 27 and a bull was fitted with a proximity logger collar and placed in with the herd to finalise the mating of any cows that did not fall pregnant to AI. Bull matings were recorded where possible. The bull was removed from the herd on December 23 and all proximity logger collars removed.

The proximity loggers recorded a contact each time another proximity logger (attached to a cow) came within a prescribed distance, in this trial 4-5 metres. The logger recorded which other logger had made the encounter, the time at which the encounter was made and the encounter length. This record was made on each of the loggers involved in the encounter. Data from the proximity loggers was downloaded periodically (every 1-2 weeks), during the morning milking. Data from the proximity loggers was collated for each cow and the sum of the encounter length calculated for the relevant periods. In this trial, the periods considered relevant for oestrus detection were the times between milkings with the time spent walking to and from the dairy and during milking being excluded as the cows were in forced proximity. The oestrus detection periods comprised 3 x 6 hour sections of a 24 hour day: 0000 – 0600 hours, 0900 – 1500 hours, and 1800 – 2400 hours. An increase to above 15 minutes in duration of time spent with at least one other cow in the herd for at least two consecutive periods was taken to indicate the cow was in oestrus. These timings were then reconciled against timings of oestrus defined using the tail paint technique. A relevant increase was tested by setting duration of encounter thresholds per 6 hour period of 15, 30 or 45 minutes, or the best one of these three, for each cow, to evaluate the most appropriate threshold to use, that being the threshold which maximises detection rate whilst minimising error rate.

For each cow, Detection Rate was calculated as sum of proximity logger records that exceeded threshold on the date before or on the same day a tail paint record was defined, divided by sum of all tail paint records x 100. For each cow, Error Rate was defined as sum of proximity logger records that exceeded threshold minus sum of proximity logger records that exceeded threshold on the date before or on the day a tail paint record was defined, divided by sum of proximity logger records that exceeded threshold x 100. Three cows were removed from the trial due to constant malfunctions in their proximity loggers and another died from natural causes. Some of the proximity loggers malfunctioned for short periods of time across the study and so tail paint records that occurred during this period of malfunction were excluded from the analysis.

RESULTS

Table 1 shows that as the threshold was increased from 15 to 45 minutes, detection rates more than halved whilst error rates declined by about one third. Varying the threshold per cow indicated a potential for proximity loggers to detect tail paint records at a rate of 68%, with an error rate of 51%.

DISCUSSION

When cows are in or about to come into oestrus they tend to form "mating groups" where they stay in close proximity to each other, spend more time per day walking, and either try to mount other cows in oestrus or stand and let other pre-oestrus cows mount them. Such behaviour commonly extends for 12-16 hours (Firk et al., 2002). This was the behaviour we attempted to infer by a simple monitoring of increases in instances of proximity extending over at least two adjacent 6 hours periods with at least one other cow. Other similar devices, such as meters that monitor sudden and extended increases in general activity, are in commercial use and can detect oestrus at rates in the order of 80%. Compared to

Table 1. Mean sum of tail paint and proximity logger records and mean detection and error rates per cow for tail paint detection by proximity logger records exceeding set or variable time thresholds[1]

Threshold (minutes)	Tail paint records	Proximity logger records exceeding threshold	Tail paint records detected by proximity logger	Detection rate (%)	Error rate (%)
Set					
15	2.4	11.4	1.7	74.0	77.3
30	2.4	3.8	0.9	42.6	60.4
45	2.4	1.8	0.7	32.3	49.9
Variable					
	2.4	6.3	1.5	68.3	51.3

[1]Either the same threshold was applied to all proximity loggers data sets for the entirety of the study or the threshold was varied (set to either 15, 30, or 45 minutes) to optimised the outcome for a given proximity logger in an attempt to define a threshold more relevant to a cow's individuality of behaviour

that, the detection rate of 68% in the current study is encouraging, especially given that the tail paint technique is itself an estimate of oestrus that can vary widely in detection rate (Firk et al., 2002).

Since we are only in the preliminary stages of developing an algorithm for a Proximity logger technique for the detection of oestrus, the data has provided sufficient encouragement for the pursuit of a more elaborate methodology. This could include validation of the proximity logger derived data against a more definitive assessment of oestrus, such as temporal changes in the concentration of milk progesterone. Plans are underway to develop a proximity device that can upload data to the dairy and provide real-time information on whether a cow is ready for AI.

REFERENCES

Firk R., Stamer E., Junge W., and Krieter J. (2002) Automation of oestrus detection in dairy cows: a review. Livest. Prod. Sci. 75, 219–232.

Swain D.L., and Bishop-Hurley G.J. (2007). Using contact logging devices to explore animal affiliations: Quantifying cow-calf interaction. Appl. Anim. Behav. Sci. 102, 1-11.