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Virtual fencing for managing lactating Holstein Friesian cows and its effect on animal welfare

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Introduction
Virtual Fencing (VF) is based on animal tracking and boundaries can be adapted to local conditions and animal needs. The use of VF in dairy farming could be beneficial as cows require high quality forage to meet their demand. This leads to more frequent paddock changes in pasture-based systems. However, the principle of VF is based on the animal's associative learning of an audio tone (AT; rising pitch) through electric pulses (EP; 0.2 J for 1 s), which might raise concerns from an animal welfare perspective.

Materials and Methods
Two separate experiments (E1 & E2) were conducted to investigate the adaptation process of 20 lactating Holstein-Friesian cows to a VF system during half-day grazing and its impact on animal welfare. In both experiments, the cows were naive to VF. In E1, the herd was divided into four stratified groups. Two groups were introduced to VF and two groups were managed with electric fencing (EF). Each group grazed simultaneously in separate paddocks for four consecutive periods in a rotational grazing system. To assess the effects on animal welfare, cow activity, feed intake, body weight, milk yield and cortisol were analyzed. In E2, the herd was divided into two groups of five younger cows (mean ± SD: 2.8 ± 0.3 and 2.8 ± 0.3 yrs, 1st lactation) and two groups of five older cows each (mean ± SD: 7.0 ± 1.4 and 8.0 ± 3.0 yrs, ≥ 4 lactations) to analyze whether age affects cow activity, milk yield and hair cortisol under VF management. Each group grazed simultaneously in separate paddocks for five consecutive periods in a strip-grazing system.

Results
In both trials, the VF system effectively kept the cows within their assigned grazing area. The cows learned to adapt to the VF system and the repetitive situation of a new virtual boundary in both a rotational and a strip grazing management system. In E1, each cow received a mean (± SD) number of 1.9 ± 3.3 ATs and 0.1 ± 0.7 EPs per day. The number of ATs and EPs decreased over time ($P < 0.001$) with the highest learning curve during the first three days after virtual fence activation. This finding was also evident in E2, with younger and older cows adapting equally fast to VF. Finally, milk yield, milk and hair cortisol, feed intake, body weight as well as activity and lying behavior were not affected by the use of the VF system.

Conclusions
The VF technology can be a helpful tool for managing dairy herds in pasture-based systems. Dairy cows, regardless of age, adapted rapidly to the VF system without compromising their welfare according to the indicators measured and during the periods studied.