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A discrete stochastic programming approach to quantify the financial value of seasonal forecasts to smallholder farmers in the Central Rift Valley of Ethiopia

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Abstract

Seasonal climate forecasts (SCFs) have the potential to reduce agricultural risk by providing valuable insights into upcoming weather patterns and fostering resilience and adaptability in response to climate variability and change. However, their use remains limited among smallholder farmers, particularly in developing countries like Ethiopia, due to a lack of understanding of its economic value. To assess this value, we designed a discrete stochastic programming model (DSP) implemented using the MPMAS (Mathematical Programming-based Multi Agent Systems) software package. The DSP estimates the economic benefit of seasonal rainfall forecasts for smallholder farmers in the Central Rift Valley of Ethiopia given different adaptation options to forecasted and observed weather trajectories, such as adjusting sowing month, crop choice, tied-ridging, and N-fertilisation. Yield estimates for crop management strategies and 2400 resampled weather trajectories were simulated using the FAO-developed Aqua-crop model and inserted in the DSP. The DSP maximises the expected monetary value determining the optimal sequential management response to rainfall patterns observed throughout the season considering weather observed until the respective decision point and the potential weather and associated risk for the remainder of the season. This distinctive approach ensures that the DSP takes into account the embedded risk that farmers face instead of assuming all decisions are taken at the beginning of the season. This avoids an important, but common conceptual bias, when comparing the expected monetary value with and without the forecast. Initial findings from the model suggest that farmers have intricate ways to respond to ongoing weather observations and it requires detailed analysis in which situations an imperfect forecast can really generate economic value for smallholder farmers.

Keywords: Climate adaptation, embedded risk and discrete stochastic programming, farm level model, value of information

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