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Interactive comment on "Optimizing cropland cover for stable food production in Sub-Saharan Africa using simulated yield and Modern Portfolio Theory" *by* P. Bodin et al.

Anonymous Referee #1

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The manuscript investigates alternative decision algorithms for cropping in Sub-Saharan Africa (SSA). "Modern Portfolio Theory" is employed to incorporate the risk of yield variability, which differs between crops. The LPJ model is used to simulate yields over a 0.5° grid for different crop functional types. While I appreciate the authors' effort to analyze cropping decisions through an interdisciplinary approach, I have severe concerns about the chosen methodology: 1) Little or no justification is given for the choice of each investigated decision algorithm. The objective of maximizing productivity (yield) is not an economically sensible objective. If farmers would truly maximize yields, they would spare no effort (cost) to irrigate, fertilize, control pests and weeds, etc. on a frequent basis. However, real farmers will always consider cost. Similarly,

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the objective of minimizing risk is an extreme form of risk aversion that is not plausible for real farmers. The only economically sensible algorithm of maximizing expected utility (with a negative objective function term for risk), however, is not investigated. 2) Rationally acting farmers do consider risk diversification. For various reasons, they may not always make the economically most efficient decision. If climate changes, it is unlikely that farmers would stick to their current land allocation. The paper does not analyze/review the current drivers of agricultural decisions in SSA. In that sense it is unclear how the results of the paper should be interpreted. 3) Food insecurity and mal-nutrition is primarily an economic problem. Sustainable income opportunities may be more important than ensuring food self-sufficiency in a region. Even in Africa, rich people do not suffer from food shortage. For some regions, the production or co-production of cash crops may be an overall more efficient (adaptation) strategy. 4) The optimization algorithm is odd. Particularly, it seems inefficient and inaccurate. Why is it necessary to explicitly create and consider all permutations of crop combinations with area shares in 10 percent steps? The optimal area share should be determined endogenously as continuous variable without restricting the analysis to predetermined values. If the authors use state-of-the-art mathematical programming algorithms, they could easily solve their model with continuous area shares. 5) The authors correctly emphasize the importance of management. They state that increasing food supply can be achieved by expanding the area or by intensifying crop production. However, their tools are not well suited to analyze the impact of management change (see page 4 lines 29-32). Many crop models exist (e.g. EPIC, CENTURY, DNDC, DSSAT), which explicitly represent the impacts of alternative management regimes (planting dates, fertilization, cultivation, irrigation) on productivity. What is the justification for using a crude adjustment of a model which predicts potential yields instead of applying a state-of-the-art crop model? 6) The authors consider alternative cropping decisions for entire SSA. They do neither account for commodity prices nor for crop management cost. However, these factors are as important for cropping decisions as are yields. Furthermore, if the analysis would reveal a substantial supply shift due to climate change and or more so-

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phisticated decision algorithms, then commodity prices are likely to change. Integrated analyses of crop cultivation changes over a large area should account for market price adjustments. Otherwise, there is a substantial economic bias of the estimated adaptation potential.

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