## **DESIGNING WEATHER INSURANCE CONTRACTS** FOR FARMERS

## In Malawi, Tanzania and Kenya

Excerpts from final report to the Commodity Risk Management Group, ARD, World Bank

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## **EXECUTIVE SUMMARY**

his report presents project products to the Commodity Risk Management Group of the World Bank for the development and evaluation of index insurance contracts for smallholder farmers in Malawi, Tanzania, and Kenya. The development of some products we are providing was supported at no cost by the NSF-funded Center for Research on Environmental Decisions.

Index insurance is a relatively new weather risk management tool. While traditional insurance insures against crop failure, index insurance insures for a specific event or risk, such as rainfall deficits. The index insurance can be more cost effective since there is no need for in-field assessment of damage because payouts are triggered by weather data directly. Index insurance addresses two problems associated with traditional crop insurance: moral hazard (incentives for a farmer to let a crop die in order to get an insurance payout) and adverse selection (in which insurance is priced based on the risks of the entire population but only the most vulnerable farmers purchase insurance).

However, index insurance only provides partial protection and is therefore only one part of a complete risk management package. It is critical that the client have a comprehensive understanding of exactly what risks are covered (and what risks are not covered) by the index product so that clients can effectively use the insurance as a part of their risk management system. Products must be transparent and completely understandable to the client or they will not be able to play their proper role.

We designed and evaluated contracts for Malawi, Kenya and Tanzania. Because some contracts existed for Malawi prior to this project, and since the insurance is in its second year of implementation in Malawi, the Malawi initial contracts and implementation are used as a starting point. Following the project specification, we have developed in depth analysis, such as process based crop simulations and quantitative analysis of historical data, for the Malawi case study. These additional analyses are unique to the Malawi case.

In general, the contract development and evaluation process has led to a set of contracts that appear to perform extremely well. So much so, that demand in many places has overwhelmed administrative capacity to serve clients. As this is an unsubsidized product that is purchased by clients, some indication of its value can be seen in its market demand. In interviews, farmers have stated that their primary strategy for adaptation to climate change is enrollment in the insurance program. Much of this success is due to the outstanding input and support from project partners, including strong data and analysis support from the Malawi, Kenya, and Tanzania Meteorological services. Because of their wide range of competencies, it is likely that these Meteorological services could play a much expanded role in project scale up.

There are several issues that we addressed in evaluating and improving the initial Malawi 2005 pilot contract design process for updated contracts in Malawi Kenya and Tanzania. First, the initial Malawi contracts had particular features in the formulas that we modified in order to increase robustness, performance, flexibility, and transparency. Second, we extended the design process to include more statistical analysis so that contracts addressed climate characteristics as well as agronomic features of crops. We evaluated and improved the crop water stress calculation techniques to more effectively represent drought related risk in the contract. We developed a systematic design methodology that could utilize the strengths of each source of imperfect information. Finally, we provided formal mechanisms to incorporate financial constraints in the contracts.

There are several important issues that have yet to be addressed in the design of future contracts, in order to ensure that the product evolves into a fully sustainable and scalable product. It is important to build capacity for local design and adaptation of contracts as existing needs change and new needs are identified. It is critical that the pace of product upscaling does not exceed the pace of capacity development and project improvement. In addition, the design process must be updated in order to allow for information in seasonal precipitation forecasts to be utilized in the insurance strategy. Crop breeding programs can be integrated into this process. Contracts could be developed further to more elegantly address failed sowing issues and sporadic starts to the rainy season. Index contracts and reinsurance must be designed acknowledging regional and global climate features, since large scale climate processes can lead to negatively correlated seasonal rainfall between regions.

Work should be done to more accurately and transparently characterize the distributions underlying historical precipitation that lead to losses and payouts beyond historical burn analysis we used for improved characterization of risk. Techniques must be developed to interpolate information between stations and to use satellite based products. These, and related techniques should be advanced to enable a quality product to be established when a new station is installed, to detect data tampering, to reduce basis risk, and perhaps enable the availability of index products where met stations are not available. Indexes should be explored to cover additional risks, such as excess rainfall. It is worthwhile to utilize economic contract theory to develop incentives that discourage tampering and encourage accurate farm reporting. Contracts could be designed to reveal the value of insurance through market transactions. It is important to develop communication tools for cooperative design, education of contract issues, and exercises to test for farmer understanding of products.

## **OVERVIEW**

In this report, we describe our project products to World Bank's Commodity Risk Management Group (CMRG) in the development and evaluation of index insurance contracts for smallholder farmers in Malawi, Tanzania, and Kenya. The development of some products we are providing was supported at no cost by the NSF-funded Center for Research on Environmental Decisions.

Index-insurance is one type of weather risk management that has recently developed as a potential tool to reduce weather risk in agriculture. While traditional insurance insures against crop failure (actual loss), index insurance insures for a specific event or risk, such as rainfall deficits (Skees 1999). Thus, the index insurance removes one or more production risks, but does not account for the loss itself. This method addresses two problems associated with traditional crop insurance: moral hazard (where farmers have incentive to let their crops fail in order to receive a payout) and adverse selection (where those farmers less skilled at farming purchase the insurance, resulting in higher premium levels and more frequent payouts). Since the index insurance only covers a specific risk, it only provides partial protection and is therefore only one part of a complete risk management package. The index insurance also becomes a more affordable option, in that there is no need for in-field assessment of damage, as damage is able to be tracked by weather data directly (in the case of rainfall, a rain gauge would be the device used).

The Malawi experience provides an example of the potential for using index insurance in developing countries to assist emerging markets and increase productivity of small holder farmers, with a bundled index insurance, loan, and input package in its second year of implementation. Our project supports this implementation. Partners include the National Smallholder Farmers' Association of Malawi (NASFAM), in conjunction with the Opportunity International Bank of Malawi (OIBM), the Malawi Rural Finance Company Limited (MRFC), the Insurance Association of Malawi, and the Malawi Meteorological Service, with support from the World Bank CRMG and IRI. ICRISAT and the Chitedze Agricultural Research Station provided important and influential input in the design process.

Following the project Terms of Reference, we designed and evaluated contracts for Malawi, Kenya and Tanzania. Because some contracts existed for Malawi prior to this project, and since the insurance is in its second year of implementation in Malawi, the Malawi initial contracts and implementation are used as a starting point for other contracts and countries. Following the project specification, we have de-

veloped in depth analysis, such as process based crop simulations and quantitative analysis of historical data, for the Malawi case study. These additional analyses are unique to the Malawi case.

Small holder farmers in Malawi have reported that they would be able to increase their yields and income if they were able to buy the higher quality inputs (hybrid seeds and fertilizer) necessary for increased production. Illustrating the potential benefits for maize, estimates of national maize yield for Malawi for the 2006/2007 growing season show local varieties of maize yielding about 50% less maize per hectare than the hybrid maize (Malawi Department of Meteorological Services 2007). In the past, many small holder farmers have been unable to purchase these inputs, such as the hybrid maize seed, fertilizer, and hybrid groundnuts, because they lack the necessary capital.

Microfinance institutions in Malawi have been uncomfortable providing loans to these farmers because they face high risk of crop failure, making it questionable if the farmer would be capable of paying back the loan. Rainfall deficits are a dominant risk faced by farmers in Malawi. Index insurance has been used as a means of removing the risk of rainfall deficits, supplying the microfinance institution with the confidence necessary to give the farmer the loan and the farmer with the capital necessary to purchase higher quality inputs, and in turn increase productivity and income.

The insurance is a part of a finance/production bundle. Illustrating with the Malawi groundnut example, the package is designed for 1 acre of production. To be eligible, a farmer must be within 20km of one of the met stations in the program. A typical groundnut package consists of a loan (~4500 Malawi Kwacha or ~\$35) that covers the groundnut seed cost (~\$25, ICRISAT bred), the insurance premium (~\$2), and tax (~\$0.50). Upon signing the paperwork, the farmer receives a bag of groundnut seed sufficient for 1 acre of production and an insurance certificate for a policy with a maximum payout of the loan size plus interest (~\$7). The prices vary, of course, by weather station and crop. Farmers are organized into joint liability groups of approximately 10-20 members. The farmers plant the groundnut



seed, and at the end of the season provide their yields to the farm association, which markets the yields. Proceeds and insurance payouts are used to pay off the loan, with profits returned to the farmer.

In Kenya and Tanzania, similar products are being developed. In Tanzania, Pride Tanzania, the Tanzania Meteorological Service, and Technoserve are some of the partners. In Kenya, some of the partners are the Kenya Meteorological Service, FSD Kenya, ECLOF, Equity, CIC. The parameters for all contracts are presented in Appendix 1.

In general, the contract development and evaluation process has led to a set of contracts that appear to perform extremely well—so much so, that demand in many places has overwhelmed administrative capacity to serve clients. In interviews, farmers have stated that their primary strategy for adaptation to climate change is enrollment in the insurance program.

As the loan/insurance are unsubsidized products purchased by clients, some indication of their value can be seen in its market transactions. Since thousands of loan/insurance have been voluntarily purchased by farmers in Malawi, the price that they have paid provides a minimum bound on the value they place on the product. Much of this success is due to the outstanding input and support from project partners, including strong data and analysis support from the Malawi, Kenya, and Tanzania Meteorological services. Because of their wide range of competencies, it is likely that these Meteorological services could play a much expanded role in project scale up. It is important to ensure that mechanisms exist to provide resources for Meteorological agencies for the necessary data collection, cleaning, reporting, and analyses.

For the future, it is critical that the pace of product upscaling does not exceed the pace of capacity development and project improvement. If pilot contracts and stakeholders cannot evolve at a pace exceeding scale up, pilot contracts may be extended beyond their limits. If financial stakeholders do not have the sufficient understanding and capability to update the products, they may not understand the important limitations of index products, and farmers may not understand what risks the contracts do not provide protection for. This is particularly important for index products, since both the provider and client must fully understand that the product does not protect against all losses, and must understand how to build risk protection against the risks the contract does not address.

There are several issues that we addressed in evaluating and improving the initial Malawi 2005 pilot contract design process for updated contracts in Malawi, Kenya and Tanzania. First, the initial Malawi contracts had particular features in the formulas that were modified in order to increase robustness, performance, flexibility, and transparency. Second, given the deterministic agronomic modeling focus in the initial Malawi contract design, it was important to extend the design process to include more statistical analysis to arrive at contracts tuned both to agronomic features of crops as well as climate characteristics. We evaluated and improved the crop water stress calculation techniques to more effectively represent drought related risk in the contract. Since agronomic models have a finite level of skill in reflecting actual losses, and since each source of information about losses has limits in terms of reliability and accuracy, we developed a systematic design methodology that could utilize the strengths of each source of imperfect information. Finally, we provided formal mechanisms to incorporate financial constraints in the contracts. See Contract Design and Reference Section 2.

There are several important issues that have yet to be addressed in the design of future contracts, in order to ensure that the product evolves into a fully sustainable and scalable product. Perhaps the most important is to build capacity for local design and adaptation of contracts as existing needs change and new needs are identified. In addition, the design process must be updated in order to allow for information in seasonal precipitation forecasts to be utilized in the insurance strategy. Crop breeding programs can be integrated into this process, leading to varieties that are adapted to play the best role possible in the bundled insurance/credit/forecast system. Contracts could be developed further to more elegantly address failed sowing issues and sporadic starts to the rainy season. Index contracts and reinsurance must be designed acknowledging regional and global climate features, since large scale climate processes typically lead to negatively correlated seasonal rainfall between regions. Work should be done to more accurately and transparently characterize the distributions underlying historical precipitation that lead to losses and payouts to bring design and pseudo-pricing beyond historical burn analysis to utilize Monte Carlo based simulation for improved characterization of risk. Techniques should be developed to interpolate information between stations and to use satellite based products.

These, and related techniques should be advanced to enable a quality product to be established when a new station is installed. These techniques would be critical for other issues, such as detecting data tampering, reducing basis risk, and perhaps enabling the availability of index products where met stations are not available. It is worthwhile to utilize economic contract theory to develop incentives that discourage tampering and encourage accurate farm reporting. Contracts could be designed to reveal the value of insurance through market transactions. It is important to develop communication tools for cooperative design, education of contract issues, and exercises to test for farmer understanding of products. Indexes should be explored to cover additional risks, such as excess rainfall. See *Design Issues that Must be Addressed in the Future* in the next section.

This report is one of the deliverables for the project. Another deliverable for this project is the R programming code that we developed to support our contract design and analysis. It is not finalized robust code. It is not designed to be a tool, and it contains outdated code fragments not used in our final analyses. It is presented for the sake of transparency in analysis to serve as additional documentation on the methods and data we used. An additional deliverable for the project is the Contract Communication Spreadsheet that illustrates each index contract. This was produced with the support of the NSF funded Center for Research on Environmental Decisions at no cost to the project.