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Climate change impacts on the agro-climatic suitability of major food and cash crops in Madagascar

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Abstract

Madagascar is one of the most food-insecure countries in the world with almost half of its population suffering from undernourishment. In 2019–21, an exceptional drought caused by well-below average rainfalls led to massive failure of the country’s main food (rice, cassava, maize and sweet potato) and cash (coffee, sugarcane, vanilla and cloves) crops. Although climate change only played a limited role in this drought, early adaptation planning is crucial to increase the resilience of mainly rain-fed agriculture. Here, we assessed the impact of climate change on the agro-climatic suitability of major food and cash crops in Madagascar using the Crop Ecological and Environmental Requirements (EcoCrop) model. Ecocrop is a mechanistic model that uses monthly temperature and precipitation data and characteristics to determine the suitability of a crop to be grown in a specific location. Model calibration was done based on input from local experts and literature, as well as, high-resolution CHELSA-W5E5 meteorological forcing data. The model performance was tested against data of harvested area at district level. ISIMIP3b climate data that provides bias-corrected CMIP6 climate forcing for ten global circulation models and three SSPs (SSP1-RCP2.6, SSP3-RCP7.0 and SSP5-RCP8.5) was used for future model runs. Model results indicate that the agro-climatic suitability of both food and cash crops is likely to decrease under global warming scenarios, however, with some regions and crops being less affected. The largest decrease in suitable land was simulated for rice, particularly in parts of the Taomasina, Mahajanga and Antananarivo province. Coffee suitability was simulated to decrease mainly on the central eastern coast of Madagascar, remaining suitable in the country’s north. Possible adaptation potentials could be the substitution of rice cultivation by maize or cassava in the northern part of the country. Simulation results also suggest that the expansion of sweet potato cultivation is a suitable adaptation option as this crop is less affected by climate change. It can be concluded that crop production in Madagascar is likely to become more challenging under climate change and that appropriate adaptation strategies are needed to increase income and food security among a highly vulnerable population.

Keywords: Climate change, coffee, simulation