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Developing Index-Based Insurance for Agriculture in Developing Countries

Index-based insurance products for agriculture represent an attractive alternative for managing weather risk. Pilot programs conducted in several developing countries have proven the feasibility and affordability of such products. This paper presents the main lessons from these pilot programs, and examines the prospects for extension and scaling up of index-based weather insurance products in developing economies to promote sustainable development.

The spectrum of risks that affect the income of agricultural producers and agribusinesses is quite broad. The two predominant risks are: price risk, reflecting variations in market prices for agricultural commodities and production inputs; and production risk, which encompasses variations in the volume or quality of the commodity produced. This note focuses on one of the most pervasive production risks, weather, which impacts all aspects of the agricultural supply chain, particularly in economies based on rain-fed agriculture. Even with the introduction of new crop varieties, production technology such as irrigation, and new management practices that offer the potential to increase yields and improve resistance to weather perils, the majority of agriculture in developing countries remains highly susceptible to extreme, uncontrollable weather events that can severely impact both quality and yield of a crop. Such events include excessive or insufficient rainfall and extreme temperatures.

The effects of weather risk are felt most acutely at the household level, particularly by

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Box 1: Market development

As early as 1999, weather index-based insurance was being discussed in academic papers as an alternative solution for developing agricultural economies. In 2002, donors began to finance the piloting of these ideas. In particular, the World Bank's Commodity Risk Management Group (CRMG) was allocated trust funds from the Swiss and the Dutch governments to pilot weather insurance for farmers to complement its price risk management work in commodity markets.

CRMG has been involved in many weather risk management technical assistance projects to commercial entities in the developing world. CRMG was involved in its first index-based weather risk management transaction in India in June 2003, the first-ever weather insurance project in the country. Since 2003 there have been several other pilots around the world, including completed pilots in Ukraine, Ethiopia, and Malawi, and upcoming pilots in Kenya, Tanzania, Thailand and Central America. Successes like the market growth in India have had significant demonstration effects and have proven that weather risk management for farmers in the developing world is possible through insurance-type instruments.

From these experiences, the group has begun to synthesize some best practices on how to create successful weather insurance schemes for farmers and how to make such initiatives sustainable and scalable, particularly in Africa.

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poor, vulnerable agricultural households, the majority of which are subsistence farmers. Traditionally, farmers have managed this risk by using less risky technologies of lower but reliably yielding drought-resistant crops; by seeking diversification both in terms of production activities on farm and income generating activities; and by devising informal and formal risk sharing arrangements. While these mechanisms may work well for low-magnitude losses, even if they are frequent, they often prove to be inadequate for risk that is infrequent but severe. Weather risks such as drought in particular typically affect entire regions at once, rendering informal risk sharing arrangements insufficient. Affected farmers are often forced to employ short term coping strategies such as borrowing from money lenders or neighbors, selling assets, or cutting already small expenditures on household goods and services.

In many cases, farmers could benefit from investing in agricultural activities that require higher initial investments but ultimately would generate higher income, if the risks affecting these investments such as weather could be managed. Since banks or other intermediaries that work with agricultural producers carry the same risks as their agricultural clients, they, too, are hesitant to invest in agriculture due to potential defaults during or after a weather event. Risk management instruments that would allow the transfer of risk to insurance markets would thus allow growers and agribusinesses to protect themselves against risk, to have a greater ability to plan for the season, and to access credit. Managing weather risk efficiently, coupled with other investment activities in the agricultural sector, could strengthen the resilience of farmers and agribusinesses to weather shocks.

Existing weather risk management instruments

Few insurance mechanisms deal efficiently with weather risk. Traditional, multi-peril crop insurance, common in developed countries, often excludes systemic weather factors such as drought. When weather is included, these traditional programs determine payouts through loss assessments performed through costly and time-consuming individual farm visits that evaluate the damage of a weather event on a farmer's field. In developing countries, the costs associated to these types of assessments can be even higher, due to small farm sizes and the condition of the transport infrastructure. Given these features, traditional crop insurance is more appropriate for large commercial farmers.

As with all insurance products that work on a loss adjustment basis, this type of weather risk management program can suffer from moral hazard and other negative elements associated with asymmetry of information. Because farmers will always know more than the insurer about their actual yields and farm practices, they could influence farm data and output, or only avail of the products when a claim is more likely. Such behavior naturally leads to higher premium rates for coverage and requires highly trained loss adjusters to ensure programs are controlled and sustainable. Given these costs, traditional

Box 2

The case of India

In 2003, Hyderabad-based micro-finance institution BASIX and Mumbai-based insurance company ICICI Lombard, with technical assistance from CRMG, launched the first pilot program for index-based weather insurance in the developing world in the Mahahbubnagar district of Andhra Pradesh. This pilot program sold weather insurance policies protecting against low rainfall to 200 groundnut and castor farmers. In 2004 BASIX incorporated farmer feedback into the design of the second generation of improved weather insurance products that were sold to over 700 farmers, several of whom were repeat customers from the 2003 pilot. In 2005 BASIX scaled up the program further, selling over 7,600 policies in 36 locations in six Indian states. These new policies were refined versions of the 2004 products and offered improved risk management features for farmers, but had a generic, standardized structure which made it easier for BASIX to retail to many clients in many locations. Intense training sessions with loan officers, who became literally one-stop-shop customer service agents, allowed BASIX to offer a large array of rainfall insurance products to its farmer clients. In 2006, BASIX sold rainfall and multi-peril weather contracts including temperature and relative humidity to over 11,000 customers.

Since 2003, the Indian weather insurance market has grown rapidly. Four insurance companies have sold weather insurance policies to farmers. Indian weather risk has been reinsured into the international risk markets. For the 2005 monsoon season, a leading Indian seed company bought a bulk weather insurance policy so that it could attach free weather insurance coupons for a minimal level of drought coverage to its cottonseed packets which were sold to 100,000 farmers in Maharashtra.

crop insurance is typically heavily subsidized. For example, in 2004 the average subsidy for all multi-peril yield and revenue insurance products offered by the US Federal Crop Insurance Program was 59% of total premiums.

Weather indexed risk management products represent a newly developed alternative to the traditional crop insurance programs for smallholder farmers in the emerging markets (Box 1). These products are based on local weather indices, ideally highly correlated to local yields. Indemnifications are triggered by pre-specified patterns of the index, not by actual yields. This reliance on factors beyond the control of farmers reduces the occurrence of moral hazard and adverse selection. It also eliminates the need for field visits, which speeds up claim settlement and significantly reduces costs. Because the insurance is based on a reliable and independently verifiable index, it can be reinsured, allowing insurance companies to transfer part of their risk efficiently to international markets.

Although a comparison between the costs of implementing an index-based weather insurance program versus a traditional loss-adjusted weather-only insurance program is not feasible given the limited number of experiences of both, it should be noted that none of the index-based weather insurance contracts currently sold to farmers is subsidized. The premium charged to the farmer to protect against deficit rainfall risk is typically 8-10% of the sum insured, including administrative costs. These levels, particularly when the contracts are bundled with credit or inputs, have proved to be affordable for farmers.

Assessing the risk

Identifying weather risk for an agricultural grower or producer involves defining the time period during which risk is prevalent, and identifying a measurable weather index that is strongly correlated to farmers' losses on a particular crop. This is the most critical process in designing a weather risk management strategy.

A weather index can be constructed using any combination of measurable weather variables, over any period of time and any number of weather stations that best represent the risk to the agricultural end user. Common variables include temperature and rainfall. After gathering the weather data, designing an index will imply looking at how the weather variables have or have not influenced yield over time; discussing key weather factors with experts such as

Box 3

An index-based contract in practice

A procedure for designing standardized deficit-rainfall insurance contracts for smallholder grain crop farmers is being developed by CRMG in conjunction with IRI Earth Institute at Columbia University. The simple contracts have the following features:

1. **A dynamic start date that mimics the decision a farmer would take as to when to sow his crop;**
2. **Three or more phases depending on the length of the crop growing period, during which cumulative rainfall is measured, with a trigger and exit levels in each phase. The trigger level determines the level at which compensation would begin for the farmer, i.e. if the cumulative rainfall measured during the phase dropped below this trigger the farmer would begin to receive a fixed payout per mm, for every mm that the cumulative rainfall recorded was below the trigger level. These trigger levels correspond to rainfall levels at which the crop would begin to feel water-deficit stress. The exit level determines the level at which the farmer would receive a maximum payout, i.e. if the cumulative rainfall measured during the phase dropped below this exit level the farmer would receive the entire limit (sum insured) for that phase as it is assumed his crop would have failed or would have been permanently damaged. Hence the cumulative rainfall totals per phase are the underlying indices for these contracts.**
3. **A payout rate per phase, i.e. the payout rate per mm if the recorded cumulative rainfall in each phase falls in between the trigger and exit levels.**

The three-phase weather insurance contract design was pioneered by Indian insurance company ICICI Lombard and sold to farmers for the first time in 2004. The design proved to be popular with groundnut and castor farmers in Andhra Pradesh and farmers of other crops, and hence was chosen as the prototype structure for the first Malawi pilot and subsequent African pilots. Currently this methodology to design deficit-rainfall contracts is being used by CRMG for a second year in Malawi, Tanzania and Kenya.

agro-meteorologists and farmers; and referring to crop growth models which use weather variables as inputs for yield estimates.

A good index must account for the susceptibility of crops to weather factors during different stages of development, the biological and physiological characteristics of the crop and the properties of the soil. If a sufficient degree of correlation is established between the weather index and yield or crop quality, an agricultural producer can insure his production or quality risk by purchasing a contract that pays in the case specified weather events occur. The index possibilities are extensive and sufficiently flexible to match the exposure of the agricultural grower or producer, as long as the underlying data are of sufficient quality and the final index can be easily understood and communicated to farmers.

Structuring a risk management solution

Once the index has been identified, it can be used to quantify the financial impact of the specified weather exposure. In order to do this, the variation in crop yield predicted by the index must be converted into a financial equivalent that mirrors the producer's exposure. This can be done, for example, by considering a producer's production and input costs per hectare planted or by considering his expected revenue from the sale of the crop at harvest. By running a regression analysis against historical or simulated production data or simply by looking at historical financial worst and best years, available information can be used to establish the relationship between different values of a weather index and the financial loss or gain a farmer can expect.

Finally, once the index has been identified and the risk quantified, the next step is to structure a contract that pays when the specified adverse weather occurs in order to perform a hedging or risk-smoothing function for an agricultural grower or producer. A risk-transfer product for farmers in developing countries usually takes the form of an insurance product, that is, a risk transfer that results in downside protection in exchange for a premium (Box 3).

Good weather insurance contracts are those that balance simplicity with the complex dynamics that characterize weather stress impact on crop yields: they must both reflect local conditions and be easy to communicate to farmers and stakeholders, so that everyone understands exactly what arrangement they are entering into. A good contract performs well from an agro-meteorological perspective, but also provides the demanded protection for clients at a price they can afford (Box 4).

Box 4

Insurance pricing overview

When establishing a price for a weather risk management instrument, providers will take into consideration their own risk appetite, business imperatives, and operational costs. While there are a variety of methodologies for pricing, in general the pricing for all contracts will contain an element of expected loss, plus some loading or risk margin that corresponds to a capital reserve charge required to underwrite the risk at a target level for the business, as well as administrative costs. Therefore in general the premium charge for a contract can be broken down as follows:

Premium = Expected Loss + Risk Margin + Administrative Costs

Expected loss is the average payout of the contract in any given season. The risk margin is charged by the providers because in some years, when extreme events happen, payouts in excess of this average can occur and the risk-taker must be compensated for this uncertainty. The values of the expected loss and the risk margin must be established from historical weather data. These values may include an adjustment to compensate for uncertainties in the data such as trends or missing values. The approach for determining the loading over the expected loss differs from insurer to insurer and many use a combination of methods to determine the risk margin included. A sensible pricing methodology uses a risk measure such as the Value-at-Risk (VaR) of the contract to determine the risk margin. A VaR calculation is aimed at determining the loss that will not be exceeded at some specified level of confidence, often set at 99%. Administrative costs are essentially the costs for the provider to run the business including charges for data, office costs, taxes and reinsurance and brokerage charges if necessary.

Implementing the program

Contract design is just one component of the program development process required for a successful weather insurance initiative (Box 5). In order to develop a sustainable program, the following prerequisites have been identified: the buy-in of a willing insurance company or companies that will serve as the primary risk taker or intermediary, with potentially a reinsurer if required; entities that can play the role of product distributors to farmers such as microfinance institutions or farmer organizations and cooperatives; entities that are trusted and known and which have existing relationships and robust lines of communications with their farmer clients to provide marketing and education; and a National Meteorological Service that can provide historical weather data.

Pre-requisites for scalability and sustainability

While use of index-based products for managing risk in the agricultural sector is still in its nascent stages, the growing body of experience in many developing countries suggests that sustainability and scalability of farmer-level weather risk management programmes are potentially feasible, given innovations in technology and thinking and a favourable business environment. In particular, there should be no disincentives for commercial providers, such as competing subsidized crop insurance programs. A number of lessons have been learnt that can inform strategies and directions for scale-up of existing programs to create new, sustainable, and active weather risk markets.

Weather data and infrastructure. Effective index-based weather insurance contracts require the presence of a dense, secure, and high quality weather station network. Nearly all weather contracts are written on data collected from official National Meteorological Service weather stations. Ideally, these are automated stations that report daily to the World Meteorological Organization (WMO) Global Telecommunication System (GTS) and undergo standard WMO-established quality control procedures. The data

Box 5

The seven steps to developing a weather insurance pilot

CRMG has drawn some lessons from its work and begun to develop a standardized approach to pilot implementation as well as contract design. While this approach is still evolving, there are seven basic components of pilot program implementation that need to be undertaken in order to develop a product that is not only technically sound but is demanded and can be afforded by clients:

1. ***Identify potential pilot areas and carry out a basic risk assessment.*** **First, identify the targeted area and clientele for the pilot program including the crop(s), weather station(s), and potential clients. Second, carry out a quick initial assessment of the available data and risks to the clients and crops. This will dictate both the technical design of the contract and the operational arrangements for implementation.**
2. ***Identify delivery channels for reaching the end users.*** **Identify an institution or institutions, such as a bank, MFI, farmer organization etc, that can efficiently and cost effectively deliver this product to farmers. This institution must have both sufficient outreach to provide marketing and education to clients and the organizational capacity to handle a new financial product.**
3. ***Design contracts.*** **Design prototype contracts for the given weather station(s) and clients. This design process should ultimately aim to design a contract that acts as the most accurate proxy for the clients' risks while taking into consideration the premium that a client is willing to pay.**
4. ***Determine the marketability of the products.*** **Discuss the prototype contracts with potential clients and stakeholders to determine their interest in insurance, willingness to pay for the contracts, and how closely the initial contracts match their risk. Since the initial contracts are only prototypes, this is a critical step to determine if the product design is appropriate and if there is demand for the product.**
5. ***Finalize contracts and insurance.*** **Revise and finalize the contract structures based on the field research and discussion with clients. After the contracts are finalized, insurance arrangements with the participating risk takers (insurers and reinsurers) and contracts will be drawn up.**
6. ***Market the product:*** **Market the product through the different delivery channels for the pilot. In order for farmers to purchase the contract, they must not only be aware of the product but also understand the product. In most cases marketing will require a substantial educational component.**
7. ***Monitoring the pilot:*** **Monitor the program in order to detect any unanticipated outcomes, determine if all participating stakeholders are meeting their commitments, and determine the performance of the contract.**

must adhere to strict quality requirements, including reliable and trustworthy ongoing daily collection and reporting procedures, daily quality control and cleaning, and an independent source of data for verification, e.g., GTS weather stations or potential for third party data verification. Also required is a long, clean, and internally consistent historical record to allow for a proper actuarial analysis of the weather risks involved— ideally, at least 30 years of daily data. The strict nature of these criteria is in part to control for potential moral hazard within an index-based insurance scheme through data tampering.

Lacking weather data satisfying these criteria, an index-based insurance program may not be feasible. First, the existing information may not be sufficient or fully represent an end user's weather risk profile. Second, without such data, it would be challenging for the commercial risk-taker to charge appropriate premiums. Lastly, lack of a weather station network that is of good enough quality for risk transfer to the local insurance and international reinsurance market is one of the key issues dictating the scalability and sustainability of weather insurance for smallholder farmers. In Africa, this presents the greatest challenge to scaling up existing initiatives and to starting new projects.

Building an index that adequately reflects farmers' risk. In order to scale up the use of index-based products, it must be technically feasible both to create indices that can act as accurate proxies for risk in developing countries, and also to transfer the index and contract design skills to local actors in institutions and government.

From a technical standpoint, in certain contexts it may be impossible to find an index that represents a particular risk to potential clients. In most contexts though, the biggest limitation of index-based weather risk management products is basis risk, defined as the potential mismatch between contract payouts and the actual loss experienced by individual farmers. Basis risk occurs when the weather index does not adequately indemnify the grower for his losses. As index-based risk transfer products cannot capture losses as faithfully as individual field inspections, basis risk will always be an issue with this class of products. However, basis risk can often be minimized by effective and simple contract and pilot design. Farmer expectations can be managed by transparent and thorough product education and training.

An additional concern is finding expertise that can provide the technical skills necessary to design these contracts. Currently most countries do not have the expertise to design index-based products locally. Therefore, an increased focus on technical training for participants in the insurance and finance sectors is necessary so that programs designed by local players can grow and evolve to suit the needs of the local market.

Developing local ownership and linkages. Often while it is technically feasible to develop index-based weather risk management products, the operational challenges of reaching end users can be insurmountable for the actual implementation of a program. One of the major operational challenges identified affecting the sustainability of pilot programs and expansion of these operations is the ability of local institutions to take ownership of the product development process. One of the major successes of the Indian pilot program was its ownership by local institutions and the technical expertise that was built within the participating institutions.

The success of a weather insurance pilot also critically depends on the relationship the farmer has with the institution offering the insurance. The stronger and more trusted this relationship, the easier it will be to educate farmers about new risk management products and their limitations, and to deliver these services efficiently. The strength of the local partner in implementation is therefore critical. Attempts to integrate risk management practices into organizations that have problems such as poor communications infrastructure, institutional instability, underdeveloped marketing and financial skills, and weak managerial and decision-making authority, are likely to be ineffective and inefficient.

Lastly, establishing links between providers of risk management instruments and providers of finance is critical in order for insurance products to be marketable at the local level. Without linking these

Box 6

Operational issues in Malawi

In 2005, 892 groundnut farmers in Malawi bought weather insurance to increase their ability to manage drought risk and in turn access credit for better inputs. The National Smallholder Farmer Association of Malawi (NASFAM), in conjunction with the Insurance Association of Malawi and the CRMG of the World Bank, designed an index-based weather insurance contract that would pay out if the rainfall needed for groundnut production in four pilot areas was insufficient. Because these contracts could mitigate the weather risk associated with lending to farmers, Opportunity International Bank of Malawi and Malawi Rural Finance Corporation agreed to lend farmers the funds necessary to purchase higher-yielding seed if the farmers bought weather insurance as part of the loan package. These loans stipulate that the bank will be the first beneficiary if there is a payout from the insurance. NASFAM served to identify the participant farmers, provide training to farmers on the products (in conjunction with the banks), and provide marketing services at the end of the season.

The pilot program, while successful enough to be repeated in 2006, highlighted a variety of challenges related to both contract design and program implementation, including:

1. ***Education of clients and stakeholders.*** **Farmer education surrounding issues such as basis risk needed to be increased. When farmers do not understand the underlying foundation of the contract — indexing, this can lead to dissatisfaction with the program, and in some cases to loan defaults.**
2. ***Other Risks.*** **There was a need to raise awareness of the limited role that weather insurance has in managing the larger spectrum of risks farmers face and to control those risks as much as possible within the program.**
3. ***Organizational Capacity.*** **The groundnut pilot also stressed the importance of the organizational capacity of the participating stakeholders. The program ultimately relies on the participating organizations and it is critical that they are comfortable and have the specific competence to carry out the roles required.**

programs explicitly to finance, such as bundling the insurance with agricultural production loans (Box 6) or inputs, farmers will lack both the capital to pay the insurance premium and sufficient incentive to use scarce resources on risk management. Additionally these linkages provide incentives for other stakeholders involved within the system, aligning incentives throughout the implementation chain (Box 7).

Adjusting the legal and regulatory framework. Index-based insurance programs must be designed to fit within the local regulatory framework in each jurisdiction and take into consideration the associated legal and financial implications. Depending on the jurisdiction, weather risk management products can be classified as financial (derivative), insurance, or gaming contracts. While some countries like the US and the UK have clearly defined regulations associated with these different types of products, in many countries there is no clear guidance within existing laws or the insurance regulatory framework. The main danger of moving forward beyond a pilot phase without strong regulatory oversight is facing an environment where the proper processes for contract design and program implementation are ignored. Therefore, engaging local regulators and assisting them in the design of general insurance contractual conditions for these new index-based products is a key component of building a successful program. Support and commitment from the regulator will also encourage high levels of ownership in-country and foster the development of a risk management environment that can sustain market growth. As weather markets grow, it may also be important to develop institutionalized consumer information systems to monitor the information that is being disseminated about these products to potential clients.

Conclusion: existing challenges and opportunities

Index-based weather insurance instruments can provide a viable alternative to traditional insurance instruments for agriculture. They potentially offer advantages to households, businesses, and governments in developing countries. Their main benefits include creating income smoothing opportunities for farmers, and enabling access to credit and therefore investment in higher-yielding crops, advanced technologies and potentially access to more lucrative markets. Pilots conducted in many developing

countries have highlighted the affordability of such products to poor farmers, without need for subsidies. This constitutes a major asset for the sustainability of this class of products. Index-based weather insurance programs will be most effective and ultimately more sustainable when implemented in the context of other efforts by farmers to deal with shocks and increase farm income.

The main limitations of index-based weather insurance contracts are that they only cover a portion of the exogenous risks facing farmers. Price fluctuations and other risks such as unmanageable pests or availability of inputs cannot be managed with such products. Basis risk is another key limitation, which must always be considered when deciding to implement a program with scale-up ambitions. The need for good quality weather data, although it constitutes a potential impediment to the development of index-based products on a large scale, can also be seen as an opportunity, since the use of good weather information has benefits that extend well beyond individual farmers and insurers, for example to businesses and agricultural lenders.

Reaching many farmers with products to manage weather risk requires infrastructure in the form of more and better weather stations and higher-quality weather data; investment to ensure that capacity building and training can be delivered to local stakeholders; and ensuring that a sound regulatory environment exists to foster market development. Without the development of thorough training material that can be deployed and taken up locally and the availability of funding to strengthen National Meteorological Services and their weather observing network, future growth of the market for index-based products will be limited. Creation of a sustainable weather risk management market supported by the international reinsurance community could not only assist farmers in covering weather-related production risk, but also enable more farmers to access finance and engage in higher income generating activities, thus contributing to sustainable development.

Box 7

Aligning incentives among stakeholders: the case of Malawi

The Malawi groundnut pilot program was conceived to be a win-win for all stakeholders. Weather insurance gave farmers the ability to mitigate drought risk and therefore secure access to finance and inputs for improved production as an alternative to lower-income subsistence farming. It also protected loan providers from weather-related production risks and allowed the banks to expand their lending portfolios into the rural areas in a managed way. With no regulatory impediment and with reinsurance potential, insurers, which in the past had had limited and unsuccessful experience with traditional agriculture insurance, saw this pilot as an exciting opportunity to re-engage with farmers. Finally, the program gave an opportunity for NASFAM to expand its operations and grow the groundnut market domestically and for export.

Key reading

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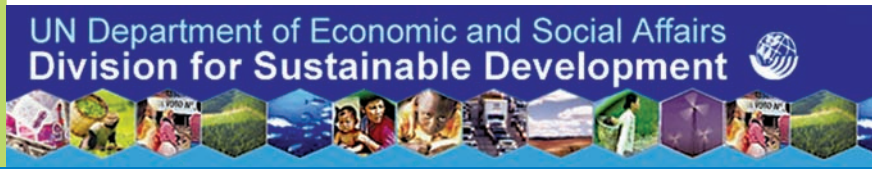

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