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"Solidarity in a competing world — fair use of resources"

Understanding Yield Constraints to Guide Climate Change Adaptation for Arabica Coffee on Mt. Elgon, Uganda

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Abstract

Coffee (*Coffea arabica*) is the most important exported crop in Uganda. Almost 90 % of coffee production originates from small farms (< 1 ha), and the livelihoods of approximately one million smallholders depend on this activity. Average coffee yields in Uganda are low (<700 kg ha^{-1} $year^{-1}$), reaching only 20 - 30 % of those obtained in high-yielding regions, such as Latin American and Vietnam. On top of low productivity, the scarcity of land due to population growth and the impacts of climate change (i.e. rising temperature and changing rainfall patterns), increase the vulnerability of farmers' households and threaten the long-term sustainability of the coffee sector. Therefore, increasing resilience to climate change while improving coffee yield is one of the top priorities over the coming years. To achieve this, it is necessary to identify major production constrains and their effects on yield gaps. This study aims to investigate Arabica yield gaps and identify limiting production factors in three altitude ranges on the slopes of Mount Elgon, eastern Uganda. A total of 173 farmers distributed homogenously in each altitude class were interviewed about their management practices and presence of pests and diseases, and asked to recall yields of three consecutive years (2013, 2014 and 2015). Moreover, their farms were inventoried to determine the vegetative structure (coffee and shade tree density, shade tree species and canopy coverage), soil and foliar nutrients. Furthermore, coffee yields were estimated in the field, and environmental parameters (i.e. rainfall, soil moisture, temperature, relative humidity) were monitored during two years (2014 and 2015) in a subsample of 27 farms. Coffee yield gaps were investigated using boundary functions for each production factor per altitude class. We found that production constrains vary along the altitudinal gradient. Structural variables such as canopy closure and density of coffee trees have higher impact on yield at lower altitudes, whereas soil fertility problems (P and N deficiency) become more prominent with increasing altitude. Our results reinforce that management recommendations, which aim to increase yield and adapt to climate change need to be site-specific, adjusted to local needs and available resources, instead of being generalised for a whole region.

Keywords: Boundary functions, climate change, coffee, productivity, yield gap

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