The Impact of El Niño Related Drought on Smallholder Farmers in Central Sulawesi, Indonesia: Who is Most Vulnerable?

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Abstract

Crop production in the tropics is subject to considerable climate variability caused by the El Niño-Southern Oscillation (ENSO) phenomenon. In Southeast Asia, El Niño causes comparatively dry conditions leading to substantial declines of crop yields with severe consequences for the welfare of local farm households. In concert with global warming, the severity of ENSO events is forecast to increase in the future. Using an interdisciplinary modelling approach that combines regression analysis with linear programming (LP) and stochastic simulation, and integrates climatic and hydrologic modelling results, the objective of this paper is to assess the impact of El Niño on agricultural incomes of different types of smallholder farmers in Central Sulawesi, Indonesia, and to derive suitable crop management strategies to mitigate the income depressions.

We identify five farm classes by cluster analysis. Our LP model maximises their cash balance at the end of the time period most severely affected by El Niño. Main activities are the cultivation of rice, maize, and cocoa. Accounting for water supply as an input factor, external Cobb-Douglas production functions generate output according to the level of production intensity and predicted weather patterns. A major limitation of LP models is that they produce deterministic estimates of the expected outcome under a given scenario, hence failing to incorporate the risky nature of agricultural production. In our modelling approach, stochastic simulation accounts for variations in crop yields due to factors not captured by the production functions. Iterative model runs produce probability distributions of the model outcomes for each household class, rather than point estimates, whereby the downside risk of failing to achieve a specified minimum level of income is a particularly policy-relevant measure of vulnerability against ENSO-related drought. The results can contribute to the formulation of enhanced development policies by illustrating that drought-related crop management recommendations must be tailored to farm households according to their location, farming system, and resource endowment.

Keywords: ENSO, Indonesia, linear programming, risk management, stochastic simulation

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