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Plant diversity and productivity in Senegalese mango orchards: evidences from UAV photogrammetry

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Against the background of global population growth, agricultural productivity must be increased for achieving long-term food and nutrition security in West Africa. Contributing to address this issue, mango is a major fruit crop grown under various cropping systems in the region. The aim of this study was to test how orchard plant diversity, configuration, and practices affect mango yields from large commercial-based monospecific orchards to agroforestry systems. In thirty orchards of different mango cropping systems in Senegal, we mapped orchard land uses by UAV photogrammetry and object-based image analysis (14 classes) and quantified plant diversity (Patch richness, Shannon diversity, Simpson evenness index). Then individual mango tree characteristics (height, cultivars, crown area, and volume) were extracted from drone canopy height models and combined with a load index (taking into account year and management effects) to inform predictive yield models. The mapping procedure reached an average overall accuracy of 0.89 for classification of plant species and mango cultivars. Yield models reached satisfying accuracy with R^2 greater than 0.77 when evaluated with actual yield of 60 validation mango trees. Finally, results showed that orchard mango yield is not only driven by planting density and management practices but also by the tree species diversity, highlighting the efficiency of UAVs to inform stakeholders of complex agroforestry landscapes.

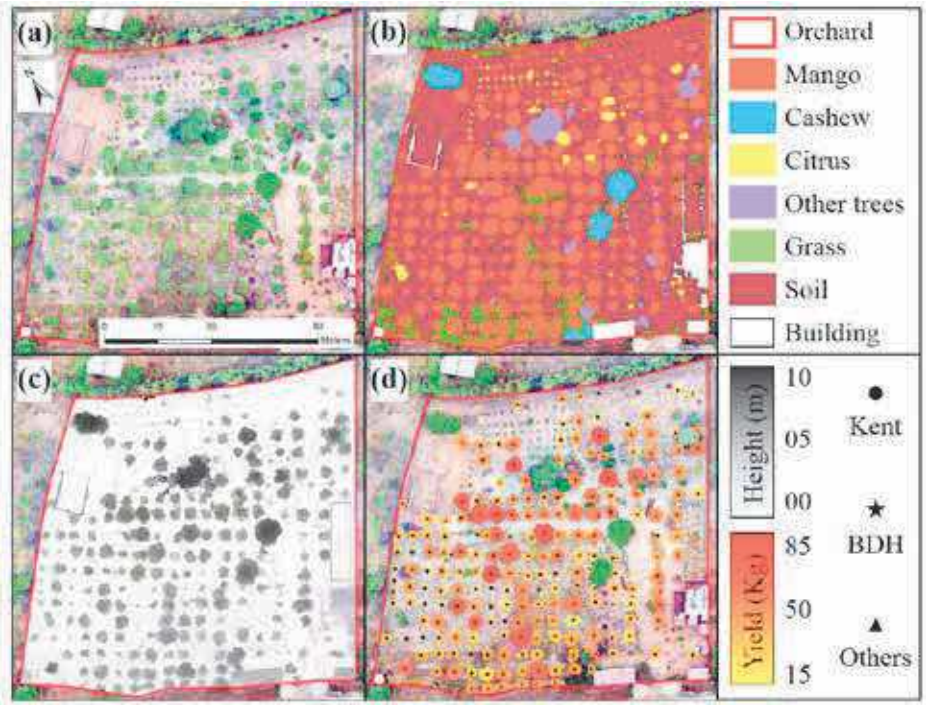

Figure. Mango orchard mapping: (a) UAV-acquired RGB orthomosaic; (b) land use map; (c) Canopy Height Model (in meter); (d) mango cultivar yield map (in kg per tree). UTM coordinates system (zone 28N); Datum WGS84.

Keywords: unmanned aerial vehicle, yield estimation, landscape mapping, GEOBIA.