Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Multispectral drone image analysis for shade tree functional traits and drought response in cocoa agroforestry systems

Issaka Abdulai[1], Nikolas Piont Konwski Grünther [2], Richard Asare[3], Muhammad Habib-ur-Rahman[4], Reimund P. Rötter[5], Munir Hoffmann[6]

[1] *University of Göttingen, Dept. of Crop Sciences: Tropical Plant Production and Agricultural Systems Modelling (TROPAGS), Germany*
[2] *University of Goettingen, Dept. of Crop Sciences: Tropical Plant Production and Agricultural Systems Modelling (TROPAGS), Germany, Germany*
[3] *International Institute of Tropical Agriculture (IITA), Ghana*
[4] *University of Göttingen, Crop Science, Germany*
[5] *University of Goettingen, Dept. of Crop Sciences; Tropical Plant Production and Agricultural Systems Modelling (TROPAGS), Germany*
[6] *University of Göttingen, Dept. of Crop Sciences: Tropical Plant Production and Agricultural Systems Modelling, Germany*

Abstract

Sustainable cocoa production plays a key role in sustaining rural livelihoods and offers a pathway for climate change adaptation and mitigation in tropical agroecosystems. While the role of cocoa agroforestry systems for biodiversity conservation is well established, their functioning for climate change adaptation remains critical due to perceived below ground competition for water, even though it is also argued that shade trees play a key role in regulating above and below ground resource use dynamics in agroforestry systems. This study utilises the 'Green Normalized Difference Vegetation Index' (GNDVI) to assess variations in shade tree canopy reflectance variations and its relations to physiological traits (transpiration and stomatal conductance) over wet and dry seasons. Thirteen (13) shade trees species belonging to different functional groups based on leaf phenology were selected across 10 smallholder cocoa plantations of similar age in the northern cocoa belt of Ghana. Tree morphological traits (DBH, height, canopy area) and leaf phenology were recorded for 8 randomly selected individual shade trees of each species. Physiological traits were measured on 4 replicate per shade tree species.

Analysis will be conducted for two distinct time points: wet season (July 2022) and peak-dry season (February 2023) from high resolution multispectral images from a DJI Multispectral camera drone and leaf transpiration and stomatal conductance data measured with Licor Li 600 porometer. The spectral data (GNDVI) will be correlated with the *in situ* measurements of leaf transpiration rate and stomatal conductance to understand how spectral reflectance changes with water status between the seasons. This will help to understand how spectral indices correlate with tree water status and soil moisture content to allow early detection of water stress compared to traditional methods of *in situ* measurements. The study will help to identify the interactions between seasonal climatic variations and shade tree leaf phenological characteristics and establish a pathway for early detection of drought stress in cocoa agroforestry systems through the use of GNDVI.

Contact Address: Issaka Abdulai, University of Göttingen, Dept. of Crop Sciences: Tropical Plant Production and Agricultural Systems Modelling (TROPAGS), Göttingen, Germany, e-mail: iabdula@gwdg.de

Keywords: Cocoa agroforestry, GNDVI, leaf phenology, morphological traits, remote sensing, shade tree species, spectral indices