BOOK OF ABSTRACTS

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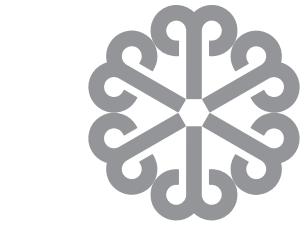

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A remote sensing approach to assess the stability of forage production from legume-rich mixtures oversown in Mediterranean wooded grasslands

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Agroforestry for the Green Deal transition. Research and innovation towards the sustainable development of agriculture and forestry

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Abstract

Grassland improvement by sowing legume-rich mixtures is gaining importance since this practice can enhance forage availability (Hernández-Esteban et al. 2018), improve soil fertility (Bondaruk et al. 2020), and enhance microbial diversity, thus N fixation and C sequestration (Moreno et al. 2021). Legume oversowing can be expensive to implement in silvopastoral farms due to the high cost of seeding mixtures. Nevertheless, legume-based forage systems can represent a means facing the raising input costs (e.g. fertilisers). The hypothesis of this study is within the insights of satellite Remote Sensing as a tool to estimate grassland forage availability. The objective of this study was to assess, through Landsat time-series, the impacts of legume-rich mixtures oversowing on the forage production and temporal stability in Mediterranean silvopastoral systems.

The study was conducted at six Dehesa farms located in Extremadura, Spain. Wooded grasslands are managed through continuous grazing of mostly cattle, pigs, sheep, and wild cervids. In each farm, legumes-rich mixtures (*Trifolium subterraneum*, *Ornithopus sativus* L., *T. incarnatum* L., T. michelianum Savi, *T. resupinatum* L., *T. vesiculosum* Savi, and *T. glanduliferum* Boiss) have been sown over years (from 2002 to 2015) in large fields. Vectorial objects identifying trees were created processing PNOA orthophotos with the eCognition© software. At least three per year spring Landsat uncloudy images (USGS, https://earthexplorer.usgs.gov) were collected starting from 4 years before the first sowing to 2019. The Normalised Difference Vegetation Index (NDVI) values were calculated and pixels with at least 70% of open-grazing-area were identified using the functions of the "raster" package within the R environment. A mixed-effect model was run to test the effect of both period (before vs after sowing) and age (years to/from the sowing) on NDVI. NDVI stability analysis identifying pixels having Stable-High (SH), Stable-Low (SL), and Unstable (U) NDVI was performed according to Basso et al. (2019). To test how long the

differences between stability classes lasted after the sowing, a sensitivity analysis was carried out by performing a paired t-test (before vs after) one age at a time.
The period significantly (P<0.001) influenced the NDVI, which was significantly higher after than before the sowing, while any significant trend of NDVI was observed. The sensitivity analysis highlighted that significant differences between periods (after>before) in the SH area can be observed up to including the 6th year after sowing. Significant differences (after<before) between periods in the U area can be observed up to the 4th year after sowing. The stability map referred to the Farm1 is reported in Figure 1.
The lack of significant trends of NDVI suggests that the positive effect of legumes oversowing could be persistent for a long time (>10 years). However, the increase of stable and high-productive areas is significant only in the short-mid term after sowing, suggesting the presence of environmental factors (e.g. P availability) affecting the spatial variability of forage production. These preliminary results suggest that the impacts of the legumes oversowing could be an effective long-term strategy to improve forage production and thus to enhance ecosystem services in Mediterranean wooded grasslands.

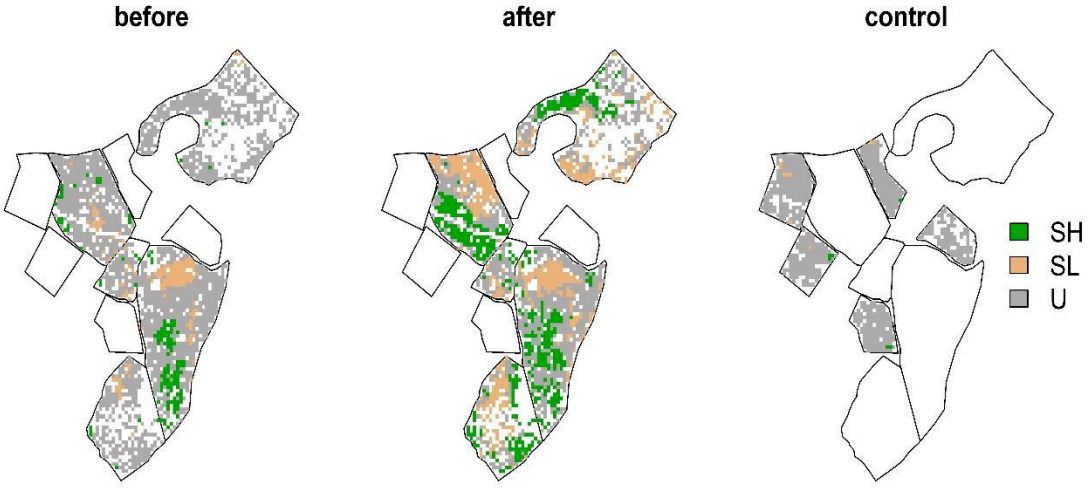

Figure 1. Stability Class map at the Farm1 (Atoquedo) in sown areas before (left) and after (centre) sowing, and in control areas. The map reporting the stability classes after sowing refers to the period from sowing to the 4th year after sowing, according to the sensitivity analysis. SH = Stable and High NDVI; SL = Stable and Low NDVI; U: Unstable NDVI.

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