Pixels to pasture: How AI can help farmers predict their pasture

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Credit: Isabela Salazar

Researchers from the Alliance of Bioversity International and CIAT have paved the way for farmers (from small-holders to big ranchers) information about the quantity and quality of their grazing pastures, right

there on their smartphone.

In 2020, global agricultural emissions were 16 billion tonnes of carbon dioxide equivalent, according to the Food and Agriculture Organization of the United Nations (FAO) and other FAO data shows that cattle—including meat and milk—contribute around 3.8 billion tonnes of carbon dioxide equivalent. Increasing the efficiency and output of cattle grazing (like increasing milk production or a larger number of animals) without adding a larger environmental footprint is a key goal in reducing these emissions.

In a 2024 paper "Pixels to pasture: Using machine learning and multispectral remote sensing to predict biomass and nutrient quality in tropical grasslands" published in the journal *Remote Sensing Applications: Society and Environment,* researchers from the University of Glasgow and the Alliance of Bioversity International and CIAT lay out a how-to guide on taking information from satellites and using predictive models to evaluate grazing pastures in terms of quantity (how much biomass) and quality (crude protein, digestibility, and ash content).

Juan Andrés Cardoso Arango, a co-author of the paper and a plant eco-physiologist focusing on tropical forages at the Alliance of Bioversity International and CIAT, explains that today, analyzing all the factors that determine quantity and quality are hard to scale: using a small drone, you can only sample nine hectares or so at a time and even less with hand-held instruments.

"In some parts of Colombia, you can have properties of 3000 hectares," he says, adding that this is one of the reasons the researchers developed a "scale neutral" system, that can gather data via satellite, square kilometers at a time, but also be just as useful to a farmer with just one hectare.

Cardoso explains that free-to-use satellite imagery databases and technological advances in AI-driven processing have "democratized" this analysis.

"When I started in 2018, nobody knew about machine learning, now you can have this information faster than before," he says.

AI-driven prediction

Diana María Gutiérrez Zapata, a senior research associate at CIAT, a data analysis specialist and co-author on the paper explains that predicting pasture productivity and quality using remote sensing is challenging due to the many influencing factors and data limitations.

"By better characterizing productive systems and capturing more accurate data on control and response factors, there is significant potential to develop high-performance predictive models," she says, "These models can underpin digital tools to support strategic decision-making, enabling farmers to optimize pasture management and better manage risks (such as water scarcity and low-quality forage) within their production systems."

Brian Barrett, a reader (associate professor) at the University of Glasgow, in Scotland, UK, a co-author of the study and an expert in spaceborne sensors, explains that in 2017, he, Cardoso and colleagues met and started to discuss the potential use of remote sensing or earth observation data and machine learning approaches for estimating forage characteristics across different climates, including intensive and extensive pastures.

"Important to us was the connection with smallholder farmers and how we could develop something that would provide useful information for them and ultimately lead to improved decision making and

management," Barrett says.

The future

Cardoso explains that the long-term aim is to develop a model with a user interface as easy to use as Google Maps.

"We want a farmer to locate their farm on a platform and check the quantity and quality of their forage," he says.

Gutiérrez explains that in a changing climate, having timely information about expected pasture production or quality is crucial for risk management.

"By being more aware of the risks associated with pasture management decisions, farmers can make better-informed choices regarding production, use, and conservation," she says, "This not only benefits farmers by optimizing resource use but also positively impacts the environment by reducing emissions and waste, addressing various issues aligned with the Sustainable Development Goals."

Barrett explains that in the future the team would like to develop the approach to allow not only a better idea of available forage resources but also how pastures would react to different management and climate scenarios.

"As most forest loss globally (~75%) has been driven by conversion to agriculture, and given increasing global populations, and the associated increases in food consumption and resource use, it is critical that we find new ways to increase food production while preserving our remaining forests," he says, adding that incorporating technologies such as satellite data and advanced machine learning approaches can lead to more efficient and profitable farming, and improved food system

sustainability.

More information: Mike Zwick et al, Pixels to pasture: Using machine learning and multispectral remote sensing to predict biomass and nutrient quality in tropical grasslands, *Remote Sensing Applications: Society and Environment* (2024). DOI: 10.1016/j.rsase.2024.101282

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