SUPER-G
SUSTAINABLE PERMANENT GRASSLAND

MEDITERRANEAN
BOREAL
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ATLANTIC

Virtual fencing for grazing livestock

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- **DESCRIPTION:** Virtual fencing is a system that allows farmers to contain or exclude livestock without the presence of a physical fence, instead using an invisible GPS boundary.

- **RATIONALE:** Virtual fencing has the potential to significantly change how we manage grazing animals both in Europe and across the world. There are a few potential ways in which this technology may be beneficial to farmers:

Farm productivity/profitability:

- ✓ **Reduce time and cost** associated with the installation, maintenance and movement of conventional fencing.
- ✓ Ability to **replace existing physical fencing** and/or introduce fencing in areas where physical fencing is not possible or financially viable e.g., short-term rented land.
- ✓ **Improve pasture management and feed utilisation** through methods such as rotational grazing, strip grazing, and more regular movements.
- ✓ Enhanced **monitoring** of individual animals within a herd/flock. Animal movements and real-time positioning can be viewed on a mobile app.
- ✓ **Flexible** grazing management – virtual fencing can be easily set up and altered at any time. Examples where this may be useful include the setting up of rotational grazing in large fields primarily used for purposes other than grazing (e.g., hay or silage production, or cover crops).
- ✓ Virtual fencing may be beneficial when managing grazing during difficult weather conditions, moving animals more regularly and **excluding animals from specific areas** that are susceptible to soil damage e.g., low-lying parts of fields that accumulate water during heavy rainfall or snow thaw.

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Sustainability:

- ✓ Virtual fencing may enable enhanced **grazing management**, which in turn could lead to improved sustainability outcomes, particularly in ecologically important areas such as upland and mountainous regions.
- ✓ Virtual fences can be placed in almost any kind of terrain (provided there is a mobile network and GPS access). This could potentially enable **managed grazing** in open and remote areas of land. Practices such as rotational grazing become a possibility whereby animals are virtually fenced within a given area and moved at regular intervals. This may reduce issues with under grazing and overgrazing and provide important **rest periods for natural vegetation to recover.**
- ✓ The system can be tailored to suit a given environment to maintain animals within desired areas, and excluding them from **sensitive habitats and landscape features** at risk of damage from grazing livestock such as streams, lakes, bogs etc. Exclusion from these types of areas can protect water quality in freshwater rivers, streams, and lakes, and help safeguard animals from dangers such as drowning, falls, and accidental entrapment.

Fig.1: Virtual pasture in an upland area with an 'exclusion zone' marked around a freshwater lake

- **MECHANISM OF ACTION:** The technology comprises two key parts (pictured below)

1. A mobile app through which the virtual fence system is controlled and monitored in real-time.
2. A GPS-enabled device (typically a neck mounted collar) capable of producing stimuli to alert and encourage the animal away from the virtual fence.

Fig.2: Virtual pasture marked on an app, and beef cows and calves fitted with neck

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When animals approach the virtual fence, they are alerted by an audio cue of its location (as illustrated below). If they proceed to cross the virtual fence, the audio cue will be followed by an electric pulse. The basis of the system is that animals learn to correctly respond to the audio cue only, either stopping or moving away from the virtual fence.

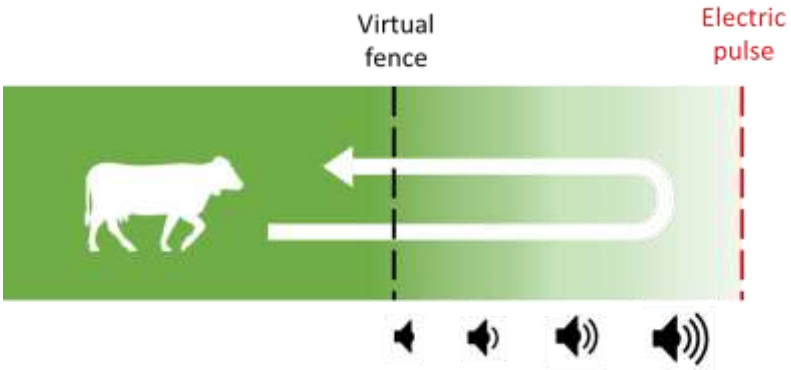

Fig.3: *Basic diagram illustrating how virtual fencing works*

There are numerous potential benefits with virtual fencing, however as this is a relatively new technology, there is a need to understand all potential challenges and concerns associated with its use. The most prominent concern highlighted with virtual fencing was animal welfare. There is an expectation that any new livestock technologies at least maintain or lead to an improvement in animal welfare, and so virtual fencing must meet these criteria if it is to be accepted as a welfare-friendly technology.

Studies in the SUPER-G project were conducted using the Nofence system (Nofence® AS, Batnfjordsøra, Norway). The cattle collars in this system have a stored power of 0.2 joules and max 3kV, while the sheep collars have stored power of 0.1 joules and max 3kV. In our studies to date, virtual fencing did not adversely impact on welfare indicators such as cortisol (stress) and activity (standing time, lying time, step count), while behavioural reactions to the virtual fence pulse were comparable to contact with an electric fence wire. The rate of learning varied between animals, with some animals receiving more audio cues and electric pulses than others. Care is therefore required during the training phase so that animals are given adequate time to learn. There is also a possibility that a proportion of animals (<5% in our studies) may not be capable of learning the system. It is important that these animals are identified at the earliest opportunity and returned to conventional fencing. Safeguards offered by existing virtual fence manufacturers such as Nofence include a three-pulse limit whereby animals that do not respond correctly to the audio cue will get a maximum of three pulses in a row, after which the farmer will be notified that the animal has escaped. Animals that are returning to the pasture will not receive any stimuli (audio or electric) during re-entry to their virtual pasture. Once within the virtual boundaries, the system automatically resumes as normal. Some manufacturers also provide an early warning system alerting the farmer if an individual animal receives many pulses in a day. This may indicate that the animal has not learned correctly, or other possible issues such as disturbances within the herd, a collar not fitted properly, or a technology malfunction.

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- **EXAMPLE OF GOOD PRACTICE:**

The institutes involved in the SUPER-G virtual fencing research group have now been using this technology for several grazing seasons with several hundred cattle and sheep in various locations across Europe. Below are some of the practicalities to consider when adopting virtual fencing.

✓ Knowledge and understanding – While this technology offers many potential benefits, it must be acknowledged that an electric pulse is unpleasant to animals and so every precaution must be taken to ensure that pulses are kept to a minimum. Before you begin using virtual fencing it is essential that you are comfortable with using smartphone technology and that you fully understand how the system works. This includes key aspects such as:

- Using the mobile app
- Fitting collars
- Training animals
- Virtual pasture design and pasture allocation

Fig.3: Ewes fitted with sheep-specific virtual fence collars

✓ Mobile network availability – Current virtual fencing systems typically rely on mobile network coverage for flow of information between the mobile app and the device fitted to the animal. Some manufacturers offer a backup feature, which allows the app and collar to communicate via Bluetooth to change or remove virtual boundaries when network coverage is an issue. The user however must be in close proximity to the animals for this to work. Technology developments are underway to overcome network availability issues although, at present, this may be a limiting factor on some farms.

✓ GPS accuracy – A common inaccuracy with GPS technologies is known as 'GPS drift', which in a virtual fencing context, is the difference between the actual location of the animal and the location recorded by the virtual fence collar. The amount of drift a GPS system has is dependent upon several factors, including the quality of the GPS receiver and antenna, the number of satellites detected, and how much of the sky is in direct view from the ground. Factors affecting drift include proximity to buildings, heavy tree cover, steep slopes and hilly terrain (if the animal is in a valley the GPS receiver sees less of the sky and fewer satellites). Heavy thunderstorms may also impact satellite signal. While the extent of GPS drift in our experience has generally been minimal (a couple of metres), there have been some cases of more significant drift reported. One of the main risks is that livestock could be blocked from accessing drinking water or shade due to GPS drift, particularly if the virtual fence is placed too close to these. As a preventative measure, it is recommended that the farmer walks along the newly positioned virtual fence, using a virtual fence collar to verify fence accuracy, and ensures there is sufficient buffer space near areas where animals require access.

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- ✓ Battery life – Virtual fence collars are typically fitted with a rechargeable battery unit, with some manufacturers incorporating small solar panels on the collar unit to help maintain battery charge. Battery life depends greatly on the grazing method and pasture design used. In larger pastures batteries can last several months without being recharged, while smaller pastures will reduce battery life. This is largely because collars have a higher requirement for GPS precision (and higher battery consumption) close to virtual boundaries. Battery is also affected by factors like connectivity blind spots, weather conditions, or when animals are in shade.

- ✓ Stockmanship – Like other precision livestock technologies, virtual fencing must be viewed as a management tool and not a replacement for physically checking animal health and welfare on the ground.

- ✓ External fencing – Virtual fencing is likely not a suitable replacement for physical fencing in situations where there is a high risk to humans or livestock, such as along roads, highways or railway lines, or where external fences are needed to protect against biosecurity hazards. It may also be a legal requirement in some countries that landowners use physical fencing for livestock in such circumstances.

- ✓ Dangerous livestock – The effectiveness of virtual fencing to contain adult breeding males (i.e., bulls and rams) is not fully known. Standard health and safety advice must therefore be followed when working with male livestock. This is also the case for other situations and periods where livestock may show aggression, such as cows post-calving.

- ✓ Cost – Virtual fencing providers offer a range of pricing models including outright collar purchase (plus subscription fee) or collar lease options, with prices varying depending on the number of collars required. The cost-benefit of adopting virtual fencing will depend on the final price of the system as well as several farm-specific factors such as the main enterprise and production system (e.g., dairy, beef, sheep), current performance/efficiency levels, farm infrastructure, and labour availability. Additional functionalities such as heat detection and integrated pasture management may also increase the feasibility of virtual fencing systems on some farms.

- **SUPPORT:**

Currently cost is a barrier to the adoption of this technology. Grants are available for the purchase of virtual fence collars in some parts of the United Kingdom. In other parts of Europe, benefits from their use may warrant financial support in the form of cost-sharing grants in the future.

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