**Online supplemental B. An integrative approach to index insurance**

Index insurance is a relatively new innovation that may have the potential to bring financial risk protection to some of the lowest income farmers in the world ([Balzer & Rispoli, 2010](#_ENREF_1)). By triggering payouts on an index, such as measurement of rainfall, instead of field observations of crop loss, many of the constraints that prevent traditional indemnity based insurance from being available in developing countries are overcome, potentially overcoming the barriers that prevent most of the world's farmers from having access to insurance. It is hoped that the insurance will unlock productivity that is currently blocked by climate risk. The central challenge that the insurance addresses is a temporal problem under uncertainty. Farmers, communities, and lenders must make decisions together on what resources to invest in sowing at the beginning of the season, with the fruit of their investments available at the end of the season. With insufficient rainfall, or other catastrophe, their entire investment could be lost as the crops fail.

If the threat of a single, rare drought prevents a farmer from being able to use a quality seed because she would not be able to repay a loan if the drought occurred, then the farmer cannot be productive in typical years; in other words, she is caught in a "poverty trap" ([Barnett, Barrett, & Skees, 2008](#_ENREF_3)). It is hoped that by providing insurance for the drought, the farmer can make more productive choices for normal years, increasing productivity in most years, and remaining viable following a drought.

Although there is a great deal of interest in index insurance, most projects are exploratory pilots, and it is unknown if it will be possible to have index insurance meaningfully address poverty at large scales ([Hellmuth, Osgood, Hess, Moorhead, & Bhojwani, 2009](#_ENREF_12)). It is not clear if products can be developed that target the risks that farmers face with sufficient accuracy ([Brown, Osgood, & Carriquiry, 2011](#_ENREF_4)). In addition, there are many questions about the extent to which farmers are interested in and understand the insurance product, or if it is even of use for their decision making process ([Banerjee & Duflo, 2011](#_ENREF_2); [Cole et al., 2009](#_ENREF_5); [Dercon, De Weerdt, Bold, & Pankhurst, 2006](#_ENREF_6); [Gaurav, Cole, & Tobacman, 2011](#_ENREF_8); [Giné, X., 2011](#_ENREF_9); [Giné, X. , Townsend, & Vickery, 2008](#_ENREF_10); [Giné, X. & Yang, 2009](#_ENREF_11)). A key question that arises in the design of the insurance is the temporal *frequency* of payouts, a dimension not considered by the major models of intertemporal choice (summarized in Section 2.2, above). Insurance that provides payouts more frequently has a higher premium, but provides more protection.

The appropriate payout frequency depends on each farmer’s temporal and risk tradeoffs, the risk perceptions of the farmers, and the interactions and risk sharing between farmers, lenders, and other players. It is a complex challenge to understand this tradeoff, as a product must be designed to assist in the decision and production process linking communities of remote smallholder farmers in Africa with lenders, NGOs, and international re-insurance corporations. The insurance design requires advanced crop modeling, climate science, and sophisticated aerospace applications such as satellite sensing of rainfall and vegetation, but must address the specific needs of heterogeneous farmers in remote locations. This is a challenge that discipline specific approaches are ill-suited to address.

This is the challenge faced in the Horn of Africa Risk Transfer for Adaptation (HARITA) project exploring the use of index insurance as the final piece of a holistic adaptation effort in the Tigray region of Ethiopia, to complete a package of risk reduction and productive risk taking. The project followed an iterative, integrative framework to address the challenge ([Dinku et al., 2009](#_ENREF_7)).

A preliminary product was developed for a pilot transaction with 200 farmers in a single village. Modeling, surveys, focus groups, and experimental game exercises were employed by a multidisciplinary team of economists, natural scientists, anthropologists, and psychologists. One key design parameter was the payout frequency (verses the premium cost) for the product. This multi-faceted process established a payout frequency of about one year out of five, with farmers deciding that the premiums associated with more frequent payouts would not be worth the increased coverage; this result roughly agreed with insurance company preferences for payouts about once every seven years.

The rainfall in the year following the pilot transaction was below average, but not low enough to fall in the 1 in 5 year category. In follow-up interviews and focus groups, farmers strongly requested more frequent payouts and claimed to be willing to pay the higher premiums associated with them. However, there was a great deal of concern from insurance companies that farmers would not actually be willing to pay the higher premiums associated with the high frequency payouts, and that high frequency payouts would not be an appropriate insurance product, since personal or community savings would better address the smaller, more common risks. The insurance companies demanded quantitative evidence that higher frequency products were actually demanded ([Osgood et al., 2010](#_ENREF_14)).

Following the parallel interviews by anthropologists and insurance design technicians, a psychology/economic experimental game was performed in which farmers were offered money that they could either keep; invest in a high frequency insurance product, a low frequency insurance product; put in a personal savings account; or put in a savings account to be managed by the community. The game payouts were to be delivered at the end of the growing season based on the rainfall measurements that would trigger the actual year two insurance transactions. The exercise was performed in the original village as well as several additional villages that were candidates for year two scaling. Farmers in the experiment overwhelmingly committed the money to the more frequent option with higher premiums ([Norton et al., 2011](#_ENREF_13)).

Based on this combined suite of knowledge, the implementation stakeholders offered a menu of insurance packages, including both high and low frequency options. In some villages, based on focus group discussions, farmers requested that they be allowed to contribute to already existing informal community risk savings as part of the insurance signup process. In the second year of the project, the commercial signup scaled to over a thousand farms in five villages, with high levels of enrollment, many farmers contributing to their communities' informal savings fund and the majority of farmers selecting the high frequency options. The oriented economic impact assessment found that in some of the villages significant yield increases attributable to the insurance could be detected ([Oxfam America, 2011a](#_ENREF_15)).

A model for bringing the project to a larger scale was developed, building upon the iterative integrative research methodologies employed. Local experts formed farmer design teams in each new village, and repeatedly visited the village for discussions, presenting the natural science and economic analysis based on the previous discussion and satellite datasets. The farmer teams worked iteratively to develop the insurance product in collaboration with the local experts and the international researchers. Using this strategy, in the third year, the project scaled by over an order of magnitude on a reduced budget, with approximately 13,000 farmers in 43 villages purchasing the insurance ([Oxfam America, 2011b](#_ENREF_16)). Together, this combined research and implementation effort has been highly visible in breaking through the barriers facing index insurance in reaching scale, serving the farmers' needs, and meaningfully addressing poverty, serving as a model for similar efforts in other countries ([Oxfam America, 2011b](#_ENREF_16)).

Major partners in the index insurance project include the Relief Society of Tigray (REST), Dedebit Credit and Savings Institution (DECSI), Nyala Insurance Company, the Ethiopian Productive Safety Net Program (PSNP), the Government of Ethiopian National Meteorological Agency (ENMA), Swiss Re, the International Research Institute for Climate and Society at Columbia University, Mekele University, and Oxfam America.

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