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Bioversity International

CIAT
International Center for Tropical Agriculture

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RESEARCH PROGRAM ON
Livestock

Improved feed & forage germplasm and new tools and technologies for breeding

Progress report:
Use of satellites and drones for estimation of forage quantity and quality

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Remote sensing approaches have the potential to estimate important parameters such as forage biomass and forage quality. Over the last four years, the Tropical Forages Program and partners have put effort to develop methods to estimate such parameters using satellite imagery and drones. This has led to significant advances which can accessed in the links below.

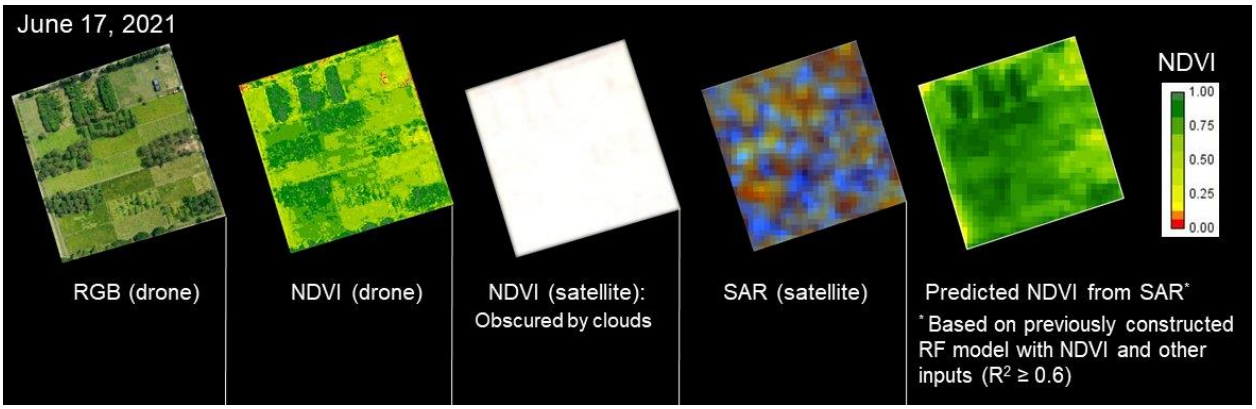
Year	Topic	Link
2018	Protocol and checklist image collection from drones collection	http://bit.ly/37AIUAs
2019	Protocol and checklist image analyses from drones	https://bit.ly/3CXJN4I
2019	Prototocol data collection and processing Sentinel 2 images using GEE	https://bit.ly/3p5cuYL
2019	Comparison of Sentinel 2 and drones analyses, and data fusion	https://bit.ly/2ZrCAwe
2019	Establishment of a machine learning classifier for identifying pastures types	https://bit.ly/3xwaeNV
2020	Remote sensing for management of pastures	https://bit.ly/3FLHoMk
2020	Remote sensing for predicting forage quantity and quality using Planetscope data	https://bit.ly/3E9x7ZW
2020	R Scripts to run analysis for prediction of forage quantity and quality using Planetscope data	https://bit.ly/3xqTGqy
2021	Remote sensing for shoot traits using drones	https://bit.ly/3CWBF4J

This body of work can be summarized as follows:

1) Drones and satellite can complement each other. Normalized vegetation difference index (NDVI) as an indication of plant vigor and calculated from satellite and drones can be used in large areas, where manual recording of pastures vigor is not possible or logistically difficult.
2) However, NDVI can be used as a proxy for biomass or height at early stages of plant growth (i.e. during establishment and when leaf growth is greater than stem elongation) but not at later stages.
3) The best classifier for identifying pastures is Random Forest (RF).
4) Ash concentration, standing biomass, crude protein and digestibility can be predicted from high resolution satellite imagery (Planetscope, 3 m pixel) using random forest regressions.
5) Red and NIR bands from satellite sensors (Plantscope) were found the most important bands to predict ash concentration, standing biomass, crude protein and digestibility.
6) Nowadays, phenotyping of shoot traits (cover area, greenness and volume of plants) using drones of large number of plants is routine work

Promising preliminary results

7) The presence of clouds in many satellite images indicates that other methods to estimate remotely vigor of plants, such a SAR (synthetic aperture radar) must be taken into consideration. Preliminary results show promise to predict NDVI from SAR data using RF (Figure below).



Next steps

8) A workflow for Remote Sensing (high and medium resolution satellites) of Tropical Forage Quantity and Quality including assessment of algorithms and approaches of feature selection
9) Improvement of prediction of forage quality from multispectral sensors mounted on a drone.
10) Data fusion of both sources of images (satellites and drones) using SATRM

Acknowledgements

The present work was partially funded by CGIAR Research Program on Livestock (supported from CGIAR Fund Donors and through bilateral funding agreements); and BBSRC funded project CoForLife.