Addendum to the independent scientific literature review on animal welfare considerations for virtual fencing

Additional information provided by Halter

November 2023

Explanatory note

This addendum does not form part of the independent scientific literature review on animal welfare considerations for virtual fencing conducted by Professor Andrew Fisher and Dr Amelia Cornish.

Virtual fencing technology and the animal welfare legislation governing its use across jurisdictions continue to evolve. Since the finalisation of the literature review, new and more detailed information on animal welfare considerations of virtual fencing technology has become available. It is important to note that the information provided in this addendum has not yet been reviewed but will be considered by the Animal Welfare Task Group (AWTG) virtual fencing subgroup at a later date. For further information, refer directly to Halter.

Halter

Halter's animal welfare standards and safeguards
Halter follows these standards to ensure animal welfare is protected when training, containing and guiding animals with virtual fencing technology.

Halter has trained more dairy cows with virtual fencing technology than any other wearable in the market. Over seven years Halter has developed and refined its technology and gained deep expertise in training and guiding animals while protecting their welfare. Halter takes very seriously the high standards around responsible animal learning and training experiences. Below are Halter's animal welfare standards:

<u>The System</u>

1. The system should support the animal's natural behaviour and should minimise disruption to their natural behaviour. The system should support animal agency by working with the animal, not against it.
2. Trained animals should be confident with the system and trusting of the guidance cues. Animal learning must ensure that the aversive cue (pulse) becomes predictable and controllable for every animal (Kearton et al., 2020):
    - Predictable: the animal knows when the consistent development of primary cues will escalate to a secondary aversive cue (pulse); and
    - Controllable: the animal can choose to change its direction to avoid the aversive cue or can ignore the primary cues knowing the consequence of doing so.

   Cues must be precise and consistent to avoid confusing or stressing the animals and to minimise the welfare impact (Weiss, 1970; Lee et al., 2018).
3. Whilst humans determine the destination of animal movements in the Halter app (i.e., a 'pasture break' or dairy shed), humans must never have direct control over the guidance cues sent to animals, and the only inputs to determine the cues should be the animal's behaviour and location.

<u>Safeguards</u>

4. If an animal fails to respond to the guidance cues, the system should automatically disable. The collar should not reactivate until the animal has demonstrated it is able to move freely.
5. If an animal crosses a virtual boundary at high speed (for example, if spooked), the system should automatically deactivate.
6. Halter must monitor cue data of animals and, if required, take action to protect animal welfare.
7. Continuous monitoring should be in place to disable guidance cues for an entire mob if a subset of the mob fails to respond to the guidance cues (for example, if a mob is blocked from moving down a race by a fallen tree).
8. The system should have in-built monitoring to detect key component failures and deactivate the system if required. The system must not attempt to guide animals if the collar is not operating according to its functional design.
9. The system should alert users if they inadvertently set pasture allocations with too small of an angle (i.e., <45°) or stocking densities that are too high (m2/cow).

10. If a communication network failure occurs, the system should put the farm into emergency mode and alert the farmer; the system should hold animals in their current zone for a set time period, allowing the farmer adequate time to respond. In this scenario, a farmer should have the ability to disable the system and take over manual control to shift the animals.

Aversive cues

11. The system should use the minimum aversion necessary per individual animal. This should be automatically customised based on each animal's tolerance to the aversive cue.
12. Aversive cues must have time-bound lockouts to avoid the risk of animals experiencing aversive cues for continuous periods. These lockouts should be customised per individual animal, based on previous behaviour.

Collar

13. Collars should be designed to optimise the comfort and safety of animals.
14. The collar and the animal should be individually paired.

Halter's virtual fencing and animal guidance

Cows wear a collar and are trained to follow the collar's guidance cues. Using the Halter app on their phone, farmers remotely shift their cows around the farm and set up virtual fences for grazing in paddocks. This reduces the need for physical fences, and motorbikes and dogs to move cows.

The collar guides a cow using two primary cues: sound and vibration.

- Sound cues give animals directional guidance if they cross a virtual boundary or to turn them towards a new break or exit point.
- Vibration cues encourage animals to walk in the correct direction.

The collar also uses a secondary cue - a low-energy electric pulse - that is used to reinforce the two primary cues if they are ignored. The pulse is mainly used during the training period (section 7 of Halter's Animal Welfare Charter) as animals learn to associate the consistent development of the primary cues with escalation to a secondary cue (pulse) unless they change their direction. Once animals are trained, the pulse is rarely used. A trained animal can choose to change their direction or can ignore the primary cues knowing the consequences of doing so (the pulse). The energy of this pulse is set to the lowest level that will dissuade a cow from ignoring the sound cues, if it is set any lower, they will ignore it. Halter refers to this secondary cue as a 'pulse' because it is significantly weaker in energy than the 'shock' from a standard electric fence. The maximum strength of Halter's collar pulse is 0.18 joules, delivered in 20 microseconds, which is significantly less energy than the shock received from a typical mains-powered electric fence (powered by energizer units ranging from 18 to 40 joules).

If a cow moves beyond a virtual boundary, sound cues (an increasing frequency of beeps) are used to encourage the cow to move back within the break. Cows receive ample time to correct their direction and as long as they make progress to return to the break, they won't receive a pulse. The precise time frame depends on the individual cow and their behaviour at the time and is informed by Halter's research into millions of days of cow behaviour to ensure cows have ample time to respond. The moment a cow moves her head in the correct direction, even only slightly, the system detects this instantly and the sound cues ease (beeping interval reduces); if she starts to walk back towards the break, the cues stop. Only if the cow chooses to ignore the primary cues and they have reached their maximum threshold, will a pulse be applied.

The pulse is used to reinforce the primary cues of sound and vibration. Because the pulse is predictable and controllable for cows, no trained cow receives a pulse she wasn't expecting. A cow will never receive a pulse without first receiving, and ignoring, the primary sound and vibration cue. The roles of the two sensory cues do not overlap, meaning different cues are never given at the same time.

Halter's guidance system allows cows to express their normal behaviour. Once trained, the guidance cues that a typical cow receives each day are almost entirely sound and vibration. Cows are intelligent, so they learn and adapt quickly to the Halter system. Once they associate the sound cue with crossing a virtual boundary, they quickly learn to correct their direction and avoid a pulse. The typical cow receives primary cues (sound and vibration) for only 0.1% of the day (1.6 minutes per day[1]), meaning that for over 99% of the day they receive no cues.

<u>(i) Sound cue</u>
The sound cue is a benign primary cue that gives animals directional guidance if they begin crossing a virtual boundary, or it turns them towards a new break or exit point. The volume is set low enough to not cause any distress. The sound cue is an increasing frequency of beeps, similar to a car's reversing sensor, and is designed to be quiet enough to direct only the cow paired with that collar, and not adjacent cows.

Most dairy cows have already learnt to avoid electric fences. With electric fences, the primary cue is the visual cue; when they see a fence, they learn to avoid it to not trigger the secondary cue of an electric shock. Halter substitutes this primary visual cue with a sound cue. Instead of seeing a physical fence, cows with Halter hear where a virtual fence is. The sound cues complement a cow's senses; cows have better hearing than humans, over a wider range of frequencies and volumes. Visually cows cannot judge distance and depth well as they only have a relatively small area of binocular vision and a binocular blind spot directly in front of them (Mounaix et al., 2014).

<u>(ii) Vibration cue</u>
The vibration cue is a primary cue, with a similar sensation to a mobile phone vibrating, and serves these roles:

- Signals an impending change in activity, such as a shift to the dairy shed or to a new pasture allocation.
- Cows that are being guided by the sound cues receive a vibration cue when they start heading in the right direction.
- Encourage consistent cow movement to the dairy shed. If a cow stops walking forward during a shift to the dairy shed, vibration cues occur. If a cow recommences walking, the vibration will cease. If she stays stationary, the intensity of the vibration gradually increases

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[1] *Tasmanian Institute of Agriculture - 'Managing dairy cows with Halter virtual fencing technology', Dr Megan Verdon (preliminary study results, September 2023)*

over a 30 second period, and if the cow chooses to ignore these cues (that she is trained to understand and respond to), the pulse is applied.

(iii) Electric pulse

The low-energy electric pulse is an aversive cue used if cows choose to ignore the primary sound and vibration cues. The maximum strength of Halter's collar pulse is 0.18 joules, delivered in 20 microseconds, which is significantly less energy than the received shock from a typical mains-powered electric fence (powered by energizer units ranging from 18 to 40 joules).

The energy of the pulse is set to the lowest level that will dissuade a cow from ignoring the sound cues, if it is set any lower, they ignore it. Most Halter staff have felt a pulse generated by a Halter collar, and the sensation is similar to the feeling of a firm slap on the wrist.

Whilst the maximum strength of the pulse is 0.18 joules, for most cows, the Halter system customises and delivers lower energy pulses based on each cow's individual tolerance to the pulse and their determination to push boundaries. This is a critical feature for animal welfare, given cows have different thresholds to push boundaries. For example, some cows will choose to push past virtual boundaries in the pursuit of fresh pasture. This feature is also consistent with the recommendations from the UK's Animal Welfare Committee's opinion on the welfare implications of using virtual fencing systems (see section 5 of Halter's Animal Welfare Charter).

Managing livestock on any farm requires the occasional use of aversive cues to contain and shift them. Aversive cues are varied and include: humans shouting, clapping, and waving arms, the use of rattles or sticks, dogs, motorbikes, and electric fences. For animal welfare purposes, Halter uses the least amount of aversion necessary to contain or move individual cows and Halter have designed the system to give highly predictable and controllable cues as these have been shown to be less aversive (Kearton et al., 2020). The Halter system uses an electric pulse as an aversive cue because:

- It is adjustable - the energy can be customised and reduced to the absolute minimum necessary for each individual animal; and
- It is designed to be highly predictable and avoidable.

Furthermore, the Halter cues are consistent. Every day the cow is guided with the same primary cues (sound and vibration), as opposed to the wide range of conventional cues which can vary considerably from day to day, for example across different farm staff. Cue consistency is essential to predictability and therefore efficiency of outcomes achieved and to the animal retaining a feeling of control.

For each cow, the Halter system finds the optimal balance between the strength of the pulse and the frequency of pulses (i.e., how the collar delivers energy) to achieve a desired change in direction from the cow without unnecessary agitation.

Preliminary findings from Tasmanian Institute of Agriculture (TIA) independent study on Halter

Training period and management period

TIA analysed extensive data from a 10-day **training period** and a 4-week **management period** following training. In total, this was equivalent to 2,950 days of collars on cows. The objective of the below cue data is to show the cows' level of understanding of the primary and secondary cues and the frequency of them receiving the secondary cue (pulse).

- During the 10-day **training period**, a typical cow received less than three low-energy pulses per day.
- During the **management period**, most cows received less than three pulses a week, and that number continued to decline each week.
- Once trained, the guidance cues that a typical cow receives each day are almost entirely sound and vibration.

Cows are intelligent and typically learn to stay within a virtual boundary within a matter of hours of beginning training. While cows generally show significant progress in their understanding within the first 24 hours, Halter prescribes a full training program of seven days, with specific daily monitoring and training modules assigned to farm staff on each of these days.

Cue ratios (pulse-to-sound ratio)
A low ratio of pulse-to-sound cues demonstrates that a cow is consistently responding to the sound cues by changing her direction to avoid a pulse. By the fourth week of TIA's management period, the pulse-to-sound ratio was two pulses per 100 sound cues. This shows that Halter-trained cows had a strong understanding of the system's primary cues. Halter monitors cue data and analyses scenarios where cows receive a high number of pulses. Halter is continually improving the ratio of pulse-to-sound cues through improvements in cow training, farmer training, and product upgrades.

References

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