VISTOCK Project: an Integrated System for Precision Grazing Management by Virtual Fencing

Giovanni Argenti[1], Camilla Dibari[1], Marco Moriondo[2], Nicolina Staglianò[1], Edoardo Bellini[1], Riccardo Bozzi[1], Carolina Pugliese[1], Chiara Aquilani[1], Lapo Nannucci[1], Andrea Confessore[1], Silje Eftang[3], Paola Semenzato[4], Sandro Nicoloso[4]

[1]DAGRI, Univ. Firenze, IT, giovanni.argenti@unifi.it, camilla.dibari@unifi.it, nicolina.stagliano@unifi.it, edoardo.bellini@unifi.it, riccardo.bozzi@unifi.it, carolina.pugliese@unifi.it, chiara.aquilani@unifi.it, lapo.nannucci@unifi.it, andrea.confessore@unifi.it
[2]CNR-IBIMET, Firenze, IT, marco.moriondo@cnr.it
[3]NOFENCE, Batnfjordsøra, NO, silje@nofence.no
[4]D.R.E.AM. Italia, semenzato@dream-italia.it, nicoloso@dream-italia.it

Introduction

Extensive livestock grazing-based systems are widespread for beef cattle feeding strategies, combining the advantages of low production costs with better animal welfare. Nevertheless, to be environmentally sustainable, grazing in extensive rangelands must be efficient in terms of livestock performance, as acknowledged being more impactful (CO_2 equivalent / unit of product) than intensive ones (Tullo et al., 2019). Consequently, an appropriate balance between forage utilized by animals and grass regrowth is unavoidable to ensure high efficiency in pasture management (Holechek et al. 2011). In this context, the implementation of rational management techniques (*i.e.* rotational grazing) may represent a valuable solution to reach this goal with respect to the traditional systems, such as continuous grazing.
This work introduces the VISTOCK (VIrtual fencing precision liveSTOCK farming) project, an integrated precision rotational grazing system, based on Remote Sensing (RS) techniques coupled with Virtual Fencing (VF) technology, in two extensive grazing areas in Tuscany. The VF consists of a GPS-GIS based technology to manage grazing without the setting of physical fences (Umstatter, 2011), which, coupled with precision livestock tools, ensures reduction in labour and material costs connected to traditional fences as well as a better protection of environmentally sensitive areas (Lee et al., 2018). Planning rotational grazing system is based on forage production and growth monitoring at high temporal and spatial resolution, which results expensive and time consuming if performed with traditional on-field methods. For this reason, the acquisition of high-resolution temporal and spatial information on vegetation by Remote Sensing (RS) techniques may represent a cost-effective method to monitor grass production along the grazing season (Hatfield et al., 2019). In this project, different RS techniques will be tested and validated for their reliability in monitoring grass production and forage quality in combination with rational grazing system settled by VF techniques over two extensive rangelands.

Materials and Methods

The trial is settled in two sown grazing sites in Mugello area (Northern Tuscany). Site 1 is located at 200 m a.s.l. in a plain area of about 30 ha surface (Fig. 1), while Site 2 is placed at 600 m a.s.l. extending about 5 ha in a hilly area (Fig. 2). In both sites, vegetation is grazed by 30 and 10 beef Limousine cattle, respectively. In each farm two plots were settled, one for testing and one for control. In order to calculate paddock areas with VF, the effectiveness of different RS techniques (*e.g.* satellite images, Unmanned Aerial Vehicle-UAV, RGB digital cameras) for monitoring and estimating pasture vegetation dynamics and quality production is tested and validated against two years of field measurements (2020 and 2021). First, data of forage production, botanical composition and quality are on-field measured at different stages from 16 exclusion cages of 1 m^2 (8 for each area). At the same time, samples outside each cage are gathered so as to determine utilization rates. Satellite images (Sentinel-2, 10 m-spatial resolution and 5 days-temporal resolution) and images at higher spatial resolution derived from multi-spectral cameras settled on UAV will be acquired in coincidence with field measurements. Lastly, 4 RGB digital cameras

(two for each site) are installed in pastures proximity to acquire daily high-resolution digital images of vegetation growth. Relevant vegetation indices (*e.g.* NDVI) are calculated from the multispectral and RGB images, and then correlated with observed data of pasture production and quality. Empirical multivariate models will be then developed to estimate pasture production along the grazing season. Finally, the developed models will be used during the second year to assess forage availability and, consequently, calculate the optimal extent of virtual fencing paddocks in a rotational grazing management. Grazing animals will be equipped with GPS collars (Nofence® Grazing technology) able to create virtual paddocks and to contain cattle inside the set area through acoustical and electric impulses. Moreover, animal performances (such as Body Condition Scoring) will be analyzed between the different rearing systems (VF vs traditional grazing).

Figure 1. Site 1.

Figure 2. Site 2.

Results

Forage growth monitoring through RS integrated with VF technology will allow to test and validate a rational management in extensive rangelands, while reducing costs of management, incrementing the performances of the whole system and ensuring animal production and welfare. The results will provide a practical and fast procedure to estimate forage biomass to adjust the grazing extent according to animal needs along the season, in order to enable a proper implementation of a precision livestock farming.

Conclusions

VISTOCK project represents a first step in the development of an innovative precision approach in extensive grazing land systems management. The results will provide scientific-based insights on the applicability of a RS-VF integrated system for precision rotational grazing management that will lead to economic benefits, improvement of pasture conditions (e.g. soil fertility, organic matter content), lower GHG emissions, reduction of pasture degradation and improvement of animal intake in extensive rangelands.

Literature

Hatfield J.L. et al. 2019. Applications of Vegetative Indices from Remote Sensing to Agriculture: Past and Future. Inventions, 4: 71.

Holechek J.L. et al. 2011. Range Management: Principles and Practices. 6th edn, Pearson Education, Inc:New Jersey, NJ.

Lee C. et al. 2018. A framework to assess the impact of new animal management technologies on welfare: A case study of virtual fencing. Frontiers in Veterinary Science, 5(AUG): 1–6.

Tullo E. et al. 2019. Review: Environmental impact of livestock farming and Precision Livestock Farming as a mitigation strategy. Science of the Total Environment: 2751–2760.

Umstatter C. 2011. The evolution of virtual fences: A review. Computers and Electronics in Agriculture, 75(1): 10–22.