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Tree planting pattern and plant diversity are major determinants of productivity in mango-based orchards in Senegal

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In West Africa, mango is a major fruit tree that contributes significantly to the food security and economy of smallholders. The mango tree is cultivated in different cropping systems that vary from diversified, which include various perennial and annual species, to large commercial-based monospecific orchards. These systems may recover different levels of productivity whose determinants are unknown. In this study, we determine how orchard structure, including plant diversity and planting pattern (planting density and spatial organization), affects mango productivity. Thirty orchards representing the three types of mango-based cropping systems (extensive, diversified, and intensive) in Senegal were mapped using an unmanned aerial vehicle (UAV). In 2017 and 2018, individual mango tree cultivar and dimension were extracted from UAV models and combined with a load index to estimate variables of mango productivity: orchard yield (t.ha-1), tree mean yield (kg.tree-1), and yield efficiency (kg.m-2 of mango canopy). Plant diversity and planting pattern were characterized using 14 different indices. Results show that orchard productivity highly depends on the cropping system. Orchard yield and yield efficiency are higher in intensive orchards than in extensive or diversified orchards. However, diversified orchards reached higher mean tree yield and intermediate yield efficiency. Analysis of correlations between orchard structure variables made it possible to select four variables (i.e., mango planting density, number of species, citrus percentage of land, and Shannon's evenness index) and explore their effect on each productivity variable. Orchard mango yield was positively affected by mango density and species diversity (Shannon index) (R^2 = 0.63). Finally, yield efficiency was positively impacted by mango density but negatively affected by species diversity (R^2 = 0.46). These results highlighted the effect of plant diversity and planting pattern as major determinants of mango productivity. However, the overall productivity of the orchard, including other species, needs to be considered in further studies.