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Alwin Keil “The socio-economic impact of ENSO-related drought on farm households in Central Sulawesi, Indonesia”, University of Goettingen, 2004

Summary

Problem statement

Crop production in the tropics is subject to considerable climate variability that is often attributable to ENSO (El Niño-Southern Oscillation), the most dramatic phenomenon of natural climate variation on a time scale from a few months to several years. On the average, El Niño events are observed in four-year intervals; however, their recurrence period varies between two and seven years, making them difficult to predict. In Indonesia, El Niño is associated with comparatively dry conditions. In four El Niño years between 1973 and 1992, the average annual rainfall amounted to only 67% of the 20 year average in two major rice growing areas in Java, causing a yield decline of approximately 50%. There is evidence that, in concert with global warming, the frequency and severity of extreme climatic events will increase during the 21st century, and that the impacts of these changes will notably hit the poor. While several macro-scale studies have modeled the impact of climate variability and climate change on crop production in the Asia-Pacific region, specific climate variability impacts at the micro-level, especially the effect on household food security, have received very little attention.

Objectives of the study

The Intergovernmental Panel on Climate Change (IPCC) identified the quantitative assessment of the sensitivity and adaptive capacity of human systems to inter-annual climate variability as one of the high research priorities with respect to policy-making needs. Hitherto, little is known about the impact of ENSO-related drought on poor farm households in developing countries and their strategies towards income and consumption smoothing. Using innovative methods, this dissertation seeks to contribute to closing this knowledge gap with a case study from a rainforest margin area in Central Sulawesi, Indonesia. Its objectives are (1) to explore the perceptions of the local population with respect to inter-annual climate variability; (2) to assess the impact of ENSO-related drought on crop yields and agricultural incomes; (3) to investigate drought-related mitigation and coping strategies; (4) to measure the resilience of farm households towards drought periods; and (5) to identify influencing factors of drought resilience in order to derive policy recommendations.

Methodology

The research area is the Palu River watershed in Central Sulawesi, Indonesia. Its mountainous topography results in a distinct rainfall gradient, with the coastal zone receiving only 600 mm of rain p.a., while precipitation rates exceed 3,000 mm at higher elevations. In order to capture the rainfall gradient in data collection, elevation above sea level was used as

stratification criterion for the selection of eight research villages: all villages located in the watershed were assigned to population octiles with respect to elevation, i.e., the total range of elevation covered by the villages was subdivided into elevation strata in such a way that each stratum comprised one eighth of the total population within the watershed; then, one village was randomly selected in each stratum. In a second step, farm households were randomly selected within each research village. For logistical and budgetary reasons, the number of selected households varied slightly between villages, amounting to a total of 228¹.

Data were collected in two stages: First, Rapid Rural Appraisals were conducted in each research village to elicit the perceptions of the local population with regard to climate variability-related issues (objective 1). The methods used comprised group discussions as well as participatory ranking, scoring, and mapping techniques. The information gained fed into the design of a detailed questionnaire applied in a survey of the random sample of farm households described above. This second stage served to collect the data required for objectives 2 to 5, relating to the most severe drought period experienced by a household.

A recently developed asset-based livelihood framework is employed to analyze household risk management with regard to drought. A distinction is made between ex-ante strategies aimed at mitigating the potential adverse effects of a drought before it occurs and ex-post responses applied to cope with reduced agricultural income as a consequence of drought. Ex-ante measures are further subdivided into strategies aimed at self-insurance and informal insurance through asset diversification on the one hand, and formal insurance and finance instruments on the other. Since formal insurance and finance markets are often lacking in rural areas of developing countries, greater emphasis is placed on diversification strategies involving investments in natural, physical, human, and social assets.

The present study is one of the very few attempts found in the literature to measure drought resilience at the household level (objective 4) and identify its influencing factors (objective 5). Household risk management aims at smoothing consumption; therefore, the resilience of a household towards drought is measured as the observed degree of drought-induced expenditure reductions for basic necessities; to capture the impact on the consumption of home-produced food, the absolute differences in the consumption of selected food items between the 'normal' and the drought situation are also accounted for. A household is regarded to be fully resilient if all these indicators remain unaffected. Principal Component Analysis is used to aggregate the indicators into a linear composite 'Drought Resilience Index' (DRI), which serves as the dependent variable in a regression model to identify determinants of drought resilience. A substantial share of households is found to be fully resilient; hence, the distribution of the DRI is censored, and an ordinary least squares regression would yield biased estimates. Therefore, a Tobit model is employed that accounts for the qualitative difference between limit and non-limit observations and uses the maximum likelihood method for parameter estimation. Applying the conceptual framework, potential influencing factors of drought resilience are differentiated into natural, economic and financial, human, and social capital.

As a novelty in risk management analysis, the study links technical efficiency (TE) in agricultural production and the self-insurance capacity and, hence, resilience of farm households. Investments in agricultural management skills are identified as a strategy that can achieve both increased and less variable returns from agricultural activities, thus facilitating

¹ To reduce costs and survey time, recent socio-economic data already collected in a random sample of farm households by a partner project were used as far as possible.

the accumulation of reserves that can be used to smooth consumption during crises. Sub-optimal management manifests itself in technical inefficiency, i.e., the failure to obtain maximum output from a given set of inputs. Technical inefficiency is caused by lacking know-how, for example with respect to the timeliness of agricultural operations such as weed control, or crop hygienic measures. In order to test the hypothesis that TE in agricultural production enhances household drought resilience, farm-specific levels of TE are estimated for the two most important crops in the research area: irrigated rice, the staple food crop, and cocoa, the primary cash crop. Among other factors, these TE estimates are used as indicators of human capital in the regression model outlined above.

Separate Stochastic Frontier production functions for rice and cocoa are used to derive TE estimates. In Asian countries, rice production has been the subject of numerous efficiency studies, whereas the cultivation of perennial cash crops has received very little attention. An innovative feature of the estimated production functions is that, apart from the input of land, labor, and capital, the adequacy of water supply is accounted for, which is crucial in an area characterized by high spatial and temporal climate variability. In addition to estimating the levels of technical efficiency attained, influencing factors of efficiency are identified in one single statistical procedure.

Results

Among the 228 respondent households, 188 (82%) have ever been negatively affected by drought. Most of the affected respondents (59%) mentioned the year 2002 to have been the most severe drought year experienced, followed by the period 1997/98 (15%); both periods correspond to El Nino events. On the average, these droughts depressed the yields of the primary crops, irrigated rice, cocoa, and coffee, by more than one-third. Disregarding efforts aimed at smoothing income as a consequence, this yield decline translates into a reduction of the average annual household income to 64% of its 'normal' level. Because of lacking access to ENSO forecasts, risk management is mostly confined to ex-post coping strategies, especially the tapping of additional sources of income (43% of households), among them the illegal sale of rattan from an adjacent National Park (10%). Due to the drought-induced income depression, 21% of affected households borrowed money exclusively from informal lenders at an average interest rate of 98% p.a.. The share of households attempting to smooth consumption on credit was almost 30% among the poorest wealth stratum. A total of 116 drought-affected households (62%) were not able to maintain their usual level of consumption with respect to basic necessities, i.e., they were not resilient. In particular, 85% of these households reduced food expenditures to merely 64% of the usual level, on the average.

Drought resilience is positively influenced by the possession of assets that can easily be liquidated in the case of drought, as well as by access to credit, meaning that relatively wealthier households are more resilient than relatively poorer households. No significant positive effect of existing off-farm income sources is supported by the data, nor is the level of formal education found to be a resilience enhancing factor. Rather, the combined household labor capacity strengthens resilience as a prerequisite to the implementation of labor-intensive coping measures. Moreover, the hypothesis is confirmed that technical efficiency in agricultural production enhances resilience, as elaborated above.

The efficiency analysis reveals a stark contrast between crops: the estimated average technical efficiency in rice production is 77% as opposed to only 37% in cocoa cultivation. The low value for cocoa is supported by field observations showing obvious deficiencies in the

management of cocoa plantations, such as inappropriate pruning practices and, most importantly, the failure to remove fruits affected by the cocoa pod borer (*Conopomorpha cramerella* Snellen). The analysis of determinants of technical efficiency shows that poverty and illiteracy have an efficiency reducing effect in both rice and cocoa production. Agricultural extension services significantly increase efficiency in rice cultivation while this effect is not observed in cocoa production.

Conclusions and policy recommendations

Despite the location in a rainforest area, farmers in Central Sulawesi face a substantial risk of recurring ENSO-related drought periods that depress crop yields by more than one-third. If no income-smoothing ex-ante or ex-post strategies are applied, this translates into a similar reduction of total annual household income. Most farmers do not have access to ENSO forecasts, and their level of preparedness for the case of drought is generally low. Household risk management is mostly confined to ex-post coping strategies, some of which imply negative consequences for the forest resources and long-term welfare: the collection of rattan may not only constitute a loss of biodiversity in the surrounding rainforest, but it also means that a substantial share of farm households resorts to an illegal activity in order to cope with the consequences of drought; the excessive interest rates charged for informal consumption loans imply that smoothing consumption on credit bears the risk of becoming indebted and, thus, may contribute to trapping households in poverty. The majority of affected households have to cut expenditures to adapt to the drought-induced reduction of agricultural income. The drastic cuts in food expenditures are particularly alarming, suggesting that droughts seriously impair the food security status of farm households in the area. Drought resilience is positively influenced by the possession of easily liquidated assets and access to credit. Furthermore, a high level of technical efficiency in agricultural production enhances resilience by facilitating the accumulation of reserves during non-drought years, which can be used to smooth consumption during drought periods; particularly large increases in productivity could be achieved in the cultivation of cocoa, the primary cash crop in the area.

The results suggest the following policy recommendations: First, the farmers' access to existing ENSO forecasts should be improved to enable them to take precautionary measures before the onset of a drought; second, in this context, the agronomic and marketing potential of relatively drought tolerant crops as an alternative during El Nino years should be investigated. Third, formal financial services should be promoted to facilitate consumption smoothing at moderate interest rates on the one hand and provide remunerative savings options on the other; and, fourth, agricultural extension efforts should be intensified in view of low productivity levels, emphasizing the proper management of cocoa above all.

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