Challenges for Use of Index-based Weather Insurance in Lower Income Countries

Jerry R. Skees[1]

GlobalAgRisk, Inc.
1008 S. Broadway
Lexington, KY 40504
859.489.6203
Jerry R. Skees, President

[1] Skees is the H.B. Price Professor of Risk and Policy in the Department of Agricultural Economics at the University of Kentucky, and president of GlobalAgRisk, Inc. The review and assistance of a number of people is greatly acknowledged — Jason Hartell, Anne Murphy, Benjamin Collier, and Celeste Sullivan. This article was the keynote address at the 101st EAAE Seminar, Management of Climate Risks in Agriculture in Berlin, Germany, July 5–6, 2007, and is forthcoming in an Agricultural Finance Review special issue of selected papers contributed to that conference. This article is published under the University of Kentucky Agricultural Experiment Station Number 07-04-091.

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Acronyms and Abbreviations

GRP	*Group Risk Plan*
IBRTP	*Index-based Risk Transfer Product*
MFI	*Microfinance Institution*
MPCI	*Multiple Peril Crop Insurance*
OTC	*Over-the-Counter*

1. Introduction

This article provides a perspective on the progress and challenges associated with index-based risk transfer products (IBRTPs)[2] in lower income countries. Effectively, IBRTPs are a proxy for loss and a vehicle to transfer risk to insurance or capital markets. These products are designed to pay out when an independent physical measure of a loss event (such as extreme weather, area yields, or even complex process models that use satellite images) crosses a threshold value of the index that indicate catastrophic conditions are creating serious problems for clients. The concept of creating an index to proxy losses is not new. Indian scholars were writing about the merits of these ideas in the early 1900s (Chakravarti, 1920), and at the University of Chicago, Professor Harold Halcrow completed a Ph.D. dissertation on area-yield crop insurance in the 1940s (Halcrow, 1949).

The interest in using a variety of IBRTPs in lower income countries has grown in recent years. A major objective of this article is to share a vision for what is possible to achieve and highlight important policy and market issues that merit serious academic attention. There are cautions to be raised. While there are enough pilot projects to begin assessing significant product design and project implementation issues, important behavioral outcomes from firm-level decision makers cannot yet be assessed due to the limited experience with these products. These efforts in lower income countries must also be placed in a larger economic and public policy context.

Underlying all of our[3] academic and practical efforts in recent years is the critical question — What are the most appropriate market and institutional arrangements to allow smallholder and mostly farm-based rural households to effectively and efficiently smooth consumption over time? This article brings together some of our current thinking. I begin by reviewing some of the history for why the special class of index insurance products has captured the attention of the donor and development practitioner community. Next, reasons for the importance of insurance access in lower income countries are reviewed. The framework for the economic considerations of agricultural insurance for smallholder households focuses on getting the "big risk" out of the way first. This is done in the context of the development literature (Barnett, Barrett, and Skees, 2006). Within the policy context, one must also address the issue of subsidizing these products since subsidies in agricultural insurance are prevalent in developed countries, but are for the most part impractical in lower income countries. Next, a few case studies are used to highlight some important lessons learned about designing index-based weather insurance for smallholder households. Finally, in the context of our own experience with pilot projects, I share my views for how IBRTPs can be used to "create a market" for more sophisticated agricultural insurance products.

2. Abbreviated History and Background

Agricultural insurance continues to capture the attention of policy markers, donors, and a large number of stakeholders in lower income countries around the world. The current agricultural economics literature is filled with articles examining various aspects of agricultural insurance as governments in developed countries have increased their support for this risk management tool. While I have worked on agricultural insurance issues for 25 years, during the past 10 years of

[2] Rather than simply referring to these products as index-based weather insurance, Skees and Barnett (2006) began referring to these products as IBRTPs to communicate that structurally they are open-ended. In the economic literature, they take the form of contingent claims. However, in the legal and regulatory environment, they can either be structured as insurance or derivatives. For lower income countries, where derivative markets are unlikely to be properly regulated, it is highly recommended that these products be structured as insurance products.

[3] I would like to acknowledge the great number of professionals that I have worked with over the years on these topics. This list is too long and the risk of omitting someone is too high to name these individuals.

researching and developing agricultural insurance products, my focus has turned from developed countries to lower income and developing countries. Previous work with the U.S. crop insurance program has shown that government support for agricultural insurance is more about political economy and income enhancement than about risk management (Skees 1999, Skees 2001).

My experience with the Congressional Commission for the Improvement of the Federal Corp Insurance Program in 1989 led to a rediscovery of research on the potential merits of area-yield insurance (Halcrow, 1949), and, in turn, to the development of the Group Risk Plan (GRP) (Barnaby and Skees, 1990; Miranda, 1991; Glauber, Harwood, and Skees, 1993; Baquet and Skees, 1994; Skees, Black, and Barnett, 1997). The GRP is an index-based insurance product that uses county yields as the mechanism for calculating indemnities for insured farmers. As such, the GRP is less prone to asymmetric information, and consequently less prone to the same levels of adverse selection and moral hazard that plague traditional crop insurance products. Work on GRP motivated Peter Hazell, who had long worked on crop insurance for developing countries (Hazell, Pomareda, and Valdés, 1986), to revisit his thinking about developing rainfall insurance products. The Skees, Hazell, and Miranda (1999) article emerged from our joint efforts to advance rainfall insurance in Nicaragua with a 1998 World Bank project. In 1999, a group inside the World Bank was awarded a Development Marketplace Contract to advance these ideas in Nicaragua, Morocco, Tunisia, and Ethiopia. A number of articles emerged from these efforts (Skees et al., 2001; Skees and Varangis, 2002; Skees et al., 2005; Varangis, Skees, and Barnett, 2002). Since that time, there has been a proliferation of interest and involvement in index-based weather insurance products for lower income countries (Barnett, Barrett, and Skees, 2006; Hartell et al., 2006; Hazell and Skees, 2006; Hess et al., 2005; Hess and Syroka, 2005; Manuamorn, 2007; McCarthy, 2003; Molini et al., 2007; Shynkarenko, 2007; Skees, 2003; Syroka, 2007; Turvey, 2002). The workshop that resulted in the articles published in this special issue is evidence of the continued and growing interest in the subject.

To a great extent, donor interest in IBRTPs has been driven by the need to find more cost-effective and efficient instruments to transfer weather risks that impact the livelihoods of millions of poor farm households who operate on extremely small parcels of land. The literature and experience with traditional crop insurance in developing countries has been extremely negative. By the 1970s and 1980s most donors and development practitioners had discounted the possibilities of agricultural insurance contributing to the development process, and attempts to foster such insurance were largely halted (Hazell, Pomareda, and Valdés, 1986). Because IBRTPs address many of the problems with traditional crop insurance, there has been a renewed interest in weather insurance for developing countries. Index-based products do not require costly claims adjustments, which are simply not practical for small parcels of land. To the extent that the index is measured by an independent third party, these products also are largely free of adverse selection and moral hazard problems. Nonetheless, no one should conclude that these products are going to be the final answer to transferring weather risks for smallholder farm households in lower income countries. To be sure, our own work has been the constant reshaping and revisiting of basic premises that have led us to pursue this class of products for lower income countries.

Insurance Is Important for Lower Income Countries

There is a significant need for effective and efficient mechanisms for transferring natural disaster risks that negatively impact the livelihoods and assets of small-unit farming households in lower income countries (Barnett, Barrett, and Skees, 2006). In the event of a shock such as extreme weather, those households without risk transfer mechanisms are more likely to be thrust into permanent poverty (Barrett and McPeak, 2005; Barrett and Swallow, 2006; Carter and Barrett, 2006; and Carter et al., 2007). In that situation, poor households must choose between further depleting assets, pushing themselves farther below the poverty line, or reducing consumption, which often has long-term health and developmental consequences.

Beyond the risk of poverty traps, the economic development literature also clearly demonstrates that the poor pay for more risks in their management decisions when risk transfer instruments are unavailable to them (see Dercon, 1996, 1998, 2004, and 2005). For example, Rosenzweig and Binswanger (1993) examine the portfolio choices for farmers in India. Their work suggests that the poor are paying implicit premium rates in excess of 30 percent based on the low risk–low return choices that they make. This form of extreme risk-averse behavior among the poor is understandable when considering riskier choices such as adopting advanced technologies, moving to the city for new employment, renting land rather than crop sharing, etc. Of particular note, these very decisions by the poor are also costly for other levels of society as they lead to more inefficient economic outcomes and slowed economic growth.

Understanding these microeconomic underpinnings is important because a growing body of evidence indicates that lower income countries with both banking and insurance markets experience the greatest economic growth (USAID, 2006). Insurance, savings, and credit can be used to smooth consumption during difficult times. Each is important for protecting against different types of risk. Savings and credit can be a very efficient means of smoothing consumption over low-magnitude loss events (e.g., temporary unemployment) but may not be adequate when high-magnitude loss events occur (e.g., natural disaster, or death of the family breadwinner). For infrequent high-magnitude loss events, insurance is generally a more efficient mechanism than savings and credit for facilitating consumption smoothing. If households can smooth consumption using a combination of insurance, savings, and credit instruments, they tend to be more willing to invest in higher-risk, higher-return activities.

The vulnerability of the rural poor in lower income countries is particularly acute because they typically lack access to these financial mechanisms to efficiently manage production uncertainties. Households in rural regions tend to have few livelihood choices, limited availability of financial services, and even less access to insurance products. In the absence of effective insurance markets that transfer risk out of a community or region, households remain vulnerable to the financial consequences of high-magnitude loss events, the kind of loss events that are capable of inflicting total financial ruin. This vulnerability further constrains a household's access to other financial instruments. Creditors are understandably reluctant to make unsecured loans to highly vulnerable households. And when an entire region is susceptible to a natural disaster such as drought or flooding, lenders are especially reluctant to extend credit (de Janvry et. al., 2003). They fear that following a natural disaster many loans will go into default while at the same time deposits will be depleted. Lenders may also be subject to political risk as governments pressure lenders to forgive even secured debt in the event of a regional agricultural production crisis.

Innovations in providing insurance for natural disaster risk to rural areas and to poor households are critically important to help the poor improve their lives and to contribute to the overall economic growth in lower income countries. The risk of these events negatively impacts production decisions and constrains capital flows into the region. It is important to note that the instruments needed to cover weather and natural disaster risk must be structured differently than traditional insurance products designed to transfer uncorrelated risks such as automobile accidents, death, and disability. Uncorrelated risks can be pooled locally within an insurance portfolio. In the case of correlated risks due to extreme weather or other natural disasters, domestic insurance companies are reluctant to offer insurance against these risks as they gain little from pooling these policies within the region unless they are able to sufficiently diversify or transfer their risk to a facility that can diversify, such as a global reinsurance company.

Innovative insurance mechanisms for transferring correlated weather and natural disaster risks out of rural areas of lower income countries are an important component to addressing the many risks faced by poor households and a vital component to the synergy among insurance, savings, and credit markets. This synergy cannot be captured by interventions focusing on only one financial service (e.g., interventions to increase credit availability). By transferring risk out of the community and

region, these insurance mechanisms lower the risk exposure of poor households and local lenders, and as a result, the poor also gain access to broader financial services often at better terms. In Mongolia, for example, lenders have provided both better access to credit and lower interest rates to herders purchasing index-based livestock insurance.

An approach that more fully considers this functional relationship among diverse financial services is required that facilitates the development of savings and credit mechanisms for financing investment and smoothing consumption over low-magnitude loss events, but also facilitates the transfer of high-magnitude risks via insurance markets. A strategy that addresses all of these issues provides a more comprehensive risk management approach for poor households and has the potential to initiate a virtuous cycle of increased local reinvestment, increased capital flow into the region, and improved economic growth.

3. Economic Considerations for Agricultural Insurance for Smallholder Households

In recent years, our focus has been on first removing catastrophic risks as part of the development process for agricultural insurance. This effectively turns the development process on its head: Insurers typically begin with individual products for smallholder households and then concern themselves with how to finance the catastrophic risks. However, once effective risk transfer for the biggest risks (the most catastrophic events, which are also more likely to be more highly correlated) has been organized, development of a broader range of financial services, including more advanced forms of agricultural insurance specifically targeted to individuals, can emerge.

Part of the development process for agricultural insurance also involves understanding that individual households should consider layering risks as part of an optimal risk management strategy. A large aspect of layering risks involves development of the most effective and efficient mechanisms for getting the big risk out of the way first. For risks that are near the median of a loss profile, self retention is usually optimal; for risks that are at lower levels or intermediate levels, a blend of borrowing, saving, and insurance is optimal; for the most extreme, catastrophic risks, some blend of insurance and government *ex ante* financing (e.g., serving as reinsurance for the most catastrophic risk) may be optimal (Skees, Barnett, and Hartell, 2005). The relative price of borrowing versus insurance generally reinforces these arguments. Still, our profession needs to dig deeper into these important economic questions and use the insights gained from more formal and realistic models of the household production and consumption process to give further foundation for the types of IBRTPs that should be supported.

At least part of the confusion about the value of agricultural insurance and the type of policy prescription that emerges when governments intervene to promote these markets is due to the way agricultural economists have approached the problem of agricultural insurance research and risk management. Very much consistent with our thinking about how agricultural insurance fits into a boarder economic development and poverty household production and consumption framework, Wright (2006) provides one of the most significant challenges to the way agricultural economists model agricultural insurance. He recast the challenge of risk management to how to smooth household consumption over time rather than how to optimize farm income from a single crop in a single crop year given certain assumptions about risk aversion. Anyone understanding the complex production choices facing rural households and the many risk management and risk coping strategies used by these households will appreciate the challenges that Wright brings to these discussions. These issues speak to the need to layer risk management and to consider which choices will be more optimal for smoothing consumption over time. To the point, how does the value of crop insurance change when examining the entire portfolio of household choices that includes farm enterprises, off-farm income choices, and formal and informal risk management mechanisms such as savings, lending, and various forms of insurance? Of course the answer depends on the variance-covariance

matrix of the activities in the portfolio. However, even when the returns from activity choices are correlated, but not perfectly correlated, the value of individual crop insurance is lessened. This becomes even more evident when one considers how savings and borrowing can help smooth consumption when specific weather events create small to moderate losses in the portfolio. Portfolio models assume that the correlation among the returns from the different activity choices is unchanged given different random outcomes. But, an interesting puzzle emerges: What if the correlation of returns among the activity choices is greater when the weather events are the most extreme? If so, then a simple drought index to indemnify when severe droughts occur may be highly effective insurance for the portfolio and, in fact, superior to having individual crop insurance for only a few, or even all, of the activities in the portfolio. Interestingly, development economists who work on household production and consumption models and poverty dynamics have understood this for some time. However, most of our colleagues in development economics have not performed research on agricultural insurance markets.

Catastrophe Insurance Helps Lessen the Effects of Activities of the Poor That Become More Correlated in a Catastrophe!

I am extending the argument for catastrophe insurance by stating that there are likely many regions of the world where the correlation among activities may be greater during extremely catastrophic weather events. The correlation of returns among the activity choices may in fact increase during a catastrophic weather event and the benefits of diversification disappear.

Even if the correlation among activities of a portfolio is unchanged for enterprise choices when there are low returns, responding to the challenge from Wright (2006) and putting insurance into a larger portfolio context where other arrangements for smoothing consumption are considered will lead to the conclusion that insurance for modest or even intermediate losses for a single portfolio activity is likely not optimal. Insurance against catastrophic losses likely fits better. For example, consider a rural community where the majority of households depend on the outcome from agricultural production. Smallholder farm households grow crops, have livestock as a form of savings, and receive off-farm income from harvesting the crops from larger households or working in post-harvest processing facilities. At the household level, a major drought destroys their crops, motivates them to sell the livestock to generate cash for current consumption, and leaves them without off-farm income as there are no crops to harvest. Because markets are not well-integrated (i.e., this community is isolated from communities outside that are not experiencing the drought problem), many households are selling livestock at the same time and depressing local prices, while experiencing higher prices for food and animal fodder. In fact, the very actions that these smallholder households have taken to manage risks — a well diversified portfolio of activities — do little or nothing to help them withstand a catastrophic drought. In this case, the addition of another activity, the purchase of catastrophic drought insurance, can provide significant transfer of high consequence risk for the household.

Extending this scenario to the broader community heightens the argument for getting insurance focused on the most extreme events. Because the catastrophe is also impacting a large geographic area, both formal and informal mechanisms for pooling and sharing risks begin to break down. We have argued that, in some regions, this is a significant constraint to the development of broader financial services (Skees and Barnett, 2006; Skees, Hartell, and Murphy, n.d.).

The nature of weather risks in some regions of the world where the correlation may indeed change as extreme drought or flooding occur raises new questions about how to frame the issue of what type of insurance may be most effective. If the propositions presented above are correct — 1) that the correlation among activities meant to diversify risk for smallholder households may change to the detriment of the household during the most extreme events; and 2) that a large number of households suffering at the same time and in the same region becomes a constraint to offering other

financial services — then the case for developing index insurance that focuses only on catastrophic risk is stronger.

Of more significance, the basic economic models used to examine the value of agricultural insurance can lead to the wrong answers. Even modeling basis risk for weather insurance products must be revisited in a world where the correlation among activities in a portfolio changes as the severity of weather events changes. In other words, if extreme events impact large numbers of households in the same location then basis risk also should be lower for catastrophic loss events.

Insurance Supply, Demand, and Subsidies

Nonetheless, if one concludes that catastrophic events are indeed the right focus for introducing insurance products for smallholder farmers in lower income countries, it still begs the question of whether individuals will purchase such products. There is significant cognitive failure literature on natural disasters that suggests that individuals forget or underestimate bad events (Kunreuther, 1979, Skees, Hartell, and Hao, 2006; Hogarth and Kunreuther, 1989). Thus, there may be a disconnect between what must be charged to insure low-probability high-consequence events and the willingness of households to pay for insurance products designed to protect against losses caused by these events. Is this a market failure that justifies some role for government? If so, what role should the government take? We have argued that the government should be cautious about simplistic approaches to subsidizing agricultural insurance premiums. Rather, if the government is to take some risk sharing, the focus should be on financing the more extreme catastrophic risks. Government programs that target catastrophic risk are largely limited. Mexico and Mongolia are exceptions (Agroasemex, 2006; Mahul and Skees, 2007).

It is largely due to the many problems that plague farm-level crop insurance that many government programs involve subsidies for multiple peril crop insurance (MPCI). Providing farm-level MPCI is problematic for any country. The problems of adverse selection, moral hazard, high transaction costs, and financing of correlated risks are well documented (Knight and Coble, 1997; Skees, 2001; Glauber, 2007). After considering actuarial problems, administrative costs, and subsidies, crop insurance programs with loss ratios exceeding 2-to-1 or even 4-to-1 (as in the United States) cannot be justified using any reasonable economic criteria (Skees, Hazell, and Miranda, 1999). These problems are exacerbated in lower income countries as it is simply out of the question to envision traditional approaches to crop insurance in a country dominated by small farms. The administrative costs of obtaining needed farm-level information and conducting farm-level loss adjustment make this type of insurance prohibitively expensive for insurance companies to offer and smallholder farmers to buy. During a 2005 workshop on the topic of delivery costs, a manager of a Mexican crop insurance company publicly stated that his company would not consider selling crop insurance to anyone who was farming less than 25 hectares.[4] Clearly, there are few farmers in lower income countries farming on 25 hectares or more.

To add to the challenge of providing subsidies, lower income countries that have a large percentage of their populations engaged in some level of the agricultural production chain can not afford the fiscal strain that would be imposed if they chose to subsidize agricultural insurance. The role of government in developed countries with agricultural insurance has led to considerable confusion among donors, policy makers, and practitioners about how to introduce agricultural insurance without subsidy in lower income countries. Wright (2006) also raises his own set of concerns about the subsidies that have gone into agricultural insurance and properly asks why those public dollars are not being used to support investments that have clear social returns, like research.

[4] Author's personal notes from the workshop, "Innovations in Agricultural Production Risk Management in Central America: Challenges and Opportunities to Reach the Rural Poor," Antigua, Guatemala, May 9–12, 2005.

This is not to suggest that government and donors do not have an important role in supporting the development of markets for agricultural insurance. We have written about this previously, emphasizing the role of government in supporting data and information gathering and sharing, product development, establishing an enabling legal and regulatory environment, *ex ante* catastrophic risk financing (removing the most extreme risk only), and appropriate social response policies (Skees et al., 2005). These investments can be significant expenditures designed to "crowd-in" markets. Such investments can be fundamental and much better than simplistic approaches that offer to provide premium subsidies as a percent of total premium. These simplistic approaches invite further rent seeking from the market (Skees, 2001). In the end, significant inefficiencies and programs that benefit the better-off segments of society are a likely outcome.

4. Learning from Case Studies

The advent of a number of pilot projects that are designed around index-based weather insurance products in lower income countries is notable (Table 1). Still, the history for these products is very limited. This section is not meant to be a detailed accounting of the ongoing activity. Rather, a few case studies illustrate how index-based weather insurance products are designed for farm and rural households.

It is worth noting that weather insurance products have been used in the United States for a number of years. Their success seems to be most noteworthy among specialty crops where other forms of agricultural insurance may be limited (e.g., high-valued citrus crops vulnerable to freeze). Beyond that, the use of index-based weather insurance in the United States is limited and may have been hindered by early mistakes in implementing these programs. In 1988, a major insurance provider introduced drought insurance for farmers growing Midwestern crops (e.g., corn and soybeans). This effort failed in the first year due to poor underwriting decisions. The sales for the product were increasing rapidly as the sale closing date approached. Rather than consider that the farmers knew what the insurance company did not, the insurance provider extended the sales closing beyond the dates set in the original contract. The painful lesson was that farmers, once again, had information superior to the insurance provider. They clearly understood that a major drought was emerging. This explained the tremendous and growing interest — farmers knew the probability of a payout was greater than implied in the contract. The insurance provider did not have adequate resources to pay the massive losses that resulted from the 1988 drought. The issue was settled in the courts. Rainfall insurance has not been offered to Midwestern crop farmers since that time. This event was a major setback to what could have emerged in the U.S. markets. This experience is a reminder — mistakes in the development of these products can easily destroy or delay future opportunities.

Among lower income countries, India has the longest running programs for selling weather insurance. From my review, the Indian weather insurance program may encounter the same intertemporal adverse problem as did the 1988 U.S. Midwestern rainfall insurance policy. Many of the weather insurance products are being sold after crops are planted when farmers will have more knowledge about the likelihood of drought or floods. Sales closing dates must be set well in advance of when information starts to emerge about the likelihood of a problem.

Table 1 Summary of Index-based Risk Transfer Products in Lower Income Countries

Country	Risk Event	Contract Structure	Index Measure	Target User	Status
Bangladesh	Flood	Index insurance for disaster relief			In development
Caribbean Catastrophe Risk Insurance Facility	Hurricanes and earthquakes	Index insurance contracts with risk pooling for reinsurance coverage	Indexed data from NOAA and USGS	Caribbean country governments	Implemented in 2007
Ethiopia	Drought	Index insurance	Rainfall	WFP[5] operations in Ethiopia	$7 million insured for 2006; Policy not renewed for 2007.
Mexico	Natural disasters impacting smallholder farmers, primarily drought	Index insurance	Rainfall, windspeed, and temperature	State governments for disaster relief. Supports the FONDEN[6] program	Began in 2001; Available in 26 of 32 states; Currently 28% (2.3 million ha) of dryland cropland is covered. Expansion is limited by data availability.
Mexico	Major earthquakes	Cat bond and index insurance contracts	Richter scale readings	Mexican government to support FONDEN	Introduced in 2006; CAT bond provides up to $160 million; Index insurance provides additional funding up to $290 million.
Mexico	Insufficient irrigation supply	Index insurance	Reservoir levels	Water users groups in the Rio Mayo area	Proposed

[5] World Food Programme

[6] Fondo por Desastres Naturales

Table 1 Summary of Index-based Risk Transfer Products in Lower Income Countries

Country	Risk Event	Contract Structure	Index Measure	Target User	Status
Bangladesh	Drought	Index insurance linked to lending	Rainfall	Smallholder rice farmers	In development; Pilot launch planned for 2008
Honduras	Drought		Rainfall		In development
India	Drought and flood	Index insurance linked to lending and offered direct to farmers.	Rainfall	Smallholder farmers	Began with pilot in 2003; Now index insurance products are being offered by the private sector and the government with an estimated 300,000 policies sold in 2006.
Malawi	Drought	Index insurance linked to lending	Rainfall	Groundnut farmers who are members of NASFAM[7]	Pilot began in 2005. 2500 policies sold in 2006 pilot season; $7000 in premium volume
Mongolia	Large livestock losses due to severe weather	Index insurance with direct sales to herders	Area livestock mortality rate	Nomadic herders	Second sales season of pilot completed in 2007; Offered in 3 provinces; 14% of eligible herders are participating.
Morocco	Drought		Rainfall		No interest from market due to declining trend in rainfall

[7] National Smallholder Farmers' Association of Malawi

Table 1 Summary of Index-based Risk Transfer Products in Lower Income Countries

Country	Risk Event	Contract Structure	Index Measure	Target User	Status
Nicaragua	Drought and excess rain during production, excess rain during harvest period	Index insurance	Rainfall	Groundnut farmers	Launched in 3 departments in 2006
Peru	Flooding, torrential rainfall from El Niño	Index insurance	ENSO anomalies in Pacific Ocean	Rural financial institutions	Proposed
Peru	drought	Index insurance linked to lending	Area-yield production index	Cotton farmers	Proposed
Senegal	Drought	Index insurance linked to area-yield insurance	Rainfall and crop yield	Smallholder farmers	Proposed
Tanzania	Drought	Index insurance linked to lending	Rainfall	Smallholder maize farmers	Pilot implementation in 2007
Thailand	Drought	Index insurance linked to lending	Rainfall	Smallholder farmers	Pilot implementation in 2007
Vietnam	Flooding during rice harvest	Index insurance linked to lending	River level	Smallholder rice farmers	In development
Kazakhstan	Drought	Index insurance linked to MPCI program	Rainfall	Medium and large farms	In development

Source: Author; also in Barnett, Barrett, and Skees, 2006

Rainfall insurance in India began with technical assistance from the World Bank working with ICICI-Lombard and BASIX, which is a livelihood promotion group working directly with the poor and providing a wide range of services including technical expertise, microfinance, and insurance products (Hess, 2003). In the first year of the pilot, the insurance was sold to more than 200 groundnut and castor farmers in the coastal district of Mahahbubnagar in Andhra Pradesh to protect against drought. I was fortunate in being able to visit a group of these farmers in 2003 and provide some limited advice about the project as it was beginning. I returned to the area in 2006 and visited a village that had obtained a payment for a severe loss from drought. This visit reinforced that, while the contract was promoted as a groundnut and castor contract, the problems in the 2005 drought for the village were much more serious: The riverbed dried up creating severe shortages of drinking water for livestock and the villagers, stopping any fishing, and preventing planting of rice along the river.

Index-based weather insurance in India is highly noteworthy in that, currently, it is being run without government subsidies and smallholder farmers are paying the full price of these products. Anecdotes abound about the successes or failures associated with the program. A large number of farmers have purchased the products (some reports suggest more than ½ million farmers over the 4 years). Most of the products have been purchased via the government crop insurance provider that began weather insurance sales in response to the introduction of these products from the private sector. The Agricultural Insurance Company of India (AIC), the administrator of the government crop insurance program, began selling unsubsidized rainfall insurance products in the khariff (the season from June to September) in 2004. In 2005, the AIC sold 125,000 rainfall insurance policies in different regions of India. ICICI continues to compete side by side with these new products from the government. Both the AIC and the ICICI products are directly linked to lending.

During 2004 and 2005, other institutions began expanding the market for weather insurance in India. It is estimated that at least 300,000 weather insurance contracts were sold in 2006. Weather insurance policies are now sold to smallholder farm households by both AIC and private-sector insurance companies, IFCCO-Tokyo, HDFC-Chubb, and ICICI Lombard (World Bank, 2007). Weather insurance is also being marketed to non-farm enterprises that are affected by weather risks such as salt processors and brick makers.

However, there have been reports of protests by farmers who had significant crop losses due to extreme rainfall when they had purchased a drought policy. Such problems are to be expected as many different weather and pest problems can impact crop yields. Nonetheless, if index-based weather insurance is sold as crop insurance, farmers who have losses from that crop and do not receive payments are bound to be disgruntled. If the educational efforts to explain these products are not significant, these types of problems can easily create enough discontent to destroy further efforts to develop weather insurance markets.

There are over 100 million smallholder farmers in India. To get a better picture of the uptake of these products, it would be useful to have more information about the percentage of eligible farmers in the market who are buying the insurance. Of course this is difficult given the vast number of farmers in India and the expansion of the market. In Mongolia, these estimates are easier to make within the limited scale of the index-based livestock insurance pilot. Some 3,400 herders purchased insurance in 2007, representing about 14 percent of the eligible herders in the second year of this pilot program (Mahul and Skees, 2007).

Nevertheless, the large number of farmers purchasing weather insurance products in India and the growth of companies offering these products in such a short time is impressive. The expansion of rainfall insurance products can be greatly attributed to the effort of ICICI-Lombard and BASIX to modify and improve the product according to field staff and client feedback. They have invested in improving the accessibility of the product by simplifying the delivery system, training agents, and incorporating new technology (Manuamorn, 2007). For example, their contract was simplified to

make it more straightforward for the customers, many of whom may be uneducated or illiterate. They abandoned a more complex payout structure in favor of a simple contract that covered up to three growing phases. A farmer can choose to cover any or all of the phases. Their rainfall contracts are generic in that they are no longer designed for specific crops; they only insure against rainfall levels for three specified time periods, beginning with the onset of the monsoon season (Figure 1).

Figure 1 Sample Termsheet for Weather Index Insurance in India

TERMSHEET FOR WEATHER INDEX INSURANCE

Product Reference	NA06
Crops	Any crop in the district
Reference Weather Station	Nalgonda
Index	Aggregate rainfall during the cover phases in mm. If rainfall on a day is < 2 mm it is not counted in the aggregate rainfall If rainfall on a day is > 60 mm it is not counted in the aggregate rainfall Above condition applicable only for deficit rainfall cover and not for excess rainfall cover
Definition of Day 1	month of June at reference station is observed >= 50 mm If above condition is not met in June, Policy invariably starts on July 1
Policy Duration	110 days

Cover Phase	**I**	**II**	**III**
Duration	35 days	35 days	40 days
	PUT		
Strike (mm) <	**60**	**80**	-
Exit (mm) <	**10**	**10**	-
Notional (Rs / mm)	10.00	10.00	-
Policy Limit (Rs)	1,000	1,000	-
Phase premium (Rs)	**90**	**90**	
	CALL		
Strike (mm) >	-	-	**240**
Exit (mm) >	-	-	**340**
Notional (Rs / mm)	-	-	10.00
Policy Limit (Rs)	-	-	1,000
Phase premium (Rs)	-	-	**110**

Combined Premium (Rs)	**280**
Combined policy limit (Rs)	3,000
Data Source	Indian Meteorological Department
Settlement Date	Thirty days after the data release by IMD and verified by Insurer.

Source: BASIX of India; a similar contract appears in Manuamorn, 2007

Incorporating client feedback, BASIX lowered the minimum liability allowed on a policy as most insureds only wanted a small amount of coverage for smaller premium. A similar behavior is being exhibited in Mongolia where herders are given a choice of insuring between 30 and 100 percent of the value of their herds. The vast majority of herders select 30 percent; again this is done to lower the premium costs. For the sample contract for India rainfall presented in figure 2, farmers can purchase insurance for one, two, or three phases of the growing season. The first phase is timed with the onset of the rainy season (planting). For the first two phases that correspond to sowing and growing periods, the index insurance covers drought risk, while for the third phase, the harvest period, it covers excess rain. The premium is 90 INR (US$2) for each of the first two phases for a sum insured of 1000 INR. The premium for the third phase is 110 INR for a sum insured of 1000 INR.

The brief review above highlights several lessons that merit further reflection:

1. Sound underwriting (including appropriate sales closing dates) is critical;
2. The poor are selecting liability levels that are relatively low; and
3. Simple weather contracts may be preferred to more complex contracts.

Sound Underwriting — Setting Appropriate Sales Closing Dates

The first issue presents an interesting and important aspect of any of these products — various sources of forecasting information can create problems for insurance products that are not properly designed. Many indigenous populations have their own systems to forecast the weather. However, beyond that, more sophisticated forecasting procedures are being developed. In our work on El Niño, it became clear that the sea surface temperature provided information about emerging problems as early as 7 to 8 months before the actual event (Khalil, et. al., n.d.). Furthermore, we learned that the lenders felt that they could control loan default problems by using this information in their lending practices to farmers. The same issue emerged in Mongolia where lenders indicated that they stopped making loans to herders in areas that were experiencing drought because they knew very well that the probability of having high mortality rates during the subsequent winter would result in higher loan defaults. If lenders exhibit this behavior, one would certainly expect that insurers must do the same.

Again, the most direct way to control this type of intertemporal adverse selection involves setting sales closing dates early enough that available information does not give someone an advantage in knowing that the insurance product is underpriced. Doing this in some regions of the world will undoubtedly mean that sales closing must be set so far in advance that it will impact purchase decisions. Dynamically pricing weather insurance products based upon emerging forecast information is another option. In part, this is why agricultural economists have been attracted to the use of weather derivatives. With effective exchange markets that have many buyers and sellers taking opposite positions on the weather, prices would change as weather conditions and forecasts change.

Weather markets in the United States began around 1997 following the deregulation of the energy markets. These markets were established within the energy sector to protect against swings in temperature that have direct impacts on the demand for energy. Most of these trades were done over-the-counter (OTC). From 2001 to 2003, I did some work with some of these emerging markets to scope out the possibilities for using OTC trading for agricultural risk. When the weather products must be specifically tailored, as they typically are, for agricultural applications, it is unlikely that the preconditions for active trading and effective price discovery will be met. Indicative of this is that nearly all of the professionals I interacted with during these early years of the market left the weather trading desk to work in the insurance and reinsurance sector. In short, active trading to dynamically price weather insurance is not practical for many of the highly tailored products that must be developed to transfer special forms of weather risk. At this point, insurance markets seem better suited for index-based weather insurance products.

Two alternatives to having early sales closing dates could be: 1) the sale of options to purchase insurance; and 2) multiple-year contracts. Both of these alternatives merit further research. Selling an option to give the buyer the right but not the obligation to purchase the insurance would still require advanced purchase decisions. Of course this type of option would be less costly than the full premium costs, but it would still require an early commitment of funds and it is not very practical as an alternative for smallholder households, given the high delivery costs. The second alternative would involve rolling the premiums forward with an annual payment for a multi-year contract. Again, this alternative is not practical for smallholder households. Both of these options are more likely to be successfully implemented for a risk aggregator like a microfinance institution.

The Poor Select Low Liability Levels for Insurance

Within the development community an interesting question has been raised: How might a massive influx of indemnity payments following a major disaster influence inflation in the local economy? The emerging evidence regarding the levels of insurance that are being purchased should ease these fears. If operators of smallholder households are purchasing such limited liability, the influx of funds following a major disaster will only partially compensate for their losses.

Of more concern is the issue of whether there will be bad publicity or negative reactions from the insured if a catastrophe occurs and they find that the indemnities they receive are less than they expected or needed. Fundamental educational efforts are needed. In part this was the reason that two different levels of index insurance were introduced for the 2007 sales season of index-based livestock insurance in Mongolia. One product pays for livestock mortality levels above 6 percent and the other pays when levels exceed 10 percent. In the educational efforts, it was explained that herders would have better catastrophe protection if they used the same premium currency needed to purchase the 6 percent policy at 30 percent of the value of their animals, to purchase higher levels of liability on the 10 percent policy for the same amount of premium. This would ensure a greater payment in the most catastrophic years. It is too early to know how herders might have changed their behavior with these options available. Preliminary information suggests that they still purchased the 6 percent polices at 30 percent of the value of animals.

Simple Contracts May Be Preferred to More Complex Contracts

The type of generic weather insurance contract that has emerged in India has some significant advantages over more complex contracts that attempt to fit weather data to crop growth models. Basis risk is always going to be an issue with weather insurance contracts. Complex scientific models that "overfit" weather data to crop yields can give the wrong impression that basis risk is lower than is likely the case.

While I highly value the science that goes into understanding crop growth processes and attempting to create the ideal weather index that will capture variations in yields, these models fail to capture the rich diversity of individual farm-yield risk that will almost always be present within a local community. Basis risk comes from a wide range of sources: 1) the weather station being used for the contract may be too far from the insured; 2) the insured may be farming soils that are different than those used in a crop growth model used to design a rainfall insurance contract; and 3) management by the individual farm operator can be significantly different than the conditions that are imposed in a crop growth model.[8] Each of these variables can result in a significant loss for an individual farmer even when a complex weather index suggests that no loss should have occurred. This becomes more likely when the weather index that is being created is attempting to protect against relatively common losses that are near the mean values, and again, is less likely when insuring against extreme, catastrophic events that affect an entire community. Still, in areas of the world where microclimates dominate, index-based weather insurance simply does not make economic sense. In areas where weather events are not correlated across a large geographical area, attempts to populate the area with enough weather stations to reduce the basis risk to an acceptable level can easily negate the cost advantage of index-based weather insurance over traditional loss-adjusted insurance.

Over promoting index-based weather insurance as the solution to individual crop-yield problems may be the largest risk that this innovation faces. If efforts to match individual crop yields to weather

[8] The very fact that management is not included is, of course, one of the advantages of index-based weather insurance. Management can be the source of adverse selection and moral hazard. Nonetheless, the poor may not have the resources to apply the same standard management practices that were assumed in the crop growth simulation models used to design the contract. Thus, the opportunity for misunderstanding about how well an index insurance contract will capture farm-level losses still exists.

events are presented in such a fashion that insured believe they have better insurance protection than they do, misunderstandings are to be expected. This does not negate the importance of using crop modeling efforts to design the most appropriate generic weather insurance products. Such efforts can be used to design the thresholds and the most critical time periods. Still every caution should be taken in the educational and sales effort that follows. Presenting the contract as a seasonal weather contract that is designed to compensate when severe weather events create a wide range of problems will be less likely to invite challenges and misunderstandings when farmers have losses on specific crops.

Selling a generic weather insurance contract similar to what is presented in figure 2 has many advantages: 1) misunderstanding about protection for a specific crop yield is reduced; 2) there are many regions of the world where inter-cropping systems are a dominant farming activity and contracts that cover major weather events within the cropping season should fit better for those farming systems; 3) giving the farmer a choice about which of the periods concern them most is a good marketing strategy; 4) these products can allow for more flexible farming systems as the farm plan can change due to changing weather conditions once a farmer has this generic contract; and 5) these contracts can be purchased for any other activity that could negatively impact rural households due to extreme weather events in one or all of the specified weather periods.

5. Summary and Conclusions — A Framework for Insurance Development

This article raises a number of important conceptual and product design issues regarding the development of agricultural insurance in lower income countries. Primarily, starting with the development of mechanisms to transfer the big risks — spatially correlated, high impact events that overwhelm even well-diversified farm activity portfolios is arguably key for easing many of the constraints to the development of rural financial markets. Giving explicit consideration to what are the most appropriate mechanisms for addressing the characteristics of different risk layers is part of the development of broader financial services for the poor. The task now becomes one of framing a model for the systematic development of market-based weather risk transfer products.

Observations shared in this paper lead to several important observations:

1. When agricultural insurance is placed into a broader framework motivated by helping smallholder households smooth consumption over time, focusing on catastrophe insurance is likely to be considered more optimal;
2. When one considers how households can use different risk management mechanisms for different layers of risks, catastrophe insurance is likely to be more optimal than insurance for less severe events;
3. When insurance against natural disaster risks is considered within a larger institutional setting that includes consideration for how to develop financial services for the poor, catastrophe insurance markets are also likely to be more optimal; and
4. When considering the development of index-based weather insurance products, generic index-based weather insurance that protects against catastrophic events is again likely to be more optimal and less likely to create misunderstandings about the nature of the index insurance products.

A focus on, and richer understanding of, the role that catastrophic weather insurance can play in markets also causes us to consider how the development process for agricultural insurance might be reversed for lower income countries. Rather than starting with products targeted at low impact, high probability risks, there is a need to start with products that get the "big risk" out of the way first.

Even those index-based weather insurance products that are targeted at smallholder households should also be focused on getting the "big risk" out of the way first.

In large part, the enthusiasm for using IBRTPs to transfer weather risk in lower income countries is motivated by a clear need for identifying new approaches to developing sustainable financial markets that serve the rural poor. Scaling up[9] financial services for the rural poor can only be achieved by adapting services and products to match the risk profile of this market demographic: Smallholder farmers with few assets and uncertain and/or seasonal cash flow. The approach must also address the concerns of lending institutions and other businesses that limit or ration their services to smallholder farmers as a strategy to reduce their own risk exposure indirectly tied to correlated weather events via their clients. And finally, the approach should display some semblance of economic efficiency tempered by equity considerations.

Our approach has been to first design a financially sustainable index-based product that will transfer the most severe segment of risk. In many cases the most efficient way to introduce IBRTPs is to begin with a product that transfers the portfolio risk of rural lenders who have exposure to natural hazards impacting agricultural and other rural enterprises, such as drought and flood (Skees and Barnett, 2006; Skees, Hartell, and Murphy, n.d.). By targeting the aggregate portfolio of an MFI, lower administration and product delivery costs are achieved than by providing direct coverage to smallholder households. The transaction costs associated with providing insurance services to smallholder households can be prohibitive. Reducing the portfolio risk of MFIs is one way to ease the constraints to greater and more efficient complementary rural financial services. In the future, once mechanisms are in place to transfer catastrophic risk, it becomes possible to envision several types of subsequent insurance product developments. Future products could include insurance that is more closely linked to agricultural credit and/or individual, farm-level insurance for independent risks. Other secondary products could include individual products that would reduce the basis risk of index insurance by using ground-level data to assess losses for larger farms. In short, introducing index-based weather insurance products that get the "big risk" out of the way first can facilitate other market developments that result in more appropriate products being targeted to users operating different size farms.

This strategy, reinforced by our work and observations of similar work around the globe, suggests a somewhat different process for developing index-based insurance that begins with a linkage to lending. The model consists of three sequential development stages that correspond to increasingly greater direct individual loss indemnification:

1. Stage 1 is the first generation of insurance that is sold to MFIs and other risk aggregators by global reinsurance markets to offset the natural disaster–linked default and liquidity risk in lending or revolving credit portfolios (Skees and Barnett, 2006; Skees, Hartell, and Murphy, n.d.);
2. Stage 2 more directly confronts the household-level factors contributing to default risk by linking index insurance to lending and provides a direct benefit to borrowers. The benefit could extend beyond the "credit insurance" aspect and include some level of payment for coping and recovery from catastrophic loss; and
3. Stage 3 uses basic index insurance products as a form of reinsurance for more traditional farm-level crop insurance linked to loans for larger farms in a lower income country. Indemnities paid would be based upon estimates of farm-level losses rather than the index insurance. In this case, the MFI or other ground-level rural network serves as an insurance delivery mechanism.

[9] Scaling up in this context refers to improving the availability and accessibility of financial services (banking and insurance) for the rural poor.

Despite my earlier concerns about traditional agricultural insurance for weather and crop insurance, index insurance and traditional insurance are not by definition mutually exclusive, a point that is often lost in articles that seek to compare the relative farm-level benefits of the two risk management tools. These different forms of insurance can coexist and complement one another since they are really designed to target different layers of risk and, frankly, different levels of administrative capabilities. Nevertheless, advances in technology that lower delivery costs and loss adjustment for traditional agricultural insurance will be needed to better cope with the problems with traditional forms of agricultural insurance. In general however, the introduction of a mechanism to clear the most catastrophic risk should precede traditional forms of insurance that cover less severe risks. Separating the layers of catastrophic risk can improve the performance and affordability of traditional insurance approaches and coverage for more frequent risks. With careful development, index-based weather insurance products that are properly designed and targeted can become a first step to facilitating the broader development of robust rural financial markets that serve the needs of the poor in lower income countries.

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