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Yearling heifer fitted with a virtual fencing collar. Collars may need to be adjusted throughout the grazing season following gain or loss of condition. Collars should allow a full range of movement without excess space.
(Photo by Jessica Syring, NDSU)

Grazing with Virtual Fence

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What it is and How it Works

Virtual fencing systems are tools that utilize digital fence boundaries with global positioning system (GPS)-enabled collars or ear tags to manage the movement of grazing animals. While design and connectivity can vary by vendor, virtual fencing systems work through the same principles. A GPS-enabled device is fitted to livestock, often as a collar. This collar communicates the livestock position to an online management platform either via a tower or cellular service. These platforms are used to create virtual fences, contain animals (in or out of designated areas) and even move animals (with assisted move features).

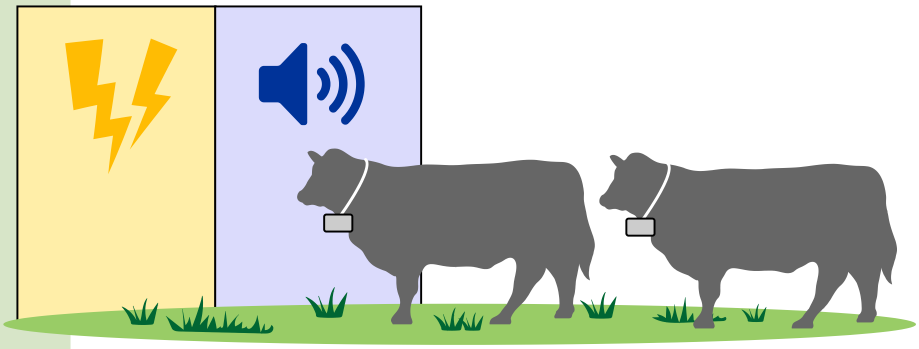
Virtual fence devices are often worn as collars on livestock. All vendors provide collars designed for cattle, while some vendors offer separate collars for small ruminants. It is not recommended to fit virtual fencing collars to calves (general consideration: under 500 lb) due to calves' growth requiring frequent adjustments to fit. When fitted to yearlings, these devices will require adjustment during the grazing season to maintain optimal fit. The devices are powered by batteries, which may be recharged by built-in solar panels or replaced as needed.

Virtual fence devices utilize GPS to determine the position of the livestock and administer various cues to manage them. Management cues include auditory tones and electrical cues. All cues are designed to be safe and provide effective stimuli. The energy equivalent for the electric cue is equivalent to a 6-to 8-volt electric fence, depending on the manufacturer and livestock class. Auditory and electrical cues are only administered when an animal enters or approaches the set boundaries. An auditory cue warns the animal that it is approaching a boundary. If the animal continues towards or past the

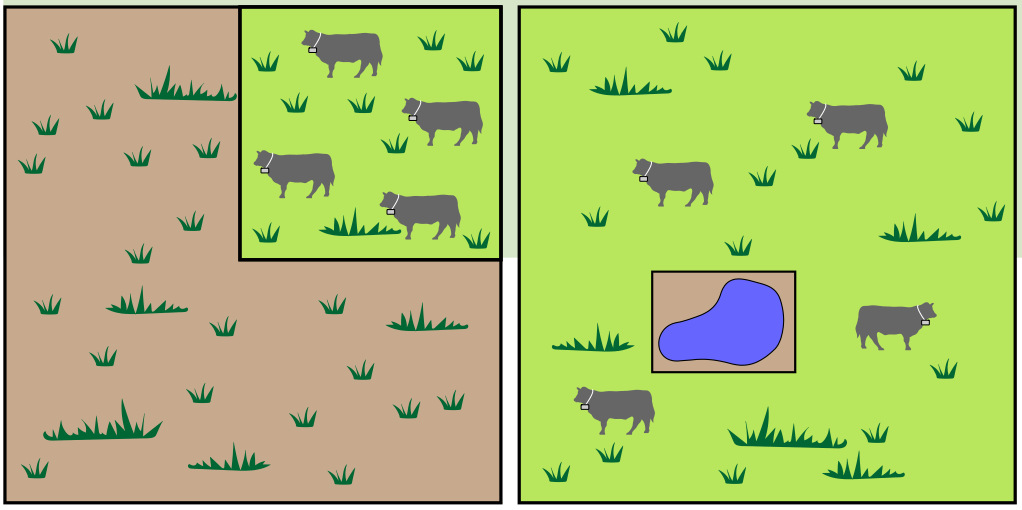
boundary, an electrical cue (or in combination with the auditory cue) is administered to deter further movement past the boundary. These cues are direction-sensitive and will not activate as animals move back into the desired area. Additionally, electrical cues are limited for animal welfare and deactivated if a cue threshold is met.

Livestock require training to effectively respond to virtual fence cues. The training period is used to teach animals to associate the auditory and electrical cues with physical fences. During the training period, a smaller, fenced area is required to ensure animals interact with virtual fence boundaries often enough to learn the cues. During the initial phase, the virtual fence boundary should overlay (or be close in proximity to) the existing physical fences to positively reinforce livestock responses to the cues when interacting with virtual fencing boundaries. Subsequently, the virtual fence boundaries are moved away from the physical fences to encourage learning of the cues. Once livestock are trained, virtual fencing is just as effective as electrical fencing options, ranging from 80%-99% effectiveness, depending on the grazing strategy and class of livestock. Ongoing research at North Dakota State University and the University of Nebraska — Lincoln has observed up to 99% effective containment when strip-grazing annual forages.

Virtual fences can be designed based on the management goals for each pasture. Most commonly, virtual fencing programs offer three types of fencing: inclusion zones, exclusion zones and movement fences. Inclusion zones are used to confine livestock within a set boundary, fencing them in. Inclusion zones are best used for creating grazing allotments under different intensive grazing practices. Exclusion zones are used to prevent livestock from entering an area by fencing them out. Exclusion zones are useful for protecting sensitive areas, such as riparian areas or wetlands. Movement fences slowly push a boundary in one direction. Movement fences are helpful in moving cattle to new paddocks or towards corrals. Using the correct virtual fence function is important, as virtual fences are one-way only: they



Visualization of virtual fencing management cues. The blue zone shows an auditory cue and the yellow zone an electrical cue. If livestock continue through each zone, cues are provided in a cycle until the animal responds positively or a safety limit is reached. Some manufacturers use a time-series approach for stimuli without articulated distance designated to audio/electric zones (e.g., three audio cues followed by an electric cue). (NDSU graphic)



Inclusion fences (left) keep livestock within the set boundaries. Exclusion fences (right) prevent livestock from entering the boundaries. (NDSU graphic)

provide stimuli as livestock approach the boundary of the restricted area, but not when animals return to the designated grazing area.

All virtual fence systems have a website-based or mobile app where managers can outline fences on their property, view animal location and check the status of their devices. Virtual fencing devices communicate either through satellite connectivity, cellular connectivity or long-range wide-area network (LoRaWAN) tower. Satellite- and cellular-enabled devices communicate directly with the platform and do not require a separate base station with an antenna to transmit data. While smartphones need strong 5G/LTE coverage for calls and texts, virtual fence devices can operate on lower-bandwidth networks such as 3G or 4G because they transmit only tiny bits of data. That means they often stay connected in places where phone service might fail.

Cellular connectivity may be limited or unavailable in some areas. This issue can be overcome with LoRaWAN-enabled devices as well as direct satellite collars. LoRaWAN-enabled devices communicate via radio to a base station placed near the grazing area, then transmit the collar data via cellular connection. These base stations can aid in connectivity in areas with poor cellular signal. In principle, a LoRaWAN tower can easily cover a 2- to 3-mile radius, assuming flat terrain with no major obstacles; additional obstacles and terrain changes correspondingly reduce the tower's coverage. Direct-to-satellite is the most recent form of virtual fence communication. These devices forgo cellular communication altogether and utilize satellite networks to communicate between the management program and collars. Satellite devices are able to communicate in the most remote and extensive areas where cellular signals have been challenging and investment in towers can be cost-prohibitive; however, communication may slow down under heavy tree cover or other obstructions to the sky.

Key Considerations for Implementing Virtual Fence

Before deciding to implement virtual fence, there are some key considerations to make. These include available vendors, design connectivity, livestock species, product availability, and additional behavioral and health data capabilities. Understanding the capabilities of virtual fencing systems, as well as the limitations, is an important step in implementing the technology.

With varying cellular coverage, you must consider signal coverage and strength when selecting a virtual fence platform. A cellular connection that allows you to send a text is sufficient for virtual fencing collars to update. Satellite collars can work in almost any area, barring dense tree cover or other obstructions. Radio-connected collars can work in more remote areas with limited cellular coverage. These systems do require a base station or tower to transmit data, which will have limited range depending on topography. Hilly or heavily wooded terrain can limit the line of sight needed for the base station to communicate with the collars. Collars do not require a constant cellular or radio connection to manage cattle; as GPS tracking and programmed boundaries continue to work, with or without a connection. A poor connection can result in slower updates and reduced information back to the management program. Virtual fencing can still work in hilly or mountainous areas, but placement of boundaries is critical.

Battery life can be a limiting factor for virtual fence implementation and may require planning the grazing system around collar capabilities. Battery life can range from a few months to an entire grazing season, depending on how many updates are sent to the collar and how many stimuli are provided. Frequent fence changes or small pastures where livestock interact more with virtual fence boundaries put greater demand on the devices and shorten battery life. Many collars have integrated solar panels to extend battery life or eliminate the need to replace batteries entirely.

When selecting a virtual fence, first consider whether additional infrastructure will be required. Since some systems rely on base stations, they can have a greater upfront cost than those that do not. While virtual fence does not replace the need for a perimeter fence, it does give ranchers the flexibility to resize and change pastures without any additional materials or labor. It is important to understand how different virtual fence systems would impact the multiyear economics of your operation.

Prior to investing in a virtual fence system, it is important to understand how this technology complements and enhances your current grazing system. It will provide the greatest return on investment to operations that require new fences to optimize grazing distribution and harvest efficiency, as well as operations that integrate extended-season grazing (i.e., bale and swath grazing, cover crop and crop aftermath grazing), where devices will get greater use.

Each virtual fencing vendor has a different pricing structure; see the product information and pricing table. For the most up-to-date cost, visit the UNL Virtual Fence Resource Hub (https://go.unl.edu/vf_hub) or contact a company representative.

Virtual Fence Products and Pricing as of June 2026

Vendor	Cost of Collar	Battery Type	Operating Infrastructure	Subscription Fees (per collar)	Estimated Cost* ($/hd/month)	Stimuli	Notes
Vence (Merck)	Leased, cost included in the subscription fee	One time use lithium battery	Base station only $10,000/station	$40/year $10/battery	$6.67 Assuming 2 batteries per year	Sound + Electrical	Requires >100 hd to purchase Wt: 2 lbs
NoFence (Cattle)	$349/collar (< 25) $309/collar (≥ 25)	Solar + Rechargeable battery (removable)	Cellular only	$45/year (<100) $35/year (≥100)	$7.48	Sound + Electrical	First year no subscription fee. Wt. 3.3 lb
NoFence (Small Ruminant)	$269/collar (< 25) $239/collar (≥ 25)	Solar + Rechargeable battery (removable)	Cellular only	$45/year (<100) $35/year (≥100)	$6.82	Sound + Electrical	First year no subscription fee.
eShepherd (Gallagher)	$299/collar (< 100) $249/collar (≥ 100)	Solar	Cellular or Base station $5,500/station	$18/year (base station) $24/year (cellular)	$6.67 (base station) $6.17 (cellular)	Sound + Electrical	Offers models in both cellular and base station Wt: 5 lb
Halter	Leased, cost included in the subscription fee	Solar	Direct to satellite	$6/collar/month	$8.25	Sound + Vibration + Electrical	Preferred > 100 hd $1,500 one-time deployment fee Vibration feature for active assistive moves Wt. 2 lb
Monil	$310/collar, Introductory price $345/collar following introductory price	Solar + Rechargeable battery (non-removable)	Cellular only	$32-$45/year	$310/collar: $7.30 $345/collar: $7.88	Sound + Electrical	Minimum 10 collars First year no subscription fee. Currently only serving IA, KS NE, MO and OK

* Estimated cost amortized over 5 years and 100 head. Active usage of all collars during all months were assumed in this scenario. One base station (tower) and one site were assumed for products that need a base station.

Benefits to Producers

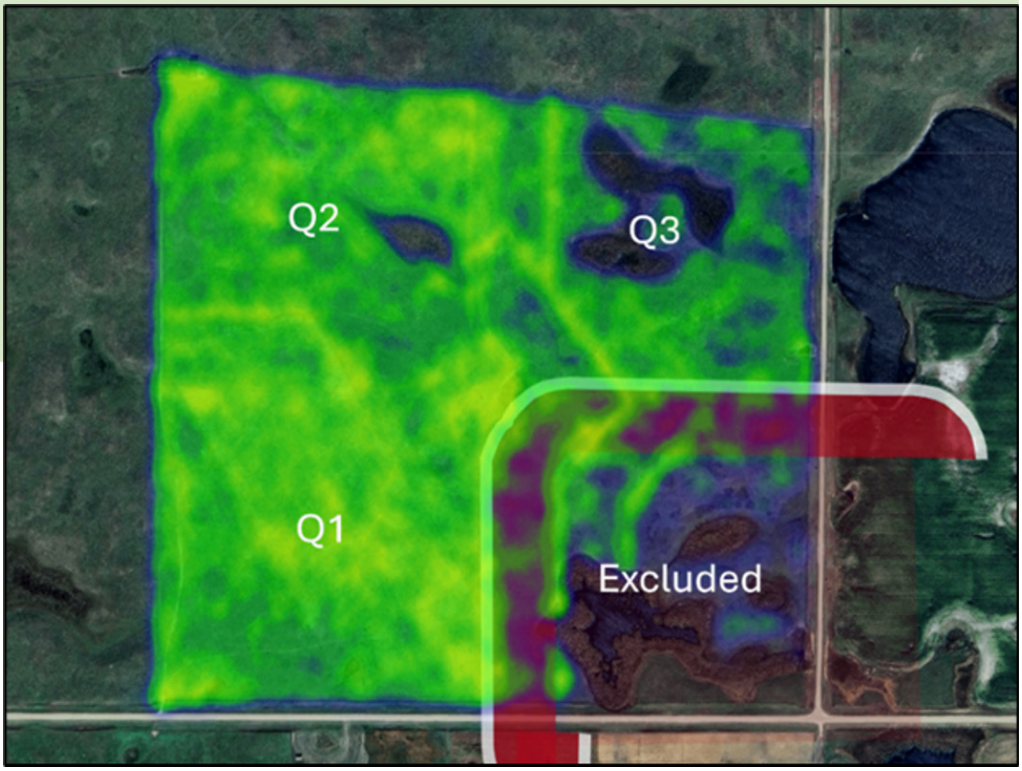
Virtual fencing offers a flexible method of implementing intensive grazing practices. By replacing the interior cross-fencing on rangelands, virtual fencing allows rotational and patch-grazing practices without the need for physical fencing. With the ability to move cattle with only a few clicks, grazing practices become more adaptable to current conditions. Virtual fencing can also be useful on public or rented grazing lands with reduced fencing infrastructure.

Outside of rangelands, virtual fencing can be useful for alternative grazing strategies where fencing is labor-intensive or otherwise difficult to implement. Research at NDSU and UNL found that within annual forage systems, virtual fencing is just as effective as conventional polywire fencing under strip-grazing practices. These uses can be further expanded into crop residue or bale-grazing scenarios, where constructing fences may be difficult or not feasible.

In addition to physically managing livestock, virtual fencing technologies provide more data to ranchers on their herds' grazing behavior. Point data and heat maps are available features in management software that can be used to determine where animals spend the most time and identify movement patterns within a pasture. Additionally, heat maps and other visualizations can aid in pasture management decisions, such as identifying preferred water sources or areas where livestock congregate. While this data can help visualize animal distribution, note that areas of high livestock activity may not always equate to higher rates of forage utilization. Point data can also help identify the exact location of an animal or herd during round-up.

A strip-grazed virtual fence line within an annual forage pasture. Virtual fencing can be just as effective as a single-strand physical fencing, even in small paddock settings. (NDSU photo)

Heat maps like this one can give insight into how livestock are moving throughout pastures. Grazing data can help determine resting areas and preferred water or forage sources. (NDSU photo)



Benefits to the Environment

Using virtual fencing can help enhance environmental health through livestock exclusion, enhanced management and removal of physical barriers. As mentioned above, virtual fencing increases the precision with which a producer can implement more intensive grazing patterns, such as patch grazing and fire management strategies, while reducing labor inputs. These grazing practices using virtual fence have added potential benefits of improving native vegetation communities, providing greater floral expression for insects, supporting diversified microbial communities and reducing fire risk through more targeted grazing to create fuel breaks. Preliminary research at NDSU has also shown that patch grazing managed by virtual fencing increased grassland bird abundance, pollinator abundance and diversity, and floral species abundance and diversity. The reduction in physical interior fencing not only reduces labor and materials but also eliminates a physical barrier that can injure or even kill wildlife, thereby promoting healthier wildlife populations. Virtual fencing can expand producers' opportunities to partner in conservation beyond immediate herd management goals. Producers can easily exclude sensitive areas from grazing to protect sensitive plant species at integral times in their development, protect breeding areas for birds, and conserve riparian zones that are critical to many important plant and animal species and improve water quality.

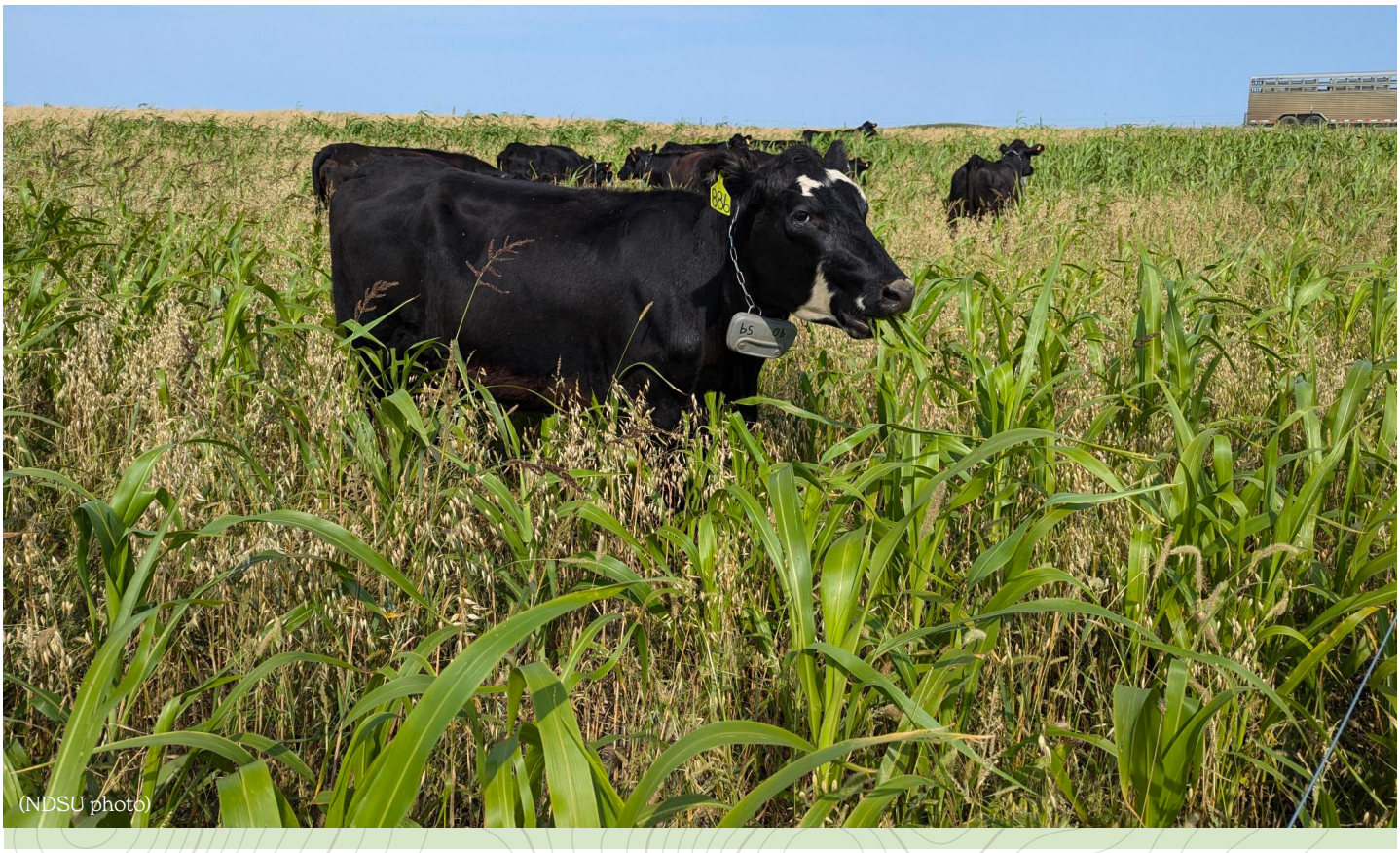
Summary

Virtual fencing is a new and fast-growing management tool available to livestock producers. This technology can aid in grazing management by helping remotely implement adaptable and flexible intensive grazing practices. The flexibility provided by virtual fencing can also be used to reach environmental and conservation goals while reducing labor. As with many new technologies, it is important to determine how virtual fencing can impact your operation.

Cows being managed with virtual fence while grazing native range. (NDSU photo)

(NDSU photo)

(NDSU photo)



(NDSU photo)

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