VIRTUAL HERDING RESEARCH UPDATE

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'Enhancing the profitability and productivity of livestock farming through virtual herding technology' is a four-year project to evaluate the application of virtual herding (VH) technology across different production systems and examine the responses of different livestock (dairy cattle, beef cattle, sheep) to various cues and stimuli to improve productivity and profitability in the livestock industries.

The project

The project received $2.6 million from the Australian Government through its Rural R&D for Profit program. A further $1.365 million has been provided by a number of Rural Research and Development Corporations and R&D providers. The R&D providers include, CSIRO, the University of Sydney, University of New England, the Tasmanian Institute of Agriculture, University of Melbourne and Agersens Pty Ltd, with additional contributions from Dairy Australia, Meat and Livestock Australia, Australian Wool Innovation and Australian Pork Limited.

Using VH, the research team will investigate the potential to constrain animals to certain areas (better grazing management and environmental outcomes), autonomously herd animals, or move individual or groups of animals in a herd differently to the rest of that herd. Fundamental research involving behavioural observations and physiological measurements will be critical to ensure that the technology does not compromise animal welfare.

Introducing project team members – Ms Patricia Colusso

Patricia Colusso grew up on her family's small hobby farm and developed a keen interest and passion for animals, particularly cattle. After completing her Bachelor of Science (in animal science) degree at Western Sydney University in 2014 she pursued a career in a commercial veterinary laboratory, working as a scientist in clinical diagnostics.

Patricia then pursued a more agricultural focused career and completed a Masters of Agriculture and Environment degree at the University of Sydney in 2017. During this time Patricia Colusso joined the Virtual Herding project as a component of her Masters research. She conducted a pilot study with dairy cows using manual VH collars to understand how the group influenced individual learning and response to the technology. This sparked a keen interest in this technology for Patricia, and she commenced her PhD in January 2018 within Sub-program 3: Determining the best sub-herd and individual animal management for dairy and beef production systems, under the supervision of Dr. Sabrina Lomax and Dr. Cameron Clark.

Patricia has developed a strong interest in dairy cattle production systems since her time working with the dairy cattle at the University facility, 'Mayfarm' at Camden and understands the benefits this technology may provide the farmer and for the dairy industry, in general.

Patricia's work during her PhD studies at the University of Sydney aims to look at how we can optimise the virtual herding technology for pasture based dairy systems, with a focus on how individuality, motivations and group dynamics impact on the learning and response to this technology.

Patricia Colusso showing the research prototype of the eShepherd™ automated virtual herding collar to a few of her dairy cow subjects

Landscape of the study where virtual fencing was used to exclude cattle from the riparian zone at Tumbarumba

Update on sub-program activities

Sub-program 1 Optimising the animal responses to virtual herding technology

Dr Dana Campbell, Dr Caroline Lee, and CSIRO lead technician Jim Lea in partnership with Agersens conducted a trial in 2017 using the automated collar of the earlier prototype of the virtual fencing system to assess the application of the technology in excluding cattle from a riparian zone.

This trial was conducted with 11 beef cattle on a commercial property at Tumbarumba in NSW. The animals were initially given free access to an 11.3 hectare land area for 3 weeks. Animals were then excluded from river access for 10 days via a single virtual fence line, before the line was deactivated and animals could have free access once more.

GPS movement patterns showed that the virtual fence line successfully excluded animals from the riparian zone for the majority of the fence activation period (see Figure 1). All audio and electrical stimuli that each animal received were also recorded. Individual animals approached the fence line daily, but there was high variation in how often specific individuals interacted with the virtual fence.

This result is similar to previous studies that also showed large variation in how individual cattle learn and interact with the virtual fence. On average, 87% of the total cues emitted by the collars over the activation period were audio tones, indicating that all cattle were learning to avoid the fence line based on the audio cue alone.

Once the fence line was deactivated, it took approximately 2 hours before animals accessed the previously excluded area. This trial was the first successful commercial application of the technology using early collar prototypes. Full details on the study are available in the open access publication: *Temporary Exclusion of Cattle from a Riparian Zone Using Virtual Fencing Technology*. Animals. 2019 22; 9(1). pii: E5. doi: 10.3390/ani9010005.

Herding trials were also conducted on site in Armidale during 2018 using an updated prototype of the eShepherd™ automated virtual herding system. Different configurations of fences were used to herd groups of 12 animals down the length of a 6 hectare paddock (350 m x 180 m). The results varied depending on the combination of virtual fences used. We concluded that a single back fence is likely to be the most successful method for herding with the current collar software as this does not involve cattle learning a new association between the cues and is comparatively the most simple.
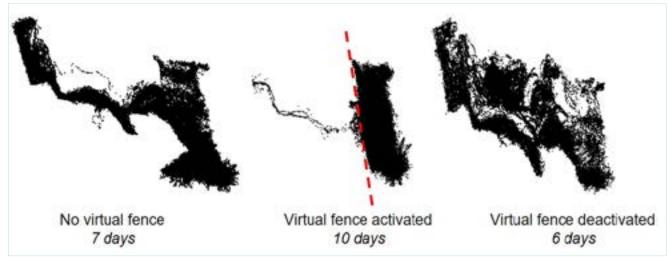

Figure 1 *The GPS locations of all animals in the commercial virtual fencing trial. Images display cattle movement when no virtual fence was present, when a virtual fence was activated (dashed line), and when that virtual fence was subsequently deactivated with days of each period length indicated in italics.*

Successful herding occurred in the animals 'own time' and so the duration of herding varied between 20 minutes and 5 hours for the animals to move from one end to the other end of the 350 m paddock, depending on the behaviour of the group on each testing day.

The eShepherd™ system is under continual updates and improvements which may result in more efficient herding capabilities for moving animals over smaller distances in much shorter time frames. From the results of the present studies, we are unsure how animals may perform if herding was something that happened regularly and they were more accustomed to what was expected of them with the collar signals being 'reminders' rather than something new for the animals to learn.

Cattle moving down the paddock in the herding study at CSIRO facilities at Armidale

Sub-program 2 Determine the best livestock and pasture management for intensive dairy and beef through more controlled pasture allocation

During spring 2018, Adam Langworthy and the Tasmanian Institute of Agriculture Dairy Centre team conducted a world first experiment evaluating the use of an early prototype of the eShepherd™ automated virtual herding system to contain a herd of intensively grazing dairy cows during early-lactation. This experiment is an initial building block for future research investigating the use of eShepherd™ collars to improve pasture utilisation in intensive dairy and beef grazing systems.

Thirty cows were managed as a single herd, milked twice daily, and every 24 hours were moved to a new perennial ryegrass-based rectangular paddock. Each paddock was surrounded by a single-stranded galvanised wire electric fence and split into an inclusion and exclusion zone by a temporary front-fence.
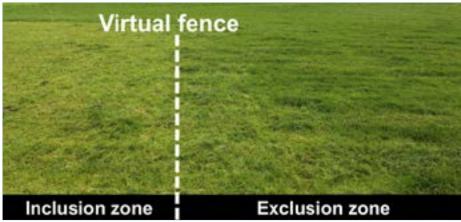
During the first 10 days, the temporary front-fence consisted of a single strand of electrified poly-wire supported by temporary posts. An eShepherd™ temporary front-fence was used during the final 10 days of the experiment. Each cow was allocated 14 kg DM/day of pasture in the inclusion zone and was fed an additional 1.8–2.7 kg/day of concentrate in the dairy.

Preliminary examination of results suggests that the virtual herding eShepherd™ system successfully contained the small herd of intensively grazing early-lactation dairy cows without adversely affecting individual cow production (live weight or milk yield) or key behaviours driving production (i.e. time spent feeding and ruminating).

Cows appeared to quickly adapt to the technology and learnt to respond to the virtual front-fence with cohorts of cows observed to move away from the virtual front-fence upon an individual cow receiving the audio cue. Results also suggest the virtual herding eShepherd™ system did not adversely affect the spatial distribution of pasture consumption by cows within the inclusion zone.

Overview of experimental herd grazing with a virtual temporary front-fence (white line). Image taken from the eShepherd™ user interface. Green circles show individual cows

Paddock after 24 hours of grazing. Pasture in the inclusion zone was depleted from 2810 to 1856 kg DM/ha while minimal grazing occurred within the exclusion zone

Latest news

- The purchase and successful installation of an early prototype of the Shepherd collars at Armidale, Camden and Elliot has enabled animal studies to be conducted in the last part of 2018. The results of these studies have shown that the eShepherd technology can constrain cattle within the 'inclusion zone' as well as herd cattle. Factors such as the effect of groups/individuals and feed motivation doesn't seem to significantly affect the response of cattle to the VH technology.

- Members of the Project team have continued to present results of the DAWR project and discuss the implications of virtual herding technology with livestock producers and advisors through several industry presentations, including sheep producer meetings in WA, SA and NSW and Livestock advisors and consultants in SA. In addition, the Project team have been encouraged to target industry symposium and conferences (as well as scientific journal publications) to present their more recent work with the eShepherd collars.

- Nikki Reichelt from The University of Melbourne, has begun to engage with the retail supermarket sector to discuss what it will mean to this sector of the supply chain if farmers adopt and integrate the VH technology into their farming businesses.

- Agersens and CSIRO have signed a Collaboration Agreement to build on their existing relationship as they develop and commercialise livestock technologies made possible by eShepherd. The eShepherd system uses a GPS-enabled, solar-powered smart collar. It contains a CSIRO developed algorithm to train cattle to stay within the virtual boundary when they hear an audio cue from the collar. The technology was patented by CSIRO and is licensed exclusively to Agersens worldwide.

- Both the South Australian and Victorian Governments have recently granted exemption for the use of the Virtual Herding technology under experimental conditions. Already the technology can be used for commercial purposes in Queensland and Tasmania.

- The fifth of a series of webinars was presented by Nikki Reichelt on 20th February. If people couldn't log into this webinar, they can access it by contacting Ray King.

- The sixth Milestone Report for the project was submitted to the Department of Agriculture and Water Resources in December, 2018. This Report has been accepted as has a 6 month extension of the Project until November, 2020.

FOR FURTHER INFORMATION

The website for this project has been established on the Dairy Australia website. The site contains information about project activities and recent news about the project, including copies of a number of presentations that members of the Project Team have made to industry over the past few months.

Agersens also have a website where you can keep up-to-date with the progress of commercialisation of this exciting technology.

KEY CONTACTS

Dr Ray King – Project Manager
r.h.king@bigpond.net.au or 0412 322 047

Cathy Phelps – Dairy Australia
cphelps@dairyaustralia.com.au or 0439 555 001