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Section 7

Livestock

Implementing virtual fencing as a tool for excluding sheep from environmentally sensitive areas

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Key messages

- **Virtual fencing is not yet commercialised for sheep in Australia, with further research and development required prior to use on farm.**
- **Virtual fencing can exclude sheep from environmentally sensitive areas within a paddock.**
- **The maximum daily temperature reduces grazing activity and therefore impacts the level of interaction with the virtual fence.**
- **There were no negative production outcomes as a result of virtual fencing.**
- **Collars were an effective method of applying virtual fencing in this scenario, but further investigation is required into the long-term suitability of this method.**

Why do the trial?

Sustainable farming practices are a large part of improving the Australian agricultural industry, with a strong focus on livestock management for increased profitability and sustainability on farm. One issue for producers is accelerated soil erosion due to limited ground cover, which is impacted by livestock grazing and requires specific management. For producers to continue to attain improvements, further solutions are required. One solution is the use of virtual fencing to exclude livestock from environmentally sensitive areas. The technology offers many benefits including managing grazing livestock, specifically the strategic management of livestock location for increased production, profitability and environmental sustainability.

Virtual fencing technology is gaining popularity with both commercial and research activity increasing throughout Australia in recent years. Virtual fencing is a GPS enabled technology that uses cues administered by neckbands to communicate a virtual boundary to livestock. Currently all forms of virtual fencing for livestock are prohibited in South Australia. Virtual fencing for sheep is less developed than cattle, with no commercial activity in sheep currently occurring within Australia. Recent research has used modified cattle devices to determine that smaller mobs of sheep can be contained for shorter durations. However, there is limited research undertaken on virtual fencing being used to effectively exclude sheep from environmentally sensitive areas within a paddock.

This trial aimed to implement virtual fencing with sheep to manage broadacre pastures and stubbles for environmental considerations in South Australia. This would enable further understanding of the success of the technology over large areas and its effectiveness as a landscape conservation tool for sheep producers.

How was it done?

The trial took place in January 2024 at the Minnipa Agricultural Centre, Eyre Peninsula, South Australia. At the beginning of the trial, fifty ewes were drafted off from the commercial flock at the Minnipa Agricultural Centre. They were weighed, condition scored and had modified Vence CattleRider virtual fencing collars fitted. The fitting mechanisms and collar length were adjusted to ensure a comfortable fit on sheep. The size and weight of the hardware and algorithms remained the same. The ewes had approximately three months of wool growth (25 mm) post shearing at the time of the trial.

Prior to implementing virtual fencing in livestock, an appropriate training period needs to take place. This ensures that the animals have the opportunity to learn the association between audio and pulse signals within a controlled environment. At Minnipa, the sheep were trained to the virtual fencing algorithm in a 7.5 ha paddock. The virtual fence was initially activated along the physical fence line of the paddock for three days to allow the sheep to begin interacting. After this, a single virtual fence line was activated across the paddock to exclude the sheep from one half. This occurred for four days with the mob demonstrating adequate learning during this time.

Following the training period, the virtual fence in the trial paddock was activated (Figure 1). This virtual fence was designed to exclude the ewes from a sensitive saline area within this paddock (exclusion zone). Thus, demonstrating the potential of virtual fencing to be adopted for this purpose in the future. The available feed in the paddock consisted of barley stubbles with germination of header losses due to summer rain. The virtual fence was active via the online platform associated with the collars once the sheep had been in the paddock for 24 hours to acclimatise.

The virtual fence remained active for 20 consecutive days. During this time the virtual fencing collars were collecting GPS locations, audio signals received, and pulse signals delivered. This enabled collection of key data to underpin the assessment of this application.

Groundcover assessments were undertaken both within the inclusion zone and exclusion zone at the beginning and end of the trial period. This allowed for capture of changes post grazing in the inclusion area, and to assess if ground cover was maintained in the exclusion zone. This was done visually through estimating the percentage of bare ground within a 0.3 m^2 quadrat.

When the 20-day trial period was complete, the virtual fence was disabled, and the sheep were removed from the paddock. They then had their collars removed and live weight and condition score. The sheep were then returned to the commercial flock at the Minnipa Agricultural Centre.

What happened?

The virtual fencing system successfully excluded the sheep from the protected area within the paddock for the entire trial period (Figure 2). The heat map shows increased grazing pressure towards the southern boundaries of the paddock with significant pressure on the virtual fence. Despite this, the virtual fence was still effective.

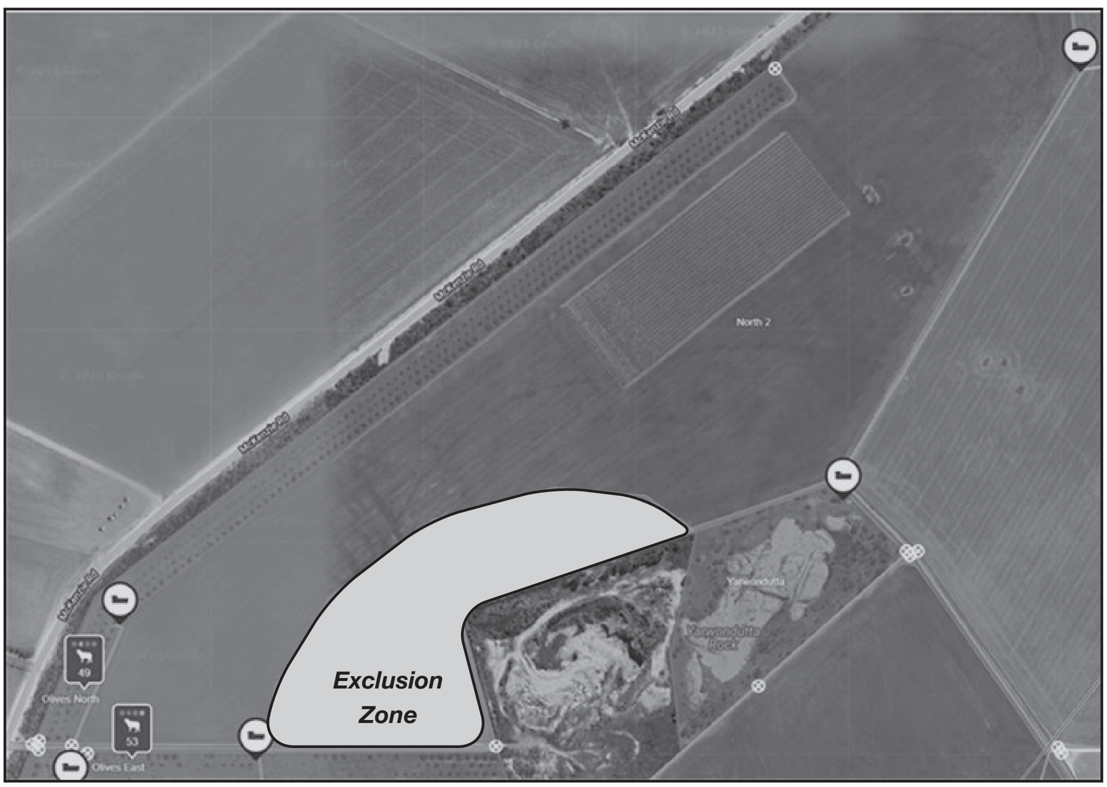

Figure 1. An Agriwebb screengrab showing the trial paddock (North 2) and the exclusion zone in the south-western corner.

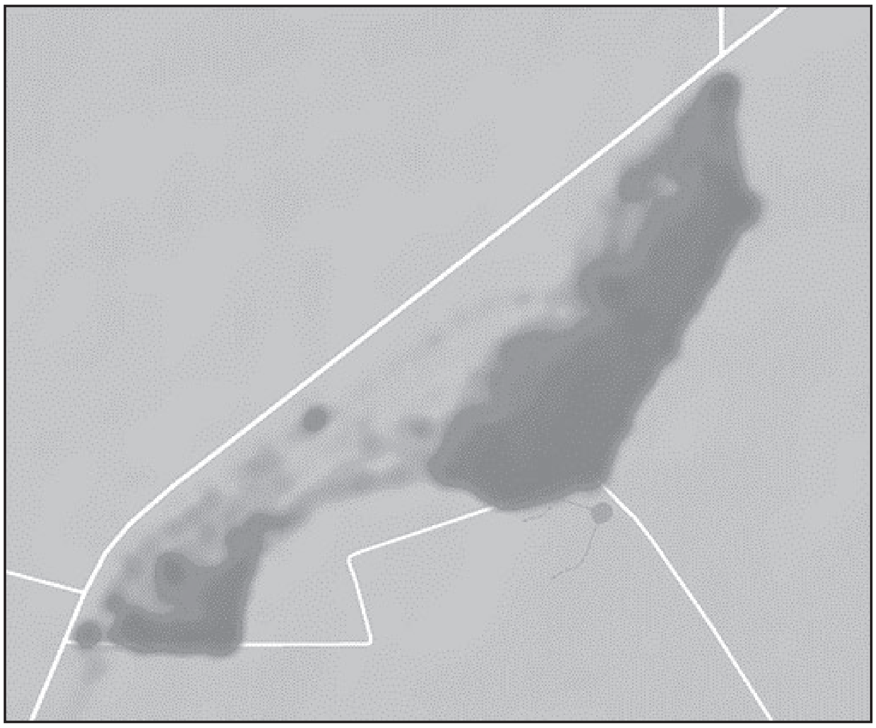

Figure 2. A heat map showing the GPS locations of the fifty sheep throughout the trial period.

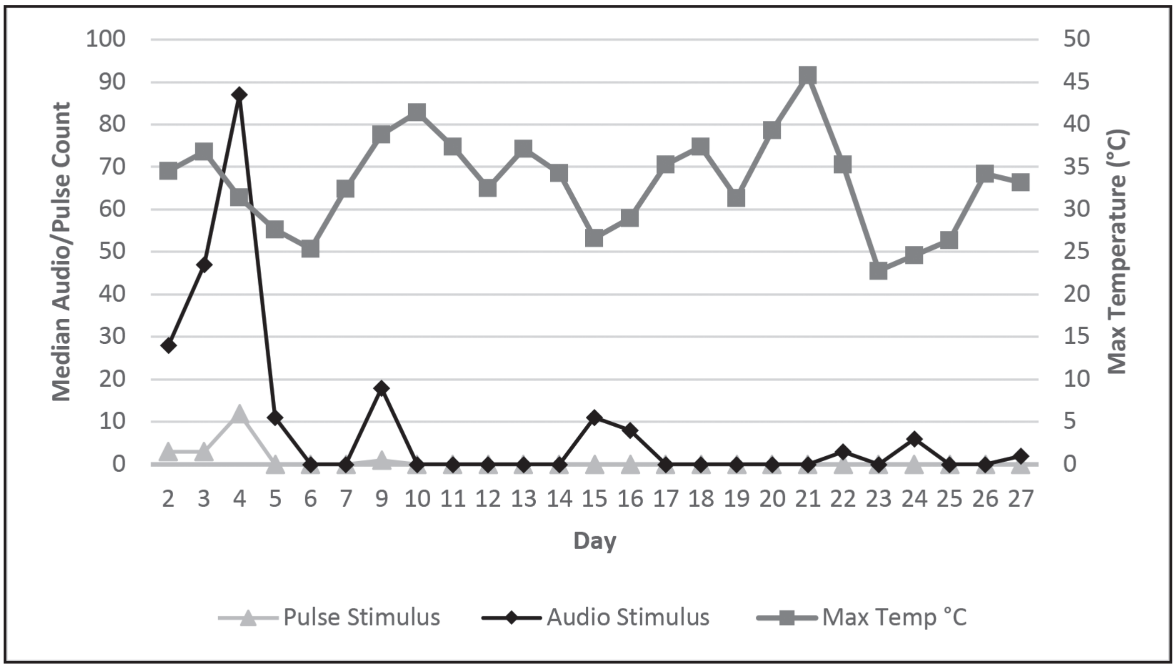

Figure 3. The median audio and pulse signals applied to the mob per day plotted against the maximum daily temperature (°C).

The number of audio and pulse signals recorded by the collars was relatively low. The pattern of signals applied per day was as expected (Figure 3). The virtual fence around the physical boundary of the training paddock was activated on day 2. The virtual fence across the training paddock was activated on day 4, where an increase in the number of audio and pulse signals can be observed. Interactions with the virtual fence significantly drop on days 5 and 6. On day 9 the sheep begin exclusion from the saline area in the trial paddock. There is no activity recorded by the collars until day 15 and 16 where audio signals are applied but pulses are not. This indicates successful learning of the association between the cues. There are again no interactions recorded until days 22 and 24, with only audios being delivered. The days of increased activity can be observed on or adjacent to days where the maximum temperature drops below 34°C (Figure 3), suggesting that decreased activity during hot weather contributes to the efficacy of virtual fencing technology.

Further analysis would be required to determine the individual rate of learning rather than mob based daily medians. This may highlight that the majority of animals did not interact with the virtual fence at all throughout the trial. Whether this was due to socially facilitated learning or inactivity during summer months would require further investigation.

Table 1. The average liveweight (kg) and body condition score (BCS) of the trial mob before and after the trial period, including the average change.

	Liveweight (kg)	BCS (1-5)
Start	74.16 ± 7.41	3.24 ± 0.43
End	80.86 ± 80.86	3.67 ± 0.49
Change	6.70 ± 2.52	0.45 ± 0.42

Table 2. The average ground cover percentage (including stubble and new germination), assessed visually, within the inclusion zone and exclusion zone at the start and end of the trial, including the average change in ground cover percentage within each area. The difference between average change in ground cover is statistically significant at the 95% confidence level (p<0.001).

Ground Cover %		
	Inclusion Zone	Exclusion Zone
Start	13.65 ± 4.23	9.80 ± 1.40
End	6.95 ± 2.42	11.00 ± 1.49
Change	-6.70 ± 5.12	1.20 ± 1.75

Wool is an insulating fibre, and it is widely accepted that the presence of wool may impede delivery of pulse signals via collars. Given that the sheep in this trial had wool present at the collar sites it isn't possible to guarantee that all sheep felt every pulse that was applied. Previous unpublished research by SARDI found that sheep with clipped wool received significantly lower pulse numbers than sheep with wool remaining at the collar site. This implies that a higher number of signals were required to contain the sheep and application of these signals may not have been consistent.

In addition to the success of the virtual fencing technology, the sheep gained body condition throughout the trial period indicating that this application did not have a negative impact on production (Table 1). There were favourable conditions for plant growth during the trial period which contributed to positive production outcomes.

The exclusion of sheep resulted in the maintenance of ground cover within the exclusion zone (Table 2), where the ground cover percentage decreased by an average of 6.7 %. This maintenance of ground cover, while allowing the utilisation of feed in the inclusion zone, further supports the use of virtual fencing. By implementing virtual fencing in this paddock, ground cover was preserved in fragile areas, while more robust areas were available for grazing.

What does this mean?

This trial established that sheep can be excluded from an area by a commercial virtual fencing technology for landscape management purposes. In the scenario implemented at the Minnipa Agricultural Centre, virtual fencing was highly effective and did not result in negative production outcomes.

The results of this work hold significance for the development of virtual fencing technology for sheep. Prior to this trial, automated virtual fencing systems had been proven to be effective for sheep. However, this had not been demonstrated on a commercially relevant scale in a real-world use case. The development of a virtual fencing solution for sheep is halted in Australia due to regulatory barriers and lack of a suitable technology. Development of products specifically for sheep is required to enable further research and development. Ongoing research into how sheep respond to virtual fencing under differing conditions is required to continue development in this space and drive commercialisation.

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