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Estimating Yield of Household Groundnut Fields in Rural Smallholder Farming Systems: Implication for Household Food Security

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Climate change has created uncertainty in agricultural production with increasing impacts on yield and food security. Limited production resources and dependence on rainfed agriculture in Sub-Saharan Africa (SSA) expose smallholder farmers to greater vulnerability to climate change. Accurate prediction of crop yield before harvest is critical for providing critical information on yield challenges to plan for household food needs. High resolution satellite data with a daily return allows for close observation of crop phenology and crop biophysical characteristics at farm-level during crop growth. Based on harvest data, in-situ leaf area index and vegetation indices (VIs), we used linear regression and random forest regression models to predict groundnut yields on smallholder farms in rural northern Malawi. We found that random forest regression outperformed the other methods in predicting groundnut yield with R^2 = 0.93 and Root Mean Square Error (RMSE) of 0.67 kg/ha. Using the RF model to predict yield with a different set of data showed that the best growth stage to predict groundnut yield in the study area is during the R3/podding stage (R^2 = 0.92, RMSE = 0.24 kg/ha) when leaf chlorophyll content is highest. The final model was applied to predict yield for four different farms and the results were compared to total reported yields from the fields. The results showed that the model underestimated yields by between 0.85% and 11% which is generally within post-harvest loss estimates in the country. The study highlights the potential for satellite imagery to provide pre-harvest yield predictions for smallholder fields to help with planning for food security in rural SSA.