Sugarcane yield prediction using UAV-derived vegetation indices and machine learning models

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Accurate yield prediction is crucial for resource planning and sustainable sugarcane production. Traditional methods are labor-intensive and spatially limited. This study explores the integration of UAV-derived multispectral imagery and machine learning models for predicting key yield attributes; field Brix and fresh weight of sugarcane variety SL 96 128. The research was conducted at the Sugarcane Research Institute, Udawalawa, Sri Lanka, using a nitrogen variability field trial. High-resolution images captured by a DJI Phantom 4 Multispectral UAV at 10, 11, and 12 months after planting were processed to compute five vegetation indices (NDVI, GRVI, ExG, DVI, and RVI). Ground data were collected from 180 Regions of Interest (ROIs), of which 70% (126 ROIs) were used for model training and 30% (54 ROIs) for validation. Simple linear regression and four ML models; Random Forest (RF), Support Vector Regression, Multiple Linear Regression, and Extreme Gradient Boosting (XGB) were evaluated. ML models outperformed statistical approaches, with RF and XGB achieving the highest accuracy for field Brix ($R^2 \geq 0.97$, RMSE ≤ 0.07) and fresh weight ($R^2 = 0.99$, RMSE < 1.3). GRVI emerged as the most robust vegetation index, particularly at later maturity stages, due to its sensitivity to chlorophyll concentration and canopy greenness. The findings demonstrate that UAV-ML integration enables highly accurate, non-destructive yield prediction, supporting data-driven decisions for harvest scheduling and input management. This approach can significantly enhance precision agriculture practices in Sri Lanka and offers a scalable model for tropical sugarcane systems.

Keywords: *Machine learning, Random Forest, Sugarcane yield, UAV, Vegetation indices*

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