From hectares to households: Farmer centric crop-modelling to assess differential climate change impacts and adaptation response

ABEL CHEMURA[1], PAULA ROMANOVSKA[2], ROOPAM SHUKLA[3], LISA MURKEN[2], CHRISTOPH GORNOTT[4,2]

[1] *University of Twente, Fac. of Geo-Information and Earth Observation (ITC), Dept. of Natural Resources, The Netherlands*
[2] *Potsdam Institute for Climate Impact Research (PIK), Climate Resilience, Germany*
[3] *Indian Institute of Technology, Centre of Excellence in Disaster Mitigation and Management, India*
[4] *University of Kassel, Fac. of Organic Agricultural Sciences, Germany*

Abstract

Crop simulation models (CSMs) are an important decision support tool in climate risk assessments and in designing resilient agricultural systems. However, the crop models simplify complex farming household diversity and systemic heterogeneities as they consider only the "mean" farmer. In this paper, we are particularly interested to understand how egalitarian is the crop simulation modelling approach in terms of its capacity to provide a more nuanced picture of impacts across different farmer types (classified based on assess and endowment of resources). To do this, we investigated the impact of climate change on maize and sorghum yield, the profitability for different types of farming households through an ex-ante assessment, and the yield response to adaptation strategies (access to irrigation and cropping improved varieties) in Northern Ghana. We find that with the same intensity of changes in climatic variables, yield impacts are different between maize and sorghum, with more impacts on the former across scenarios. We further observe that the highest impacts on maize (16 % low emission scenario and 25 % for high emission scenario) and sorghum (6 % low emission scenario and 14 % for high emission scenario) are on the medium resource endowed farmer (MRE), whose yield losses are in order of magnitude of about twice of the low resource endowed farmer (LRE) and the high resource endowed (HRE) farmer. The yield response to adaptation measures was also different across the three farmer types and crops. Irrigation was the most effective adaptation strategy but was more effective for the MRE farmer for maize (52 % low emission scenario and 66 % for high emission scenario) and sorghum (74 % low emission scenario and 76 % for high emission scenario). However, using an improved variety was only effective for maize for the MRE farmer but not so much for sorghum across the farmer types. Our findings underline the critical need to integrate farming household diversity into crop simulation models, to understand the differential impacts of climate change and the prioritised adaptation responses within the same region. These differential impacts and responses should be considered in designing and implementing climate change resilience initiatives.

Keywords: Climate impacts, crop modelling, farmer types, Ghana