## ABSTRACT

Climate change is expected to negatively affect crop productivity in several agro-ecological zones, especially in East Africa resulting in a deterioration of farm-households' livelihoods and incomes. Whereas adaptation to climate change and variability takes center stage in the agricultural development discourse, farm-households are still grappling with low crop productivity due to limited information on effectiveness of available adaptation practices and drivers of their adoption within complex farming systems at various scales. Using quantitative, qualitative and modeling approaches, this study determined the biophysical and socioeconomic drivers of adoption of climate adaptation practices; evaluated the effect of selected climate adaptation practices on current crop productivity; and assessed the near-term future climate change effects of selected current adaptation practices on crop productivity in Coffee-Based Farming Systems (CBFS) of Uganda. A total of 693 farm-households were surveyed in the targeted CBFS. The different CBFS were clustered into farm-household systems, and the uptake as well as current and future effect of adaptation practices was assessed using regression models at different scales. Trends and patterns of historical climate data (1980–2009) obtained from AgMIP Modern-Era Retrospective Analysis for Research and Applications (AgMERRA) depository database were characterized using the Mann-Kendall test, Sen's slope estimate and Rainfall Anomaly Index. Climate was projected in the near-term future (2010–2039) using twenty-nine Global Climate Models (GCMs) embedded in the Agricultural Model Intercomparison and Improvement Project (AgMIP) protocol under two Representative Concentration Pathways (RCPs), RCP8.5 and RCP4.5 for five climate regimes. The induced climatic suitability of major crop species was assessed using the Crop Ecological and Environmental Requirements (EcoCrop) model. The study results indicate that the range of biophysical and socio-economic drivers of adoption of adaptation practices increased at more localized scales with social and physical factors at landscape level; social, physical and natural factors among the five identified farm-household systems; social, physical, natural factors and parcel characteristics at parcel/farm level. Financial and human factors also affected adoption across farm-household systems and parcels. Consultation with extension staff was the generalized adaptation practice at landscape level in both CBFS; while coffee-banana-maize and coffee-maize-beans farm-household systems, specifically adopted crop diversification and on-farm activities; and coffee-off-farm, coffee-livestock-off-farm and coffee-banana systems additionally adapted through diversification into off-farm/non-agricultural activities. Farm-households experienced cyclic droughts and extreme rainfall, floods, landslides and hailstorms; crop losses, food shortages, pests and diseases across altitude gradients. The direct and indirect positive effects of current adaptation practices on crop productivity were most significant with agroforestry in both CBFS; inorganic fertilizer in Arabica CBFS on mainly annuals (maize and beans); mulch and organic manure in Arabica CBFS as well as soil bunds and trenches in Robusta CBFS majorly on perennials (coffee and banana). The study concludes that the current adaptation practices have significant potential to mitigate crop yield reductions especially if future climate becomes drier than wetter in the near-term, despite the likely decline in climatic suitability of most crops under drier climate scenarios (ensemble mean, cool-dry and hot-dry) and suitability improvement under wetter conditions (cool-wet and hot-wet). In addition, although the CBFS are likely to continue producing coffee, Ugandan coffee systems remain environmentally fragile and sensitive to climate change, where perennial crops are more vulnerable than annuals especially with future changes in rainfall within Robusta and high altitude Arabica CBFS under RCP4.5. The future changes are more likely in March-to-May and June-to-August, with extremes during September-to-November. The study recommends formulation of policies and strategies that promote adoption of the most promising adaptation practices to reduce current and future climate vulnerabilities with an agile extension service that has enhanced capacity to innovate and respond to the diverse adaptation needs within each CBFS. Further research is also needed to identify complementary adaptation practices e.g. through bioengineering, soil loss control and water draining efficiency technologies; that would boost positive crop productivity effects of current adaptation practices, as they are not sufficient on their own in the near-term future even with enhanced adoption rates.