Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Remote sensing for predicting maize yields in South Africa to enhance food security

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Abstract

Maize is a crucial staple for food security in Southern Africa, and timely and accurate yield forecasts are needed to mitigate potential food shortages. With increasing pressure from climate change and changes in land use, understanding and predicting crop yields accurately is vital for food security and resilience in rural communities. This research provides a modern approach to monitoring agricultural performance, allowing proactive measures in the management of food production. This study investigates the application of remote sensing techniques, specifically the Vegetation Condition Index (VCI), to estimate maize yields in South Africa. A regression approach was used to correlate the number of dry dekads, derived from VCI, with official ground-based maize yield estimates over four growing seasons: 2019–20, 2020–21, 2021–22, and 2022–23. The VCI was calculated using a time series data set of the Normalised Difference Vegetation Index (NDVI) from Sentinel 2 satellite imagery spanning 2019 to 2023. The analysis revealed a highly significant negative correlation between the number of dry dekads and the maize yields, with regression models explaining between 70 % and 88 % of the variation in yield. These models were validated using independent official yield data, demonstrating strong agreement and strengthening the reliability of the findings. The persistent negative relationship between dry dekads and maize yield underscores the effectiveness of VCI-derived metrics in forecasting yield before crop maturity. This predictive capacity is vital for strategic agricultural planning, allowing timely interventions to manage potential food deficits or surpluses. The use of remote sensing data can improve decision-making processes, ultimately contributing to improved food security in the region. Furthermore, this study highlights the importance of integrating technological innovations in agriculture, particularly in the context of reconciling changes in the land system with planetary health. As agricultural practices evolve in the face of challenges such as climate change and urbanisation, understanding how to balance productivity with environmental sustainability becomes critical. Therefore, the application of remote sensing to estimate maize yield not only supports agricultural productivity, but also promotes sustainable practices essential for the health of our planet.

Keywords: Agricultural forecasting, food security, maize yield, Normalized Difference Vegetation Index (NDVI), remote sensing, Vegetation Condition Index (VCI)

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