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Seasonal variability of gndvi in selected shade trees within cocoa agroforestry systems in Ghana

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Abstract

Cocoa agroforestry systems have the potential to diversify production, increase cocoa yields and boost farmers income. However, the impact of shade trees on cocoa production remains a complex issue, with both positive and negative effects. Traditional methods of assessing shade tree impact rely on manual observations and direct measurements, which can be resource-intensive and limit the scope of the study. Utilisation of high-resolution multi-spectral drone imagery offers a promising approach to examine biotic and abiotic stress in agroforestry systems. Multispectral drone images were captured using a DJI Multispectral drone during three distinct seasons: late-wet season (November 2021), peak-dry season (February 2022) and mid-wet season (July 2022) across ten smallholder cocoa plantations of similar age in Ghana. Cocoa and nineteen shade tree species, representing different functional groups based on leaf phenology, were selected for analysis. This study primarily investigates the potential of the Green Normalized Difference Vegetation Index (GNDVI) in detecting variations in canopy reflectance properties among diverse shade tree species in agroforestry systems. We found that GNDVI can effectively distinguish species-specific canopy reflectance properties when observed over multiple time points. However, single observations may require a relatively high number of individuals due to intraspecific variations. Additionally, GNDVI proved useful for examining species-specific physiological responses to seasonal and environmental variations. Our findings suggest that the GNDVI can be utilised to enhance the understanding of mixed agroforestry systems and individual trees. Moreover, we aim to investigate the potential of GNDVI in improving the selection process for suitable shade tree species within agroforestry systems. Further analysis of shade tree traits and interactions with cocoa trees through drone image analysis has the potential to provide innovative insights into cocoa agroforestry system functioning. Future research could further analyse shade tree characteristics and their effects on cocoa trees, further enhancing the understanding of cocoa agroforestry systems and their interactions to offer practical insights for sustainable agricultural practices.

Keywords: Agroforestry, cocoa