Virtual fencing for better crop integrated weed management

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Key messages

- Virtual fencing technology is approaching commercial availability in Australia for use with cattle and opportunities for benefits to crop-livestock systems have been successfully demonstrated using on-farm trials.
- The project demonstrated successful virtual fencing application and potential directions in virtual fencing developments relevant to mixed farms in seven different trials involving e-shepherd devices for cattle and research trial prototypes for sheep.
- The results of trials with cattle highlighted the strong potential for virtual fencing application for purposeful grazing of actively managed targeted zones within crop-livestock paddocks for cropping system benefits, including targeted heavier grazing of weed or frosted areas, spatial biomass and groundcover management when grazing dual purpose crops in paddocks with variable soils, minimising grazing pressure on potentially erodible light soil areas or areas with poor establishment.
- For virtual fencing to have the greatest benefit to mixed farming in Australia it needs to be available for use on sheep. Trials conducted involving sheep demonstrated that sheep have a virtual fencing learning ability similar to cattle and the potential for ear and, for sheep without growing wool, neck delivery.

Background

Virtual fencing technology has the ability to contain livestock within a boundary through the implementation of a warning cue (audio tone) when animals approach the virtual fence, supported by an aversive stimulus (electrical) used to train animals to respond to the warning cue. Through associative learning animals quickly learn to avoid the virtual fence by responding to the audio warning alone.

Prior to this project starting in 2019-20, virtual fencing research trials had not been conducted on southern Australian mixed farms with the exception of small trials limited to less than 10 animals, very small paddock sizes and durations of no more than a week. This was due to the need for 'manual' implementation using research-only devices designed for dogs because of the unavailability of GPS-based virtual fencing. However, the potential benefits of virtual fencing to crop-livestock systems was becoming increasingly apparent to growers. This included the potential for applications of virtual fencing to better manage grazing pressure on mixed farms with typically large and variable paddocks used for cropping. Benefits of such applications include the potential to not only improve grazing efficiency and groundcover management but to achieve improved weed control.

Although still not fully commercially available, GPS-based VF devices were becoming available for on-farm research application with cattle, including e-Shepherd developed in a partnership between Agersens (now Gallagher) and CSIRO. These automated devices enabled cattle trials to take place in larger crop paddocks, over durations where larger animal numbers and more intensive grazing management at the paddock scale could be used.

The advances also made it possible to test the potential of automated GPS VF trials using adapted devices with sheep during the life of the project. Sheep are the most common livestock on southern mixed farms. The project introduced the opportunity for the first cattle and sheep trials of their kind using virtual fencing in southern mixed farming systems.

Aims

The project aimed to successfully apply virtual fencing technology in pasture, summer fallow or in-crop, for the benefit of crop, environmental and weed management. The work contributed to the long-term goal of on-farm application of virtual fencing with sheep. It has previously been identified that a collar is not likely to be feasible for use on wool sheep due to the insulating

property of wool and its rate of growth. In addition to testing mixed farm applications with cattle, supported by availability of the e-Shepherd devices, the project aimed to pursue two potential forms of delivery and development for sheep to enable on-farm trialing. This included ear tag and collar-based delivery. The latter is more likely to be suited to non-wool sheep and given the increasing use on non-wool/ shedding sheep in mixed farming regions this became a focus towards the end of the project.

Objectives

The project had the objective of developing and demonstrating application of virtual fencing with cattle using near-commercial devices on crop-livestock farms and furthered the potential for sheep VF development. By doing so the potential efficacy and feasibility of applying virtual fencing for crop integrated weed management on mixed farms was to be identified. The longer-term objective was to contribute to future commercial use of spatial grazing through virtual fencing technology for improved weed management on Australian mixed farms.

Methodology

The project objectives were successfully achieved through the conduct of a series of on-farm cattle and sheep trials conducted by CSIRO teams based on SA, NSW and the Agersens/Gallagher technical team. Testing, development and initial trialing of new apparatus was conducted at the CSIRO Chiswick farm where animal ethics requirement could be guaranteed for this initial sensitive work. All other trials were conducted on commercial farms. The trials conducted were:

1. On-farm trial of application of VF-enabled strip grazing for weed control (November 2020, Long Plains SA, 18 days, 40 cattle/ 20 VF).
2. On-farm trial of VF-enabled grazing of a sub-paddock zone with frost risk and high weed load in a near-mature grain crop (October 2021, Pinnaroo SA, 13 days, 40 with activated e-Shepherd Cattle)
3. On-farm trial of VF-enabled grazing of a dual-purpose cereal crop in a paddock with erosion-prone areas (July 2022, Pinnaroo SA, 60 cattle/35 with activated e-Shepherd (postponed from original covid-affected 2021 date))

4. Testing with individual animals and adaptation of ear tag delivery determining optimal stimulus and mechanism for trial application using enduro tag delivery (February 2021, Chiswick, 16 sheep, manual Garmin).
5. Paddock trial of ear-tag delivered virtual fencing using straight-line virtual fence to create exclusion zone (March 2021, Chiswick, 12 sheep (2 groups x 6 x 3 days, manual Garmin).
6. Paddock trial following testing with individual animals and adaptation of harness and collar-based probe design for non-wool sheep (Dorpers) (May-July 2022 with 5 day paddock trial, Chiswick, 37 animals, e-Shepherd based with deliver to neckband).

Photo: Sheep with ear tag virtual fencing device applied in the experiment paddock at Chiswick. The sheep on the furthermost left-hand side is at the virtual fence line responded to the audio cue by lifting its head.

7. On-farm trial of automated GPS VF with exclusion zone in a weedy late-season paddock using 10 Ultra White shedding sheep (October 2022, Lameroo SA, 10 sheep, 5 day trial, e-Shepherd delivery to collars)

Results summary

- Using early versions of the e-shepherd virtual fencing devices virtual fencing was used to successfully apply strip-grazing for increased grazing pressure on a vetch paddock with maturing ryegrass, reducing weed seed production compared to an open-grazed paddock area.
- In the Long Plains trial, weed damage due to grazing was significantly higher where strip grazing using virtual fencing was applied over 18 days, with ryegrass seed head density reduced by over 50% compared to an open grazed paddock.

Photo: Trial layout at Long Plains showing cattle locations before shift into 3rd virtually fenced sub-paddock (south), ungrazed buffer zone (middle) and open grazed area (north). Nb some GPS drift evident in location points outside of fencelines as well as some cattle spending time ahead of virtual fence during learning period of new fence location.

- Trials at Pinnaroo demonstrated the ability to implement virtual back fencing with use of mobile water-points and '3-sided' virtual fence designs within a large cropping paddock to graze frost and weed affected areas of a grain crop in spring.

Photo: Animals grazing second inclusion zone at Pinnaroo trial after completing grazing of first area. showing curved virtual fence lines to support animal learning and avoid right angle fence corners when grazing cells within large paddocks. (Photo: GRDC/Anvil Media)

- The potential for virtual fencing application in grazing dual purpose crops was demonstrated by allowing grazing pressure to be actively managed to avoid overgrazing of erosion prone areas of a paddock and manage biomass using multiple multi-directional fence changes.

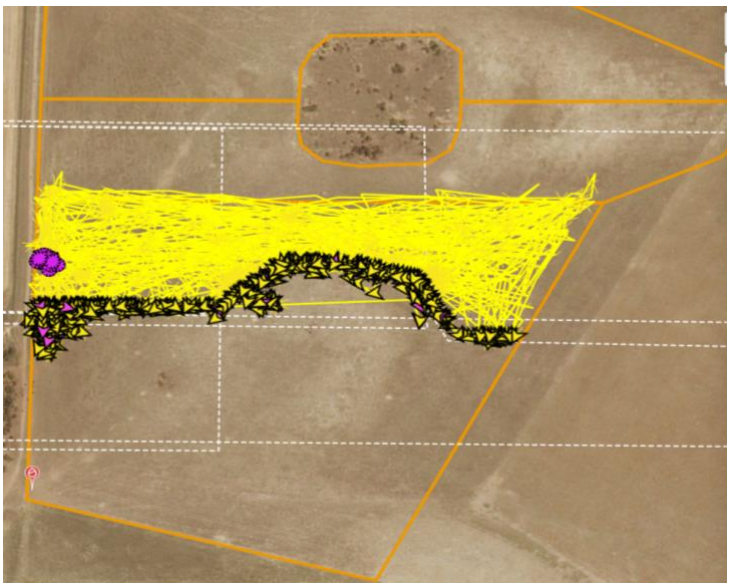

Photo. Pinnaroo trial using virtual fencing to manage grazing pressure on a dual purpose crop paddock showing animal tracking on a grazed section excluding further grazing of a potentially erodible sandy rise.

- While the potential for some individual animals to challenge the virtual fence much more than others was demonstrated in each trial. For the common seasonal grazing applications likely in crop-livestock paddocks where new grazing area is regularly opened up ahead of animals (e.g. strip grazing-type applications) this is likely to be of low consequence (e.g. compared to use of virtual fencing for long-term fixed exclusion or as a substitute for permanent physical fencing).
- The trials were conducted in partnership with Agersens and Gallagher using pre-commercial e-shepherd devices. The trials informed further commercial device development, including the new Gallagher e-shepherd device design expected to be released in 2023-24.
- While further investment into smaller scale, lower weight GPS-based devices is necessary, the short-term trialling using delivery from e-shepherd devices showed how sheep can potentially be managed using virtual fencing audio-electrical stimulus.
- On-farm trials at Chiswick and Lameroo showed the potential for wool (e.g. merino) and non- wool shedding (e.g. Dorper) sheep control and informed the priority technology areas for future development including ear tag and GPS-based algorithm requirements adapted for sheep mob behaviour.

Photo: Non-wool (shedding) sheep trialing collar-delivered virtual fencing GPS-based control at Lameroo.

Conclusions and Practical Implications

- There will be many potential opportunities for mixed farmers with cattle to apply virtual fencing in the near future, with virtual fencing well-suited to the seasonal paddock and sub-paddock scale spatial grazing applications in a crop-livestock system.
- Opportunities include purposeful application to optimise grazing pressure across dual purpose crop paddocks; targeted grazing of frosted/weed affected areas; strip grazing for increased weed control impact; minimising risk of overgrazing on erosion-prone areas of paddocks.
- The ability for sheep to 'learn' and be controlled by virtual fencing was demonstrated in the field trials. The challenge for commercial-scale virtual fencing with sheep is how to successfully deliver the required stimulus on animals smaller than cattle requiring greater device miniaturisation and different delivery modes for animals with growing wool.
- Potential for further development of ear and neck delivery was demonstrated using trials with prototype research devices.
- The increasing importance of non-wool (shedding) sheep in mixed farming regions presents an opportunity for sheep virtual fencing development where growing wool is not necessarily a major barrier to device fitting and stimulus delivery.

References

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