Effectiveness of virtual fence in North Dakota grazing systems

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Virtual fence is a relatively new technology that has the potential to improve grazing management without physical fences while providing GPS tracking of livestock. For the last year, researchers at North Dakota State University have been evaluating the use of virtual fence to graze rangeland and annual forages. Virtual fence was effective in containing animals in a designated grazing area 92% of the time in both grazing systems. Virtual fence was effective in managing grazing animals. Virtual fences also provided increased management flexibility as they can easily be moved or adjusted to improve grazing distribution, increase harvest efficiency, and enhance wildlife habitat.

Summary

Virtual fence is a relatively new technology that has the potential to improve grazing management without physical fences while providing GPS tracking of livestock. For the last year, researchers at North Dakota State University have been evaluating the use of virtual fence to graze rangeland and annual forages. In both rangeland and annual forage systems, GPS location data was logged at 30-minute intervals, and the number of management cues received by each animal was recorded. This data determined the number of breakouts and time spent outside the designated grazing area. The virtual fence was utilized in two experiments. For the first experiment, virtual fencing was used to patch graze on rangeland at different grazing intensities to create heterogeneity. Four herds of cow-calf pairs with 19 to30 pairs per herd grazed rangeland from June 8 to Oct. 20, 2023. Herd size was based on the estimated carrying capacity of each pasture. For the second experiment, yearling heifers grazed annual forage pastures in the fall using four grazing and technology treatments: 1) continuous grazing, 2) strip graze with manual fence, 3) strip graze with automated fence and 4) strip graze with virtual fence. Stocking rates were estimated based on biomass production at the time of grazing. Each treatment was grazed by 8 to 12 head of yearling beef cattle, depending on forage production, from Oct. 6 - Nov. 27 at the Central Grassland Research Extension Center (CGREC) and Oct. 2-16 at NDSU. Virtual fence was effective in containing animals in a designated grazing area 92% of the time in both grazing systems. Virtual fence was effective in managing grazing animals while providing increased flexibility in management as fences could easily be moved or adjusted to better meet management goals of improving grazing distribution, increasing harvest efficiency and enhancing wildlife habitat. As with any technology, producers must understand how this technology can be integrated into their production system to better enable them to meet their individual management goals.

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Introduction

Virtual fence is a relatively new technology that has the potential to improve grazing management without physical fences while providing GPS tracking of livestock. Livestock wear collars that communicate animal location in relationship to a virtual fence boundary via radio and/or cellular tower to a web- or phone-based application. Each animal receives audio and electrical cues, depending on its location in relationship to the virtual fence boundary.

Virtual fence has been shown to be effective in either including or excluding livestock from a designated area with the majority of research reporting 90% or greater success in managing grazing access of livestock (Aaser et al. 2024; Campbell et al. 2018; Campbell et al. 2020). When livestock have an adequate forage supply, the effectiveness of virtual fence increased over the grazing period as animals learned the cues, resulting in reduced electrical

cues to be effective (Hamidi et al. 2022; Ranches et al. 2021). There is variability in effectiveness between classes of cattle and individual animals. Boyd et al. (2024) and Utsumi et al. (2023) reported that cows with calves received more audio and electrical cues when compared to dry cows because of the social interactions with uncollared calves.

In addition to enhancing management of grazing animals, virtual fence can be used to improve habitat and wildlife management. The most obvious improvement is the removal of physical fences that inhibit wildlife movements. However, virtual fence also can improve our understanding of habitat use by livestock (Aaser et al. 2024) and manage livestock use of sensitive habitats by either limiting use or restricting use (Campbell et al. 2018; Campbell et al. 2020). To date, there is limited research published on the use of this technology in the United States and no research using it to manage cattle grazing of annual forages.

Experimental Procedure

For the last year, researchers at NDSU have been evaluating the use of virtual fence in grazing systems to manage livestock grazing on both rangeland and cropland to enhance grazing efficiency and livestock production. Prior to the grazing period for both experiments, cattle were fitted with virtual fence collars and went through a four-day training period. Calves were not collared. Across both projects, GPS location data was logged at 30-minute intervals, and the number of management cues received by each animal was recorded. These data determined the number of breakouts and time spent outside of the designated grazing areas.

On rangelands, the team evaluated the use of virtual fence to create heterogeneity of vegetation compared to traditional rotational grazing using fence and season-long grazing systems. The virtual fence was managed to patch graze at different grazing intensities. Animals were given access to a quarter, then half, then three quarters of a pasture, leaving one quarter ungrazed (Figure 1). The goal of this project was to enhance conservation benefits to wildlife while benefiting livestock production. To see if this goal is being achieved, the following metrics are being tracked: vegetative structure (wildlife habitat), plant species diversity, wildlife populations, forage production and livestock performance.

This project was piloted in 2023 at the CGREC near Streeter, ND. Virtual fence was used to manage four herds of cow-calf pairs with 19 to30 pairs per herd from June 8 to Oct. 20, 2023 Herd size was based on the estimated carrying capacity of each pasture. During the pilot study, vegetation structure was measured using Robel readings at the end of the grazing period. Livestock performance was collected by weighing cows and calves at the start and end of the grazing period.

The team is also evaluating strip grazing using different technologies on soil health, animal performance and behavior, and economic viability for cattle producers. We tested three techniques of strip grazing a cover crop: manual fence movement (polywire), automated fence movement, and virtual fence. The objective is to improve harvest efficiency, soil health, and livestock performance in an integrated crop and livestock system. The following parameters are being evaluated: forage production, harvest efficiency, soil chemical and physical properties, and livestock performance.

The strip grazing project was piloted in 2023 at the CGREC and the NDSU campus in Fargo, ND. An annual forage was grazed in the fall using four grazing and technology treatments: 1) continuous grazing, 2) strip graze with manual fence, 3) strip graze with automated fence

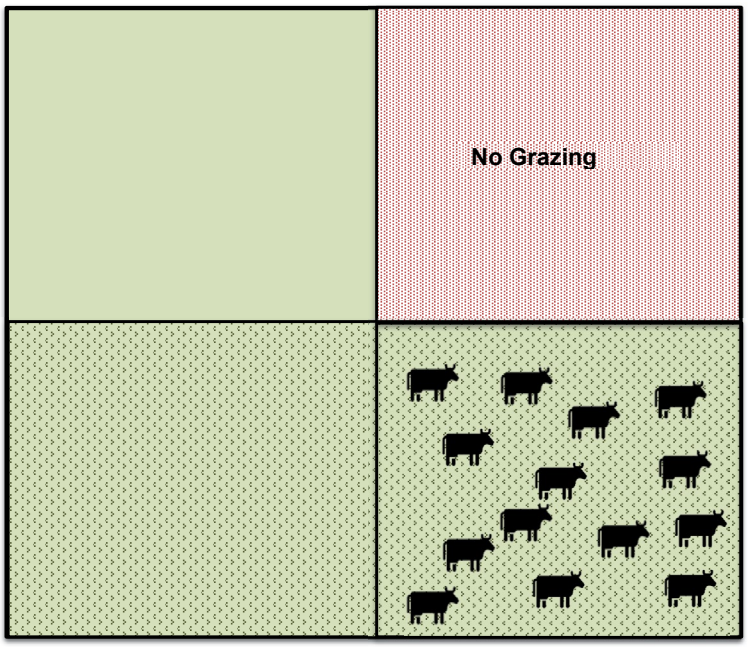

Figure 1. Diagram of patch graze system where cattle are restricted to the southwest quarter, then to the south half, then given access to three quarters, leaving the northwest quarter ungrazed.

and 4) strip graze with virtual fence. There was also an ungrazed treatment at each location. Field size was approximately nine acres, and stocking rates were estimated based on biomass production at the time of grazing. Each treatment was grazed by 8-12 head of yearling beef cattle Oct. 6 - Nov. 27 at CGREC and Oct. 2-16 at NDSU. Each treatment was clipped post grazing to estimate harvest efficiency of the grazing treatments. Livestock performance was also collected by weighing cows and calves at the start and end of the grazing period.

Results and Discussion

One of the greatest concerns from producers looking to adopt virtual fence is its effectiveness in keeping animals in or out of a designated area. Across both studies, we observed 92% containment of grazing animals to designated areas. This is consistent with research conducted in other locations, which reported 90% or greater containment (Aaser et al. 2024; Campbell et al. 2018; Campbell et al. 2020). Similarly, we observed increases in the number of cues animals received following move dates when becoming familiar with the new boundary and at the end of a grazing period when available forage was reduced. Boyd et al. (2024) reported a decline in containment from >94% to 75% as available forage was reduced.

Initial results suggest that we were successful in creating heterogeneity in structure across the pasture (Figure 2) with no negative impacts to cow or calf performance in comparison to the other grazing treatments. Heterogeneity in structure increases the habitat types available for waterfowl and grassland birds, and increases biodiversity of the bird population. Heterogeneity also increases plant species biodiversity, which benefits pollinator populations. These results indicate that virtual fence can be an effective tool in managing grassland ecosystems for wildlife.

Initial results of using virtual fence to graze annual forages indicate that similar harvest efficiency was achieved across all treatments. However, livestock performance varied between treatments with the virtual fence and manual fence treatments having higher performance (Figure 3). The reduced performance observed in the auto-gate treatment is likely due to animal behavior, as the animals did not move through the gate to utilize the last strip of forage. The reduced performance with similar harvest efficiency for cattle on the continuous graze treatment may be because of increased forage waste because of trampling and foraging behavior that resulted in lower quality forage as the grazing period progressed.

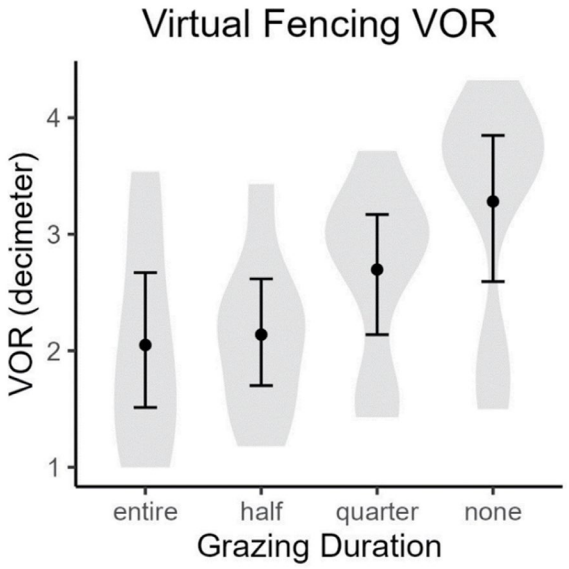

Figure 2. Virtual fence patch grazing structure measured using visual obstruction readings (VOR)

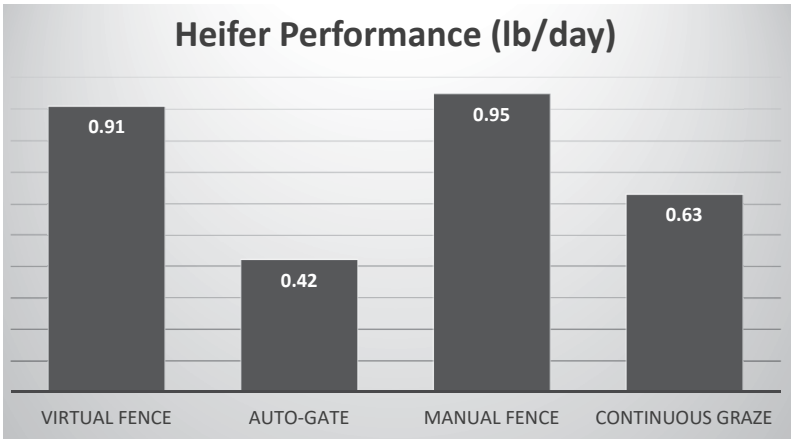

Figure 3. Heifer performance in pounds per day (lbs/day) when grazing late season annual forage with virtual fence, automatic gate, manual fence (polywire) and continuous grazing (no strips).

The initial findings of our research indicate that virtual fence is effective in managing grazing animals, providing increased flexibility in management as fences can easily be moved or adjusted to better meet management goals of improving grazing distribution, harvest efficiency, and wildlife habitat. However, adapting this technology is not without challenges. The cost is likely a barrier to many producers, and more economic information is needed. Economics will be evaluated as the current projects proceed. Additionally, time is needed to learn how to effectively use the technology to manage livestock to meet individual management goals. As with any technology, producers should understand how this technology can be integrated into their production system to better enable them to meet their individual management goals.

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