Virtual fencing

Technology fact sheet

DIGITALISATION FOR AGROECOLOGY

What is virtual fencing?

Virtual fencing is used in different cattle and sheep rotational grazing systems for precision pasture management. It works similarly to conventional electric fencing, but without relying on physical barriers. Rather, fences are digitally created with the help of a mobile application or other software. The animals experience such virtual fences by means of an audio cue and potentially an electric shock administered via a collar worn around their neck.

The first concept of using audible cues emitted by a collar-mounted device worn by an animal appeared about 50 years ago, but it was initially only used on companion animals. Peck's Invisible Fence manufactured the first virtual control devices for domestic livestock in the US in 1987.

In 2022, there were more than 140 virtual fencing users in the UK, and the technology is spreading quickly. Globally, there are four main virtual fencing system manufacturers located in Norway, Australia, the US, and New Zealand.

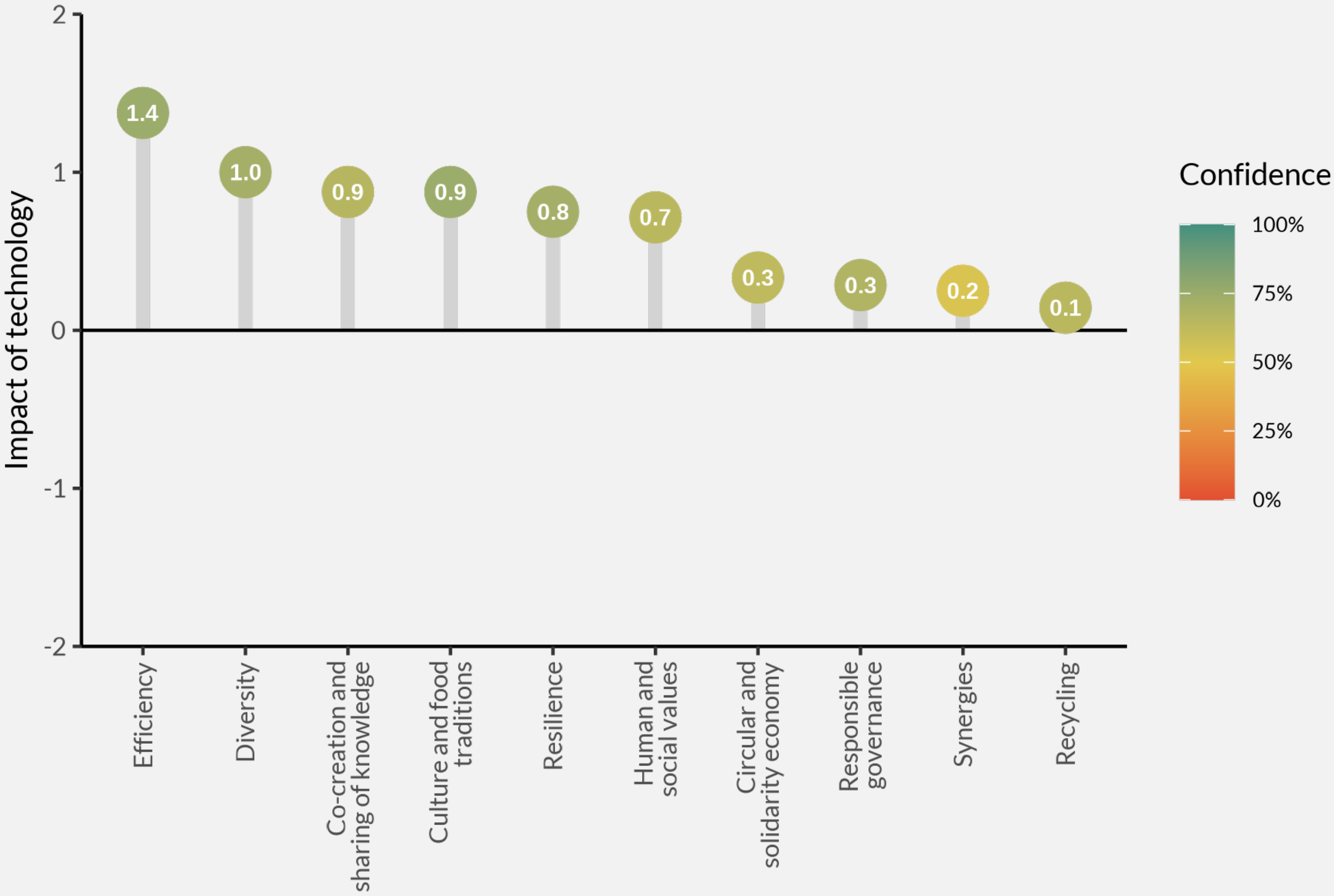
Virtual fencing in a test field. Cattle wearing the Nofence collars while a herds-woman checks information on collars status via the Nofence mobile application. The dark green patch at the back will be the next paddock in the rotation. Photo credit: Conceição Santos Silva.

What is agroecology?

Agroecology is broadly defined as a way of managing food systems more sustainably by following different environmental, economic and social principles. The assessment here is based on the **Food and Agriculture Organization's 10 elements of agroecology**, one of the most important recent frameworks for agroecology.

Agroecological performance

The figure below shows how virtual fencing affects the FAO's 10 elements of agroecology, based on discussions between farmers, academics and digitalisation experts during our workshop. The height of each bubble represents the average impact ranging from strongly negative (-2) to strongly positive (+2), with the exact score inside the bubble. The bubble colours reflect how confident participants were in their evaluations on average (0% - not confident at all, 100% - highly confident). Note that the figure only shows averages and does not reflect variation in individual assessments.



Examples of potential effects on agroecology

As shown in the figure above, virtual fencing is likely to greatly improve the **efficiency** of farms. Despite the high costs of collars and their annual subscriptions, it can improve pasture management in areas where physical fencing is not allowed or practical, lower labour time, and avoid physical fencing management costs. By protecting certain species like ground-nesting birds from livestock grazing, preserving landscape connectivity, and simplifying mixed farming management (combining livestock with crop production), virtual fences can boost **diversity**. On the downside, however, these effects can be limited by battery life and issues with connectivity in vegetation-dense areas. The data generated by a virtual fencing system may also be useful for analysing livestock behaviour, which can aid the **co-creation and sharing of knowledge**. Yet interpreting the data can be complex, and while farmers can provide valuable feedback to private companies, their potential role in technology development is often limited. The collars can slightly reduce labour requirements and thereby promote **human and social values**. However, they require more skilled labour, which could decrease the availability of entry-level jobs. More mixed effects are likely in **synergies**. While virtual fencing can enable flexibility in land management, there are technical issues due to increased battery energy requirements in wooded landscapes. The data can also be difficult to export and a high level of involvement with the company's customer support is needed for a smooth experience. Similarly, while concerns about **recycling** are alleviated by the 4-year warranty of Nofence collars, it is unclear if second-hand collars would be suitable for use. The collars also tend to get damaged quickly, especially in rough vegetation. Recycling batteries and moving them to new collars could reduce current recycling issues.

Why does digitalisation matter?

Agriculture in Europe and globally is digitalising rapidly. While digital tools often aim to enhance farming efficiency, they bring a variety of environmental, economic and social effects ranging from changes to fertiliser use to data privacy. Digitalising agriculture can therefore enable a sustainable transition and boost the resilience of food systems, but it also introduces new challenges and risks.

OPPORTUNITIES 🚀

- The technology can reduce labour requirements and provide economic benefits to farmers, particularly when managing large areas
- Virtual fencing preserves landscape connectivity and allows for targeted and tailored land management, which can benefit biodiversity
- The data collected by the collars can be used by farmers to learn more about their livestock, although data accessibility needs to be improved

CHALLENGES 🧩

- Repairing the collars is currently complicated and needs to be done by the technology provider, and locating lost collars in the pasture is also difficult
- The collected data are currently difficult to export and use without the company's help, limiting the potential for broader use of the technology
- There are concerns related to data privacy and the reliability of the technology in areas with poor mobile network coverage

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to evaluate virtual fencing was organised by the Harper Adams University on 13 October 2023. The university campus is surrounded by agricultural land, where several living labs are established for research. The virtual fencing living lab consists of a 2-hectare rotational grazing system comparison between virtual and electric fencing. Each experimental plot contains six cattle and is divided into several paddocks. Workshop participants, who came from all over the UK, included farmers, farm advisors, digitalisation experts, and academics. The workshop focused on cattle and sheep grazing farms mostly involved in conservation grazing.

Harper Adams University

BOKU UNIVERSITY

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