Weather Index Insurance for Agriculture and Rural Areas in Lower Income Countries

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This session focuses on innovations in risk transfer for natural disasters in lower income countries. In particular, the focus is on weather index insurance products that can be used to transfer various weather-related risks. This paper discusses the linkage between weather risk and poverty, provides background information on weather index insurance products, describes requirements for the implementation of weather index insurance and possible roles for governments, donors, and international financial institutions in facilitating implementation, and briefly reviews recent efforts to provide weather index insurance products in rural areas of some middle and lower income countries. The other papers in this session build on this background material by providing detailed examples from India, Peru, Vietnam, and Kenya.

Weather Risk and Poverty

Approximately 1 billion people live on less than $1 per day. Three-quarters of those live in rural areas (Chen and Ravallion 2007) and over one-half depend on agriculture or agricultural labor as their primary livelihood strategy (International Fund for Agricultural Development 2001). Thus, poor rural households are particularly susceptible to the financial consequences of weather-related natural disasters. Even if they are not directly involved in agricultural production, many of the rural poor have income sources that are tied to the success of agricultural production or are otherwise highly susceptible to extreme weather events.

While health problems are often cited as the greatest risk facing many rural households, uninsured weather risks also contribute both directly and indirectly to the existence of chronic poverty. Extreme weather events, such as droughts and floods, can
directly destroy productive assets that have been accumulated at high opportunity cost through years of foregone consumption. Households that are thrust into poverty by such shocks often find it difficult to recover and restart the long process of accumulating productive assets (Carter et al. 2007).

The risk of extreme weather events also contributes indirectly to the existence of chronic poverty. Households that recognize the potential for weather-related shocks are often reluctant to forego short-term consumption to invest in risky productive assets. Instead they adopt low-risk, low-return investment strategies that reduce their exposure to extreme weather events but also keep the household trapped in chronic poverty (Rosenzweig and Binswanger 1993; Carter and Barrett 2006).

In some areas, the rural poor protect themselves from weather-related losses using various structural mitigation measures. Examples would include supplemental irrigation to offset the risk of insufficient rainfall or dams and levies to control flooding. However, these structural mitigation strategies are not always feasible, reliable, or cost-effective. Households can also mitigate the financial effects of risk through savings, diversification, share tenancy, producing lower risk outputs, or producing outputs that require less investment in risky productive assets. However, these strategies may not be available to all households. Further, the implied risk premium on such risk mitigation strategies can be very high. Rosenzweig and Binswanger (1993) estimated the implied risk premium for risk mitigation strategies employed by some households in rural India at 35 percent.

In principle, traditional insurance instruments, including crop insurance, can be used to transfer the risk of extreme weather events. However, insurance markets are underdeveloped and often non-existent in rural areas of lower income countries due to
poor contract enforcement, asymmetric information, high transaction costs, and high exposure to spatially covariate risks (Skees and Barnett 2006). These problems are particularly acute for crop insurance.

In the absence of formal insurance markets, households may also utilize a variety of informal risk transfer mechanisms (Besley 1995). These mechanisms include family and community mutual-aid obligations as well as semi-formal micro-insurance or state-contingent loan entities. These mechanisms can be somewhat successful in addressing the asymmetric information and transaction costs problems that plague formal insurance markets, but they tend to break-down when spatially covariate shocks occur (Zimmerman and Carter 2003; Townsend 1994; Rosenzweig 1988; Dercon 1996). Also, the poorest of the poor are often excluded from informal risk transfer arrangements since they have little to offer mutual-aid associations.

**Weather Index Insurance**

In recent years, researchers and development organizations have been exploring the potential for using weather index insurance to provide risk management opportunities for the rural poor. Weather index insurance pays indemnities based not on actual losses experienced by the policyholder but rather on realizations of a weather index that is highly correlated with actual losses. In its simplest form, a weather index measures a specific weather variable (e.g., rainfall or temperature) measured at a specific weather station over a defined period of time. Weather index insurance policies specify a threshold and a limit that establish the range of values over which indemnity payments will be made. If the insurance policy is protecting against unusually high realizations of the weather variable (e.g., excess rainfall or extremely hot temperatures) an indemnity is
made whenever the realized value of the index exceeds the threshold. The limit is set higher than the threshold and the indemnity increases incrementally as the realized value of the index approaches the limit. No additional indemnity is paid for realized values of the index that exceed the limit. Conversely, if the policy is protecting against unusually low realizations of the weather variable (e.g., drought or extremely cold temperatures) an indemnity is made whenever the realized value of the index is less than the threshold and the limit is set lower than the threshold.

To illustrate how weather index insurance works, consider the following example of an index insurance policy that protects against insufficient rainfall over a three month period with rainfall being measured at a specific weather station. The threshold is set at 100 millimeters of rainfall and the limit at 50 millimeters. Assume the policyholder purchases $1,000 of insurance protection. If the realized rainfall at the weather station is less than 100 millimeters, the policyholder will receive an indemnity equal to $20 for each millimeter less than 100 millimeters, up to a maximum of $1,000 for rainfall realizations of 50 millimeters or less. Note that the indemnity does not depend on losses incurred by the policyholder but rather is based strictly on rainfall measured at the weather station.

Relative to traditional insurance products, weather index insurance has several advantages:

- The insurance contract is relatively straightforward. This greatly simplifies the sales process.
- Indemnities are paid based solely on the realized value of the underlying index. There is no need to estimate the actual loss experienced by the policyholder.
• Unlike traditional insurance products, there is no need to classify individual policyholders according to their risk exposure.

• There is little reason to believe that the policyholder has better information than the insurer about the underlying index. Thus, there is little potential for adverse selection. Also, there is little potential for *ex ante* moral hazard since the policyholder cannot influence the realization of the underlying weather index.

• Operating costs are low relative to traditional insurance products due to the simplicity of sales and loss adjustment, the fact that policyholders do not have to be classified according to their risk exposure, and the lack of asymmetric information. It is important to note however that start-up costs can be quite significant. Reliable weather and agricultural production data and highly-skilled agro-meteorological expertise are all critical for the successful design and pricing of weather index insurance products.

• Since no farm-level risk assessment or loss adjustment is required, the insurance products can be sold and serviced by insurance companies that do not have extensive agricultural expertise.

An important limitation of index insurance is that policyholders are exposed to basis risk. In this context, basis risk refers to the fact that the index and the losses experienced by the policyholder are not perfectly correlated. It is possible for the policyholder to experience a loss and yet receive no index insurance indemnity. Likewise it is possible for the policyholder to receive an index insurance indemnity and yet experience no loss. There are two potential sources of basis risk. First, losses may be caused by disease, insect infestation, or any number of factors other than the weather
variable on which the index is based. Unless the index is based on a weather variable that is the dominant cause of loss in the region, basis risk will be unacceptably high. Second, the weather variable being used as the index may not be highly spatially covariate. Thus, the measure of the weather variable at the farm or household may be quite different than the measure at the weather station. Basis risk can be reduced by offering weather index insurance only in areas where a particular, highly covariate, weather variable (e.g., drought or extreme temperatures) is the dominant cause of loss.

Finally, it is important to recognize that in many cases the appropriate target market for weather index insurance may not be individual households. Instead, the appropriate market may be various local-level risk aggregators – that is, organizations that do business with many households in the local area and thus are highly exposed to covariate weather risks. Examples would include microfinance entities and other formal or informal lenders, mutual-aid associations, farmers’ cooperatives, input suppliers, output processors, and even local governments or disaster relief providers (Skees and Barnett 2006). Since these organizations aggregate risks from multiple households, they can effectively pool idiosyncratic risks. However, they remain highly vulnerable to extreme covariate weather events.

**Requirements for Weather Index Insurance**

While the basic concept is simple, effective implementation of weather index insurance is not at all simple. The availability of accurate historical weather data and the continued availability of those data are critical. It is also necessary to determine whether any of the available weather variables are, in fact, highly correlated with realized losses and, if so, the time periods in which losses are most likely to occur. International experience has
also shown that effective implementation requires careful attention to the services currently being provided by local risk aggregators as well as legal and regulatory constraints.

Governments, donors, and international financial institutions can facilitate the offering of weather index insurance by assisting with demand assessment, establishing an appropriate legal and regulatory framework, collecting and managing the required data, training insurance suppliers and providing objective information to potential users of weather index insurance, developing and pilot-testing potential weather index insurance products, and possibly providing some level of catastrophic risk-sharing. Each of these is discussed below.

Demand Assessment
Before investing in data collection and product development it is important to assess the potential demand for weather index insurance in a particular area. Personal interviews, focus groups, and surveys can be used to determine answers to the following questions. What are the key weather perils of concern? How frequently do the perils occur and how significant is the impact? Who is affected by these perils? What mitigation or informal risk transfer strategies are currently being employed? What is the (opportunity) cost of those strategies? How much are end-users willing and able to pay for an insurance product?

Legal and Regulatory Framework
To facilitate the offer of weather index insurance, governments must establish an appropriate legal and regulatory framework. The legal framework should address not only the proper regulation of insurance sales but also contract enforcement. In many
lower income countries, insurance is so poorly understood that courts often force insurance providers to pay indemnities for losses that were clearly not covered under the contract provisions. Conversely, insurance providers may refuse to pay claims to poor policyholders because they know that the policyholders cannot afford to have an attorney represent them in court. Thus, to protect the interests of small-scale policyholders some sort of binding arbitration procedure is typically desirable.

Even in countries where the legal and regulatory system is more highly developed, the existing regulatory standards for traditional insurance products may not be appropriate for index insurance products. Index insurance creates unique regulatory challenges because the indemnities are not based on the actual loss incurred. Also, index insurance is highly exposed to spatially covariate losses, so the minimum capital (or contingent capital) requirements need to be higher than those for traditional lines of insurance.

**Data Collection and Management**

For weather index insurance to be successful, both the insurer and the policyholder must have confidence that the index is being measured accurately and the data are secure from tampering. To build this confidence, the underlying index should be measured by a trusted government or private source of publicly available weather data.

In addition, a sufficient amount of historical (normally daily) data on the underlying weather variable must be available for the insurer to estimate premium rates. The amount of historical data required depends on the frequency of the risk. Twenty years of data may be sufficient to set initial premium rates for relatively frequent weather events. Thirty or forty years of data may not be sufficient for infrequent but potentially
catastrophic weather events. Without sufficient data on which to base premium rates, the insurer will either refuse to sell the insurance or add a large premium load to account for uncertainty.

Since weather data have public goods characteristics, they are unlikely to be collected, cleaned, archived and made publicly available by private-sector companies. Government meteorological bureaus normally provide these services. However, many lower income countries find it difficult to adequately fund meteorological bureaus or sustain a sufficient network of weather stations. To facilitate the availability of weather index insurance some donor organizations have provided funding for expanded meteorological services in lower income countries.

Training of Insurance Suppliers and Consumer Education

Insurance suppliers in lower income countries are unlikely to be familiar with weather index insurance. Thus, they require training and capacity building opportunities to build the expertise needed to offer these unique insurance instruments.

Similarly, in rural areas of many lower income countries, insurance products are not widely available. Even if potential policyholders are familiar with other types of insurance products, they will almost certainly not be familiar with weather index insurance. To make an informed purchase decision, it is critically important that potential policyholders understand the basis risk inherent with weather index insurance. Said differently, they need to understand that they may experience a loss but not receive an indemnity. Thus, the successful introduction of weather index insurance will require a significant educational effort. While insurance suppliers will provide some information as
part of their sales efforts, potential policyholder also need information from objective sources.

Government entities and donor organizations can provide training on weather index insurance to insurance suppliers. They can also serve as an objective source of information and educational materials for potential policyholders.

Product Development

Once a weather index insurance product is developed and offered for sale by an insurance supplier, it can easily be copied by competitors since the underlying index is based on publicly available data. This “free rider” problem makes it very unlikely that private-sector insurance suppliers will invest in the research and development required to bring a weather index insurance product to the market. For this reason governments and donors have tended to fund feasibility studies and pilot tests of new weather index insurance products. Local private-sector insurance suppliers are generally involved in these product development efforts. This facilitates the transition from a successful pilot test to a scaled-up, private-sector, insurance product.

Catastrophic Risk-Sharing

Local suppliers of weather index insurance policies must be able to transfer their loss exposure outside of the local area. Traditional lines of insurance (e.g., automobile, life, property and casualty) are offered on loss events that are largely uncorrelated, so the law of large numbers reduces the variance in indemnities for local insurance providers. But weather index insurance protects against spatially covariate loss events. When a policyholder collects an indemnity on a weather index insurance product all other holders of that same policy will be collecting indemnities as well. This implies that, in any given year, indemnities can be very high relative to premiums collected. While, in principle, it
may be possible for insurance suppliers to set aside adequate liquid reserves to cover the potential for large indemnities, in practice this is highly unlikely. There is a high opportunity cost associated with keeping such large amounts of capital in investments that can be readily liquidated. Further, in many countries there are tax disincentives for holding large reserves. Thus, index insurance suppliers generally obtain contingent capital via reinsurance. Catastrophe bonds and contingent loan mechanisms can also be used as sources of contingent capital.

Governments and donors may also assist with providing contingent capital to suppliers of weather index insurance. Some evidence suggests that those at risk tend to ignore the probability of the most extreme and infrequent loss events (Kunreuther 1996; Kunreuther and Slovic 1978). But insurers and reinsurers of weather index insurance cannot afford to ignore the potential for such events. They must load premium rates to reflect the potential for highly infrequent weather events including events that are more extreme than any in the available historical data. Since there are no data from which to calculate the frequency and magnitude of such extreme events, insurers and reinsurers tend to be extremely conservative when calculating the premium load. This creates a gap between what buyers are willing to pay and what sellers are willing to accept for protection against extreme weather events.

To address this market failure, governments or donors can provide contingent financing (e.g., reinsurance or a contingent loan) for extreme realizations of the weather variable underlying the weather index insurance product. To keep from crowding-out private sector risk transfer markets, any government or donor contingent financing should be carefully structured so that it covers only the most extreme weather events. If
insurance suppliers can obtain contingent financing for this extreme tail risk at a reasonable cost, they can pass along the benefits in lower premium costs to policyholders. This will increase the number of policies sold, thus increasing market opportunities for reinsurers to provide contingent financing against all but the most extreme weather events.

**International Experience**

Experience with weather index insurance in middle and lower income countries is both too limited and too recent to draw conclusions about its long-run sustainability. Table 1 lists some middle and lower income countries where weather index insurance has been sold to date. However, except for Mexico and India, sales have occurred within pilot programs so the volume of business has been marginal. In addition, weather index insurance products are currently being developed in countries such as Tanzania, Nicaragua, Thailand, Kazakhstan, Senegal, Morocco, Bangladesh, Vietnam, and several of the Caribbean islands (table 2).

Among middle and lower income countries, Mexico and India currently have the most developed weather index insurance programs. In both countries the products offered focus primarily on rainfall deficiency (drought). Also, in both countries, technical support, provided by international organizations, facilitated the offering of weather index insurance products.

**Mexico**

The Mexican public reinsurance company Agroasemex has been providing weather index insurance since 2001. Most of the policies are based on rainfall but some have been based on temperature and wind speed. The policies are marketed primarily to state
governments in Mexico to protect against calamities (mainly drought) in the states and are linked to the social program *Fondo Nacional para Desastres Naturales* (Natural Disasters Fund—FONDEN). In 2005, 1.16 million hectares in 18 states were covered by the contracts. In 2006, 2.3 million hectares were covered. This represents 28 percent of the dry-land (non-irrigated) crop area in Mexico. The main limiting factor to providing wider coverage is a lack of rainfall data and weather stations.

*India*

Agriculture accounts for around 23 percent of India’s gross domestic product. An estimated 65 percent of the population is engaged in agriculture and associated activities. Most of the agricultural production is small-scale. Eighty percent of the more than 120 million landowners own parcels of less than 2 hectares. Weather risk is a major concern to agricultural producers and agribusinesses alike. It is estimated that rainfall variability accounts for more than 50 percent of the variability in crop yields.

Weather index insurance was first introduced in India in 2003. In collaboration with the microfinance institution BASIX, ICICI Lombard General Insurance Company began selling a rainfall index insurance product. BASIX holds no risk on the insurance policies but instead acts an intermediary that receives commissions from selling the index insurance to its customers. Between June 2003 and March 2006, BASIX sold a total of 7,653 rainfall index insurance policies in six Indian states.

The parastatal agriculture insurance company AICI introduced a weather index insurance product in 2004. In 2005-06, AICI sold weather index insurance policies to more than 125,000 farmers. Most (98 percent) were sold to farmers in the state of Maharashtra. The World Bank has provided technical assistance to the Government of
India and AICI in the development of weather index insurance. This assistance has focused on product design, rating, and large scale implementation.

Conclusion

Effective mechanisms for transferring risk can catalyze investment and economic growth, thus contributing to poverty reduction in rural areas of lower income countries. Weather index insurance is a relatively simple concept that, under certain circumstances, can effectively transfer spatially covariate weather risks. Because the policyholder has no better information than the insurer about the underlying index, weather index insurance is not highly susceptible to the asymmetric information problems of adverse selection and moral hazard. Further, operating costs are generally lower for weather index insurance than for traditional insurance products.

However, weather index insurance also has significant limitations. It only protects against losses caused by extreme occurrences of the underlying weather variable and is only effective when basis risk can be reduced to an acceptable level. Purchasers must utilize other strategies to protect against the financial impacts of loss events that are not covered by the index insurance product. In some cases, it may be more cost-effective for households or communities to adopt structural mitigation measures rather than purchasing weather index insurance. But structural mitigation measures may also complement weather index insurance purchasing, by allowing policyholders to choose less expensive policies with thresholds that protect only against the most extreme weather events when structural mitigation measures may fail.

Start-up costs for weather index insurance can be quite high and, once developed, the insurance products have public goods characteristics. For these reasons governments,
donors, and international financial institutions have facilitated the offer of weather index insurance in several middle and lower income countries. While experience to date is too limited and too recent to draw general conclusions about the long-run sustainability of these efforts, the experience in Mexico and India suggests that, at least in some areas, these products may prove to be a valuable risk transfer mechanism for the rural poor.

References


Table 1. Weather Index Insurance Policies Sold in Middle and Lower Income Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Product(s)</th>
<th>Clients</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>Drought index insurance</td>
<td>State governments</td>
<td>1.2 million hectares covered; premium volume of US$17 million</td>
</tr>
<tr>
<td>India</td>
<td>Drought index insurance for main crops (rice, groundnut)</td>
<td>Small farmers serviced through direct agents or rural financial institutions</td>
<td>250,000 policies sold in 2005-06; premium volume of about US$20 million.</td>
</tr>
<tr>
<td>Ukraine</td>
<td>Drought index insurance</td>
<td>Large farms</td>
<td>Only 2 contracts sold in 2005</td>
</tr>
<tr>
<td>Malawi</td>
<td>Drought index insurance for groundnut</td>
<td>Small borrowing farmers</td>
<td>2,500 policies sold in 2006. Premium volume of US$7,000</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Drought index insurance</td>
<td>World Food Program</td>
<td>US$7 million coverage.</td>
</tr>
<tr>
<td>China</td>
<td>Drought index insurance for vegetables</td>
<td>Borrowing farmers</td>
<td>Small scale pilot in Shanghai.</td>
</tr>
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</table>
Table 2. Weather Index Insurance Policies Under Development in Middle and Lower Income Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Product(s)</th>
<th>Clients</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicaragua</td>
<td>Drought index insurance</td>
<td>Small farmers</td>
<td>Under implementation</td>
</tr>
<tr>
<td>Thailand</td>
<td>Drought index insurance</td>
<td>Small borrowing farmers</td>
<td>To be implemented in 2007</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>Drought index insurance</td>
<td>Medium and large farms</td>
<td>Complements compulsory multiple peril crop insurance.</td>
</tr>
<tr>
<td>Senegal</td>
<td>Drought index insurance for peanuts</td>
<td>Small borrowing farmers</td>
<td>Possible link with an area yield insurance scheme.</td>
</tr>
<tr>
<td>Morocco</td>
<td>Drought index insurance for major crops</td>
<td>Borrowing farmers</td>
<td>Complements the indemnity-based drought insurance scheme.</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Drought index insurance for rice</td>
<td>Small borrowing farmers</td>
<td>To be piloted in 2008</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Flood index insurance</td>
<td>Natural disaster fund</td>
<td>Work in progress</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Flood index insurance</td>
<td>Small borrowing farmers</td>
<td>Work in progress</td>
</tr>
<tr>
<td>Caribbean Islands</td>
<td>Drought index insurance and hurricane index insurance</td>
<td>Cash crop farmers</td>
<td>Newly established Caribbean Catastrophe Risk Insurance Facility.</td>
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