Chapter 3: INTRODUCTION TO WEATHER INDEX INSURANCE

3.1 OVERVIEW

Having undertaken a risk assessment, identified a particular risk (weather), chosen a management strategy (transfer), considered the relevant risk-layering arrangements, and decided that perhaps a traditional agricultural insurance product may not be the most suitable solution, we find ourselves at the juncture of needing to discuss in more detail what exactly WII is and, equally important, what it is not.

Index insurance is a simplified form of insurance in which indemnity payments are based on values obtained from an index that serves as a proxy for losses rather than upon the assessed losses of each individual policyholder. The sum insured is normally based on production cost on an agreed value basis (fixed in the policy in advance), and payouts are made based on a pre-established scale set out in the insurance policy (discussed below).

The origins of WII come from the international weather derivative market, where major corporations hedge weather risks. The interest in WII applications for agriculture grew from a belief that traditional insurance products (especially MPCI) were not viable for developing countries, where limited commercialization and small average farm sizes are a major hindrance to the sustainable development of commercial agricultural insurance products.

In order for the underlying index to be a sound proxy for loss, it has to be based upon an objective measure (for example, rainfall, wind speed, temperature) that exhibits a strong correlation with the variable of interest (in this case, crop yield). Additionally, the weather variable that can form an index must satisfy the following properties:

- Observable and easily measured
- Objective
- Transparent
- Independently verifiable
- Reported in a timely manner
- Consistent over time
- Experienced over a wide area

Given the above requirements, weather indexation is most applicable to highly correlated risks, such as drought and temperature. Localized (independently occurring) risks, such as hail or fire, do not lend themselves to index insurance.

As mentioned above, indemnity payouts are made in accordance with a schedule laid out in the policy itself. An example of a payout structure for rainfall deficit coverage is shown in figure 3.1. In this instance the index payout threshold is 100 mm of rainfall, falling during a specified period, and the payout (maximum) limit is reached when rainfall falls to or below 50 mm.

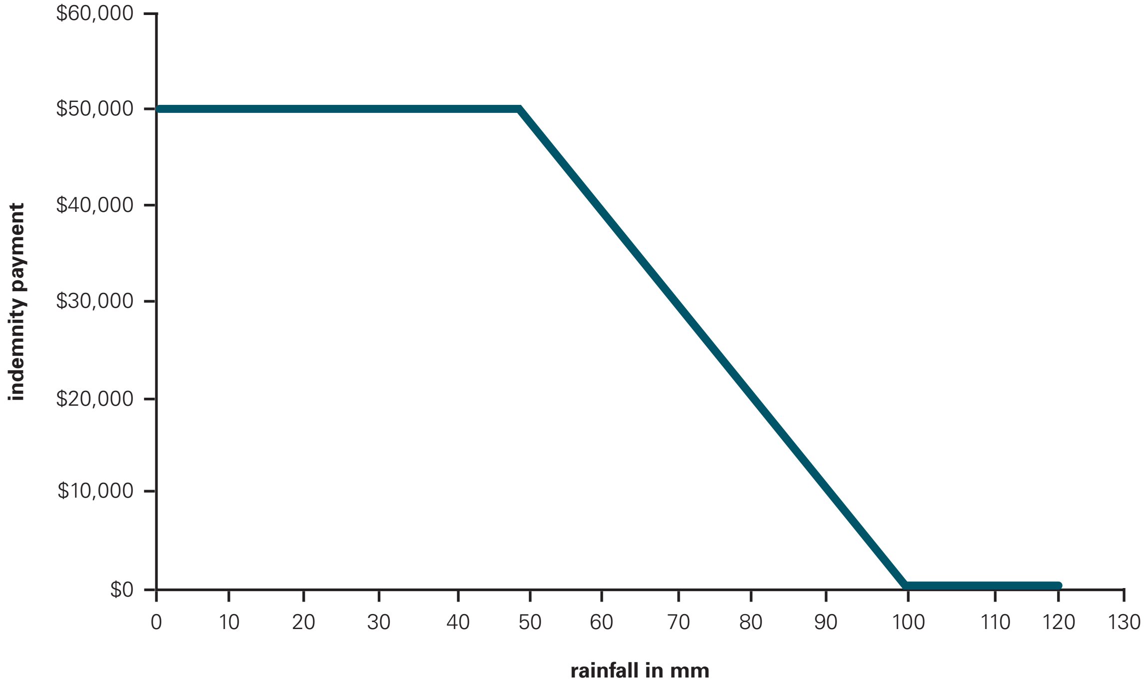
In reality, the payout structure in figure 3.1 is too simplified to capture the true correlation between rainfall and crop yield loss. The timing, not just the amount of rainfall during the various growth phases of a plant, is very important for satisfying the soil water balance and therefore the ultimate yield. Dry spells, or deficits over the main phases of crop growth, can cause yield loss, even if cumulative season rainfall is adequate. Commonly, index product designs use several phases of measurement during the crop season (typically three phases for grain crops), each with their own thresholds and limits of the weather parameter. These options are described later in this paper.

3.2 WEATHER RISKS, CLIMATIC CONDITIONS, AND INDEX INSURANCE

To date, most practical experiences with the development of WII have been with deficit and excess rainfall and have relied on data collection with terrestrial-based monitoring systems (weather stations). However, a wide range of weather risks are indexable, and table 3.1 draws out the main features of insuring different weather risks using index products. Additionally, and especially given the lack of weather monitoring systems in many developing countries, there is growing research on the use of alternative data sources and risk modeling (see box 3.1).

The scientific community has taken much interest in the design and adaptation of innovative models to simulate crop

FIGURE 3.1: Payout Structure for a Hypothetical Rainfall Contract



Source: Authors.

behavior and to overcome some of the limitations related to reliable access to rainfall data in developing countries. Box 3.1 illustrates some of those efforts.

3.3 ILLUSTRATIVE APPLICATIONS OF WII: MICRO, MESO, AND MACRO LEVELS

An advantage of WII is that it can be designed for different client types.

At the **micro level**, local WII for drought and excess rainfall is being sold to farmers through the Indian microfinance institution BASIX. Since its inception in 2003, the product has undergone a number of changes. Currently the contract is not tied to specific crops but offers a generic contract for three phases of the growing season for specific rainfall thresholds. The success of the BASIX–ICICI Lombard product sparked broad interest from other insurers, including the state-owned Agricultural Insurance Company of India (AICI) to enter this market. Swiss Re estimates that more than 539,000 Indian farmers have purchased weather index insurance to date. The Indian experience has also given rise to similar pilots and feasibility studies that target individual farmers in many countries around the world, including Thailand, Indonesia, Malawi, Kenya, and Nicaragua.

At the **meso level**, an index insurance product has been developed for a pilot project in northern Peru. The product will be sold to rural microfinance institutions to help offset loan defaults and liquidity problems caused by El Niño–induced excess rainfall (Skees and Collier, 2010).[5] The index is based on Pacific Ocean surface temperatures measured by the National Oceanic and Atmospheric Administration. Increases in the sea surface temperatures are a good indication of an El Niño weather pattern that brings torrential rain and catastrophic flooding to parts of northern Peru. These extreme rainfall events destroy crops and infrastructure, which in turn affects the ability of some borrowers to repay their loans. With the ability to insure against financial losses resultant from this weather phenomenon, microfinance institutions (MFIs) will be encouraged to increase agricultural lending and rural financial services.

At the **macro level,** an example of a macro application of index insurance is the Caribbean Catastrophe Risk Insurance

5 Skees, J.R., and B. Collier. "New Approaches for Index Insurance: ENSO Insurance in Peru." *2020 Vision for Food, Agriculture, and the Environment, Focus 18 Innovations in Rural and Agriculture Finance.* Kloeppinger-Todd, R., and M. Sharma, eds. Washington, DC: International Food Policy Research Institute, July 2010.

TABLE 3.1: Weather Parameter and WII Applications

WEATHER PARAMETER	IMPORTANCE FOR INDEX	KEY FEATURES AND EXAMPLES
Rainfall deficit	High	• Rainfall is the main, but not only, contributor to low yields from drought • Drought is difficult to insure by traditional insurance (MPCI or named peril), especially for small farmer systems • Most frequently used parameter for weather index for agriculture • Not possible to index rainfall for irrigated crops • Other variables (especially soils and temperature) affect transpiration and water balance, but drought indexes have so far been limited to rainfall as a single peril • Key period of risk: crop establishment and crop flowering, but also vegetative stage
Rainfall excess	Medium	• Causes problems of inability to harvest or loss of mature crops • Complex effects influenced by soils and drainage • Impact may be flood • Not widely developed as weather index peril • Key period of risk: maturing and harvest
High temperature	Medium	• Most important impact is in combination with lack of rainfall and high evapotranspiration during drought • Drought indexes so far have been limited to rainfall deficit and do not incorporate temperature • Key period of risk: high temperature can impact any growth stage, but particularly crop establishment and flowering

Low temperature	Medium	• Complex effects according to season:
		  • winter freeze (medium-length event)
		  • autumn and spring frost (sudden event)
		  • insufficient growing degree days (long-length event)
		• Short-term frost events difficult to index (heavy dependence on exact growth stage)
		• Local basis risk from microclimate and topography
		• Yield loss from spring frost (lack of flowering) or quality loss in autumn (fruit)
		• Winter freeze damage can depend on snow cover
		• Growing degree days important in some crops, such as cotton, especially if growing season limited
		• Key period of risk: spring frost in flowering in fruit and nuts, autumn frost in fruit, cool temperatures in maturation, mid-winter freeze in cereals

High wind speed, wind direction	High (macro index) and low (micro index)	• Impact of high wind (especially cyclones) is very complex at local level (high basis risk) • Cyclones associated with variable amounts of rainfall, high rainfall can occur under low category cyclones • Impact is very widespread • Currently macro indexes have been developed for cyclone winds, feasibility for micro application are now being researched
Sunshine hours	Low	• Some vegetable crops require combination of sunshine and high temperature to mature • Low sunshine hours (overcast) can lead to lack of maturity • May be difficult to index

Source: Authors.

Facility (CCRIF). CCRIF is a risk-pooling facility owned, operated, and registered in the Caribbean for Caribbean governments. It is designed to mitigate the financial impact of catastrophic hurricanes and earthquakes to Caribbean governments by quickly providing short-term liquidity when a policy is triggered. It is the world's first regional fund utilizing parametric insurance, giving Caribbean governments the unique opportunity to purchase earthquake and hurricane catastrophe coverage with lowest-possible pricing. CCRIF represents a paradigm shift in the way governments treat risk, with Caribbean governments leading the way in pre-disaster planning.

3.4 IS WII ACTUALLY INSURANCE?

Although these index products are referred to as insurance, there remains a question as to whether they might more accurately be called financial derivative products (the value being derived from the index). The simple answer is that this decision is one that has to be based on the structure of the product and the regulations prevalent in the jurisdiction in which the product is being sold (this will be discussed more in the section on legal and regulatory issues). In box 3.2, we discuss the two types of product and the markets they are traded in.

BOX 3.1: Innovations: Cheaper Weather Stations, Use of Satellites and Flood Indexes

Innovations in low-cost automated weather stations are providing increased opportunities for deficit and excess rainfall coverage, as the costs of denser networks are reducing.

Other data sources, such as satellite imagery coupled with computer models, also have the potential to measure risks in new regions. For instance, the normalized difference vegetation index (NDVI), which uses satellites to measure a plant's ability to absorb sunlight, can be used to proxy major droughts in certain parts of the world. NDVI is already being used in indexation of pasture growth for insurance in Spain and North America, and is under development in Kenya.

Specialized satellite imagery and computer models can be used both to model flood risk and to show areas that have been inundated by water (and also to monitor inundation periods). The type of flood strongly impacts the feasibility of flood index insurance. Index may be more applicable to river inundation flooding affecting large geographic areas, more challenging coastal flood, and not possible for flash flood. Flood index insurance would be very challenging to implement but may be technically feasible at the macro/meso levels.[6] The postfactual inundation information can also be used for more precise loss estimation.

Source: Authors.

3.5 WHERE CAN WII BE MOST USEFUL?

Arguably (and from ARMT experience) WII is most useful when it is used to augment an existing value proposition. WII (and agricultural insurance in general) is a tool option to manage risk in extreme cases. WII cannot solve or seriously address other agricultural constraints (unless, perhaps, there is an underlying and indexable weather risk). If farmers have no access to finance or markets, WII is unlikely to be able to solve these constraints as a standalone intervention. WII (or other agricultural insurance products) should be grafted onto a system where other vital parts are already reasonably functioning. The role of the coverage is to improve efficiency or unlock further potential.

Ideally, WII should be integrated within coordinated supply chains, where there are established linkages between

6 World Bank 2010. "Assessment of Innovative Approaches for Flood Risk Management and Financing in Agriculture." Agriculture and Rural Development Discussion Paper 46. Washington, DC.

BOX 3.2: Derivative and Insurance Index Markets

In the context of the weather market, weather risk is defined as the financial exposure that an entity (an individual, government, or corporation) has to an observable weather event or to variability in a measurable weather index that causes losses to either property or profits. As this risk can be measured through either an observable weather event or a weather index, it is possible to transfer this risk from a client to an organization interested in taking on that risk in the form of a weather risk management product. More specifically, a weather risk management product can be an insurance product or a derivative-based product. While the two instruments feature different regulatory, accounting, tax, and legal issues, the risk transfer characteristics and benefits are similar.

Derivative contracts derive their value by looking at an underlying index. They are not necessarily associated with any physical loss and simply base their payouts on the performance of the index. Currently, the majority of weather trading is in the derivative market. The Weather Risk Management Association monitors transactions in the derivative market, which may be considered as the weather wholesale market. There are two different types of derivative products, exchange-traded contracts (ETCs) and over-the-counter contracts (OTCs). Only OTC contracts are applicable for developing country clients and clients in the agricultural sector.

Insurance is the transfer of risk by a client (the insured) to a third party (normally an insurer). In exchange for a "consideration" (premium paid by the insured to the insurer), the insurer agrees to pay valid claims that occur during the period of the policy, in accordance with the terms and conditions of the insurance policy. Indemnity payments are paid in accordance with the contract and settled as compensation for suffered, assessed losses.

In most cases, weather risk transactions involving developing country producers will be structured as insurance, while derivatives more often serve large-scale buyers of weather insurance, such as large corporations or major national macro-level transactions. They may also have a role behind the scenes in allowing reinsurers to offset weather risk that they accept by passing some risk on to derivative markets. It should also be noted that there is a major international market for the reinsurance of traditional agricultural insurances, for which weather risk is a main, but not exclusive, exposure.

Source: Authors.

input provision, commodity sales, extension services, technical advice, finance, and so on. Contract farming is a good example of such a situation. Introducing insurance products within such integrated systems can also facilitate simpler contract design, as other mechanisms will more efficiently address other, nonindexable risks within the supply chain.

Finally, a key linkage that should be emphasized is the potential one with agricultural finance. Without linking these insurance programs explicitly to finance (such as bundling the insurance with agricultural production loans or inputs), a WII initiative will often find that many farmers lack both the capital to pay the insurance premium and sufficient incentive to use scarce resources on risk management.

To illustrate the value of such linkages, box 3.3 provides an example of a project in Malawi that integrates WII with access to finance and supply chain development. In this case, WII played a vital role in unlocking credit for small holders, which enabled farmers to access new productivity enhancing technologies and high value markets.

This program started insuring 900 farmers in 2005, insured 1710 farmers in 2006, and was discontinued in 2007. The reason for canceling the program was widespread default by farmers to the bank due to side-selling of groundnuts outside the contract farming structure. This was a counterparty risk that was not properly assessed at program launching since the financing scheme relied solely on index insurance to protect against weather risk only. There were no other mechanisms to manage other risks.

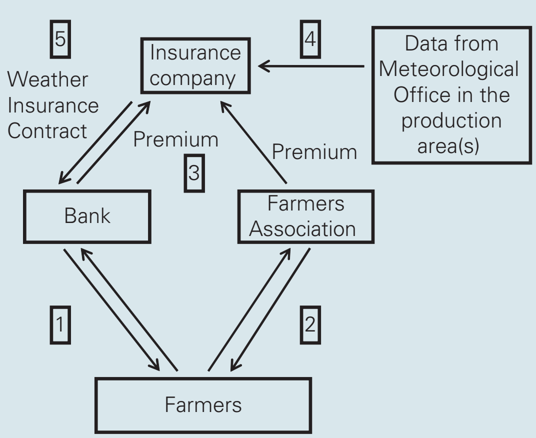
3.6 ADVANTAGES OF INDEX INSURANCE

Although the development and application of WII is still in its early stages, there are a number of theoretical advantages of the product. The degree to which these theoretical advantages may be realized through implementation and further development of the product remains to be seen.

- *Reduced risk of adverse selection*. Adverse selection can occur in agricultural insurance because farmers are more likely to buy insurance if they are a higher risk. Underlying this is an asymmetry of information, which places the insurer at risk (one that they need to manage through detailed, individual risk appraisal prior to premium pricing). An advantage of index insurance is that farmers subscribe based on the terms, conditions, and payout scale for all farmers in their defined area, virtually eliminating the adverse selection problem for insurers.
- *Reduced moral hazard*. In traditional insurance farmers may be able to influence the claim (by exacerbating physical losses) through their behavior, a phenomenon referred to as moral hazard. With index insurance, farmers have no ability or incentive to influence the claim, since payout is based on an independent and exogenous weather parameter, independent of farmers' behavior.

BOX 3.3: Linkages Between Access to Finance, Supply Chain Development, and Weather Risk Management in Malawi

The Malawi Groundnut Production Case



1. Bank lends to farmers growing groundnuts under contract farming.
2. Contract farming company distributes inputs, provides extension services, and purchases produce at guaranteed price.
3. Bank takes out insurance for its loan portfolio. Bank and contract farming company pay most of the premium.
4. Insurance payout is indexed to weather stations in groundnut production areas.
5. In case of drought, payout goes to bank, while farmers are given loan relief benefits.

Source: Authors.

- *Field loss assessment is eliminated.* Loss assessment is a challenge for any traditional crop insurance program, because of the need to mobilize large numbers of skilled or semiskilled assessors who possess some agronomic knowledge. The ability of index insurance to make payouts without field assessment clearly reduces administrative costs by eliminating the need for assessors.
- *Reduced information requirements and bureaucracy*. Traditional insurance products require considerable work to collect data to establish yields and to classify farmers according to their individual risk exposures. Because of the use of the index, it is not necessary to collect such detailed data, nor to differentiate between individual farmers. This can be particularly useful in countries in which there is limited access to detailed data.
- *Facilitation of reinsurance.* Experience suggests that international reinsurers are likely to reduce the portion of the premium charged for uncertainty ("loading") when the insurance is based on independently measured weather events.
- *Transparency*. The assessment process in traditional products often leads to disputes between farmers and assessors due to the partly subjective nature of the loss adjustment process. Weather index contracts are based on the measurement of weather at defined weather stations and are therefore extremely objective and theoretically less likely to lead to disputes (although basis risk becomes the real driver for dispute).
- *Facilitating access to financial services*. By removing the most catastrophic, spatially correlated risk from vulnerable communities, successful index insurance markets have the potential to facilitate other financial instruments that are important for poverty alleviation and economic development.

3.7 CHALLENGES OF INDEX INSURANCE

Despite the apparent advantages of the weather index product, practical implementation through pilots and feasibility studies has shown that there are a number of challenges or disadvantages inherent with index products.

- *Basis risk*. Basis risk is the most problematic feature of index insurance. It is the difference between the payout as measured by the index and the actual loss incurred by the farmer. Because no field loss assessment is made under index insurance, the payout is based entirely on the index measurement and may be either higher or lower than the actual loss. The level of basis risk is influenced by several issues. First, basis risk is lower when the insured risk is correlated—that is, affecting a large geographical area relatively to the same extent and simultaneously. Poorly correlated risks are hail and localized frost. Better correlated risks are drought, temperature, and winds. Second, basis risk is higher where there are local microclimates, different management practices, and different crop varieties—that is, the weather risk may be correlated, but its impact is highly variable.
- *Data availability*. Despite simpler data requirements, accurate and complete data sets are still required for index insurance. This applies to the historical record of the chosen weather parameter(s) for underwriting and pricing purposes and for the recording of the parameter(s) for payout calculations during the period of insurance, as well as historical yield data to assess risk, design, and price the product, if the weather index is to serve as an accurate proxy for loss. For weather index insurance, a long and high-quality time series of meteorological data are required (circa 30 years of daily data).
- *Integrity of weather stations*. Weather stations used for index insurance must be sufficiently secure to prevent tampering. Additionally, they should have automatic, as opposed to manual, recording of data. Preferably, data will also be collected from the weather stations using automatic reporting systems such as Global System for Mobile Communications (GSM) devices. Not only do these provisions increase the quality of the data, but they also reduce the potential for human error or data manipulation. The degree of integrity has a direct impact on the cost of the uncertainty loading that goes into the insurance premium.
- *Need for farmer/insurer/regulator capacity building and education.* Index insurance is a new concept for farmers, and therefore any rollout of the product requires intense education programs to help them to understand the principle of the payout system and also the fact that it covers only one risk variable. To date, experience with this education requirement has provided mixed results.[7] For insurers, this is a new type of insurance product, so they require substantial technical assistance in designing contracts and indexes and extensive capacity building to enable them to undertake product development on a sustainable basis.

7 Gine, X. 2010. "The Promise of Index Insurance." The World Bank. Washington, DC.

BOX 3.4: Collaboration between IFC and IBRD under the Global Index Insurance Facility (GIIF)

The objective of the GIIF is to promote the development of effective and sustainable markets for indexed weather and catastrophic risk insurance in developing countries.

The GIIF program was launched by the WBG in December 2009 and is jointly implemented by IFC and International Bank for Reconstruction and Development (IBRD). In this collaboration, IFC works with the private sector to develop local capacity, while IBRD assists with public sector regulatory and policy reform work.

The European Commission and the Africa, Caribbean, Pacific (ACP) Secretariat are the primary donors to the GIIF Trust Fund (GTF) and have committed €24.5 million to facilitate reaching the objectives of the facility. The GTF is also supported by Japan's Ministry of Finance with an initial grant of $2 million, and the Dutch Ministry of Foreign Affairs, which provided $500,000 to establish the facility. The GTF is a broad-based facility and is open to a plurality of donors. The activities supported under the GTF are (1) local capacity building, (2) financial assistance to partner financial institutions, (3) performance-based premium support, and (4) regulatory policy and capacity building.

Since its formal launch, a total of seven grants have been conferred under the GIIF initiative. It is expected that these grants in Kenya, Rwanda, Mozambique, and the francophone West Africa will help expand access to index insurance in Africa. While GIIF sustains its growth in Africa, it has commenced expanding to other regions including Latin America and the Caribbean, South Asia, East Asia, and the Pacific. For the expansion projects in target regions, the GIIF program management unit is liaising with IFC regional offices to inform them about the program, and also with IBRD to develop a framework to address regulatory and policy issues.

GIIF has also entered into a technical partnership with Swiss Reinsurance Corporate Solutions, which will provide technical services to GIIF projects and will support GIIF's strategic objectives through its long-standing experience in developing innovative risk transfer solutions for emerging markets. As a technical partner, Swiss Re will support the implementation of approved projects and the rollout of the regional expansion strategy by:

- Providing secondary markets development support
- Undertaking capacity development of local partners (local insurance partners and other aggregators)
- Ensuring that projects meet minimum reinsurance requirements to find support in the reinsurance arena
- Enabling GIIF to be effective in standardizing, reviewing, and implementing projects and to initiate new projects in new areas including those where there is documented demand but no interested insurance parties

Major GIIF projects currently under implementation include:

- **Syngenta Foundation/UAP Insurance** aims to develop the technology for SMS-based mobile applications and assist in scaling up of drought or excessive rainfall insurance product in Kenya.
- **PlaNet Guarantee** aims to develop and implement an index-based insurance product in Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal, and Togo.
- **MicroEnsure** aims to develop local capacity and a favorable environment to reach low-income people with flexible, affordable and responsive weather index insurance in Rwanda.
- **Index-based livestock insurance (ILRI)** has designed and developed an index-based insurance products to protect Kenyan pastoralists from drought-related asset losses.
- **Guy Carpenter** aims to help develop index-based micro insurance for flood and drought risk in Mozambique.
- **SANASA Insurance** aims to help develop a simple, flexible, affordable weather index–based crop insurance product for different food crops in Sri Lanka.

In collaboration with IBRD, GIIF supports the regulatory and policy reforms for index-based agricultural insurance. Projects are ongoing in Nigeria and in the Inter-African Conference on Insurance Markets (CIMA) region of West Africa. Additionally, efforts in capacity building to develop an appropriate policy and regulatory framework for index-based agricultural insurance in 14 countries across Africa, the Caribbean, the Pacific, and Latin America are progressing through the involvement of IBRD.

Source: IFC.

Experience in this area has shown that transferring sufficient capacity is extremely challenging. Likewise, index insurance will be a novel concept for many insurance and other regulatory authorities that have jurisdiction over index insurance. Involving these regulatory authorities from the outset helps ensure their support, legal guidance, and favorable legal classification, all of which are critical to the product success.

- *Currently limited product options for different weather risks.* The majority of WII products have been designed for rainfall risk, which is not necessarily the most serious or prominent weather risk in many areas. Experience insuring other weather risks with new indexes is needed. In many regions farm losses often result from a complex interaction of perils—for example, increased temperature that leads to pest problems. A "simple" WII product is not suitable for this and thus would need to consist of more than one index rolled into a single product or would require the farmer to take out a different type of insurance product for the other risks.
- *Research, local adaptation and scalability.* The process of designing an index involves the analysis of weather data and interpretation of it in relation to the specifics of the crop to be insured. Correlations need to be carried out between the weather data and historical yield data in order to find good index parameters. Once the product is designed, trigger levels have to be adapted to each weather station. Where new automatic weather stations are needed, they need to be calibrated based on interpolation between stations. Further, ongoing annual reviews of the trigger levels are advisable, especially in the first years of a program. All of this technical work limits the speed at which the scaling up of a pilot program to a regional or national program can be carried out. It should be remembered that any given index needs to be reviewed and recalibrated every time it is moved to a new weather station, and a totally new index designed every time a new crop or even a new variety is introduced.
- *WII does not have universal application.* WII can be an effective instrument, but not for all crop types, cropping systems, or hazards. Where crop type or climate show complex and multiple factors affecting crop damage or loss, as may occur in humid climates or where pest and disease are dominant causes of loss, indexation with WII may be problematic. In such circumstances, an area yield index product may be more applicable.

In order to address these challenges and to promote effective and sustainable markets for WII and catastrophic insurance in developing countries, the World Bank Group (WBG) launched in 2009 the Global Index Insurance Facility (GIIF), administered by the International Financial Corporation (IFC). The GIIF is meant to be a comprehensive insurance-based program to address the scarcity of affordable insurance protection against weather and natural disasters in developing countries (see box 3.4).