Predicting plant height, tiller number, and stem girth in sugarcane from UAV-derived vegetation indices via linear regression

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Efficient, scalable monitoring of sugarcane is constrained by labour-intensive field measurements. We developed and validated linear regression models using UAV multispectral imagery to predict plant height, tiller number, and stem girth. Model development was conducted at the Sugarcane Research Institute (SRI), Udawalawa, in a field trial of 64 plots comprising two varieties: SL 96 128 and CO 775 under eight nitrogen treatments. Multispectral data (DJI Phantom 4 Multispectral; Blue 450 nm, Green 560 nm, Red 650 nm, Red-edge 730 nm, NIR 840 nm) were collected at 10, 11, and 12 months after planting. Ground truth was recorded across 180 regions of interest (ROIs). We used a 75/25 split for model training/testing, yielding n = 135 for training and n = 45 for internal testing. Vegetation indices (NDVI, RVI, GRVI, ExG, DVI) were computed and regressed against agronomic traits. At 12 months, NDVI consistently outperformed other indices at SRI: plant height R^2 = 0.76 (RMSE = 5.92), tiller number R^2 = 0.75 (RMSE = 2.99), and stem girth R^2 = 0.71 (RMSE = 0.20). To assess generalizability, independent validation was performed on an unseen commercial dataset from the Lanka Sugar Company, Pelwatta. Validation retained strong performance for NDVI-based models: plant height R^2 = 0.74 (RMSE = 5.88), tiller number R^2 = 0.73 (RMSE = 2.78), and stem girth R^2 = 0.70 (RMSE = 0.15). Findings indicate that simple, interpretable linear models built on UAV-derived NDVI provide reliable predictions of sugarcane agronomic traits at maturity, with consistent accuracy across research and commercial settings. This workflow reduces dependence on manual sampling and enables timely, cost-effective decision-making for precision management.

Keywords: *UAV, NDVI, Linear regression, Precision agriculture, Sri Lanka*

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