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Accounting for weather variability in farm management resource allocation in northern Ghana: An integrated modelling approach

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Abstract

Smallholder farming systems in the Northern Region of Ghana are confronted with a wide range of risks related to weather variability and market volatility, among others. Together they are key reasons explaining farmers' limited investments to improve farm sustainability and productivity. Modelling can assist in understanding complex relationships and trade-offs between productivity, environment (e.g. soil fertility), and economic aspects in farm systems analysis. However, to date, few model assessments have explicitly explored the effects of weather variability on crop management and farm-level resource allocation. As crop yields and fertiliser response are highly sensitive to weather dynamics, this has implications for farm outcomes in any given year, as well as influencing subsequent investments in crop and farm management. This study introduces a new integrated modelling approach to optimise farm-level resource allocation considering annual weather-dependent variation in crop grain and biomass yields as well as annual variation in cash at hand and herd size for the case of smallholder mixed crop and livestock farming systems in northern Ghana. The integrated model combines a process-based crop model linked to a farm simulation model and an annual optimisation model. To better investigate the effects of weather, the crop model simulations are driven by a large ensemble of weather time series for two scenarios: good and bad weather. The key output from each iteration of the integrated model is an optimised resource allocation after 5 years. Considering the distributions in outputs across the large weather ensemble, the probability of farm asset increase and decrease in livestock number is determined for each of the two weather scenarios. We show that the current cropping systems in the study area operate below the economically optimised level. According to the model results, farmers could improve incomes with increased allocation of their land area to cash crops like rice, groundnut, and soybeans. Farmers have more than a 50 % probability of increasing their income over five years under bad weather scenarios when using optimised cropping patterns rather than the current cropping systems.

Keywords: Bio-economic farm model, CLEM, integrated model, mixed cropping system, northern Ghana, SIMPLACE, weather risk

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