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Index insurance and climate risk:
Prospects for development and disaster management

Index insurance and climate risk: Prospects for development and disaster management

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Foreword

At the first annual meeting of the Global Humanitarian Forum on 'The Human Face of Climate Change', in June 2008, Swiss Re and the International Research Institute for Climate and Society hosted a policy roundtable on the use of index insurance for poverty reduction. The discussion brought together experts from fields as diverse as reinsurance, climate science, economics and food security to take stock of their experience and insights on how this innovative tool can best serve development. They highlighted how index insurance is being tested in the context of development, disaster management and climate change adaptation. Pilot experience had shown that index insurance has the potential to reduce conditions of chronic underdevelopment by both enabling investment and reducing shocks in agricultural livelihoods. At the roundtable, important issues were identified, such as the role of different stakeholders, the challenges for scaling up to meet broader development objectives and the value of index insurance as a development tool.

Outcomes of the inaugural Forum made it clear that we have the technology, the expertise and the financial resources to take on the challenge presented by climate change – but that action to tackle these problems is largely missing. We need to step out of our narrow confines and areas of expertise and share our knowledge – to pool our resources and act together in order to have real impact. This publication, born out of discussions at the Forum and subsequent meetings, represents the commitment of one group of experts to pool and share their experience and knowledge of index insurance. I applaud the efforts of this community to take the time and energy to capture current knowledge and experience and make it available to the broader global development community.

For several years our eyes have been set on Copenhagen. As a global community we have been trying to focus attention on climate change impacts and to bring innovation to the service of equity and sustainability. This year the United Nations International Strategy for Disaster Reduction (UNISDR) launched the global assessment report on disaster risk reduction – which continues to remind us how ill-prepared we continue to be in the face of climate-related hazards. As an innovation, index insurance may hold answers for some of the more obstinate problems faced by the poor and the vulnerable. I hope this publication will help us to appreciate how much has been learned over the last few years, and show us where we can usefully concentrate our collective efforts.

Kofi A. Annan
President
Global Humanitarian Forum

Partner statement

Before the current economic crisis, the preceding years of global economic growth were optimistically reflected in the progress indicators of the Millennium Development Goals. In sub-Saharan Africa, for example, the economies of countries grew at more than 6% in 2007. As the world's economy has slowed, these advances are now being threatened. These trends imply risks of deepened hunger and reduced affordable access to adequate nutrition.

At the same time, the Intergovernmental Panel on Climate Change's fourth assessment report has warned us that climate change is likely to reduce food production potential, especially in some already food-short areas. It further states that there is now higher confidence in the projected increases in droughts, heat waves and floods, as well as their adverse impacts – which will be hardest felt by the most vulnerable, who are often in the weakest economic position.

Climate has always presented a challenge to those whose livelihoods depend on the weather. Even though a drought (or a flood, or a hurricane) may happen infrequently, the threat of the disaster is enough to block economic vitality, growth and wealth generation during all years – good or bad. The risk of drought and flooding can keep people in poverty traps, as risk-adverse behavior limits productivity and the willingness of creditors to lend to farmers, for example. Lack of access to financial services, especially in rural areas, in turn restricts access to agricultural inputs and technologies, such as improved seeds and fertilizers. At the national level, when disaster strikes, many developing countries rely on humanitarian aid, whose delay can lead to higher human and economic costs.

There is a global recognition of the pressing need for fresh approaches to confront these challenges at scale. This type of thinking is epitomized by the Hyogo Framework, which advocates for a new approach to disaster management focusing on disaster risk reduction, as well as the Bali Action Plan which advocates for a more comprehensive consideration of risk sharing and transfer mechanisms, such as insurance. In this publication, we discuss one innovative response to enable poverty reduction through better climate risk management: index insurance.

The partners and contributors to this publication are working together in their networks throughout the world on developing and testing index insurance as an approach which, when combined with other financial, governance, structural and policy options, can enable us to better meet our collective goals of poverty reduction and economic growth. This entails working with national governments, such as the Ethiopian government and those of the Caribbean region, to enable more timely and reliable disaster response. It means working together with farmers and the private sector in places such as India, Mongolia, China, Ethiopia, Nicaragua and Thailand to remove the barrier of climate risk and enable access to credit. It involves using innovative climate science, such as remote sensing, to expand coverage of index insurance to areas where data are sparse or limited.

As we move forward towards meeting international goals such as poverty reduction or climate change adaptation, we are applying new thinking to confront old and new problems. As the publication details, we are doing this by bringing state-of-the-art knowledge and practice into new settings: by applying innovative science and technology, by enhancing the role of private sector players, by connecting to international risk pooling, and by working with countries in developing the capacity of their people and institutions. Increasingly, we have recognized that strengthening capacity – from the community level to the global scale – is at the centre of the development challenge. This publication highlights the relevance of our work and the critical importance of tackling this agenda together.

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During 2008–09 a series of meetings were held that explored different aspects of scaling up index insurance. Many of the players who worked on pilot projects and are now involved in efforts to scale up attended and contributed their experiences, insights and technologies. This publication is largely a distillation of the outputs of this process. It is not a detailed collection of the workshop materials; these are available elsewhere (Barrett *et al.*, 2007; Bhojwani *et al.*, 2008; technical papers at http://iri.columbia.edu/csp/issue2/workshop). Rather, it synthesizes the main points, and builds on them to reflect the ongoing debate on if and how index insurance could have a role to play in poverty reduction, disaster risk reduction and development. The document reflects a wide range of views from different stakeholders, some of which may be conflicting.

The team would like to acknowledge the input of many stakeholders from development partners, relief organizations, universities, research institutes, the private sector, civil society and nongovernment organizations, who were present at the following workshops:

- A roundtable discussion held during the Global Humanitarian Forum's Annual General Meeting in Geneva, 24–25 June 2008
- A technical workshop held at IRI in New York, 7–8 October 2008
- A meeting hosted by the International Task Force on Commodity Risk Management in Brussels on 22–24 October 2008
- A workshop hosted by BASIX, WFP and IFAD in Andhra Pradesh (Hyderabad) India on 18 November 2008
- An expert roundtable discussion convened by WFP and IFAD in Rome on 30–31 March 2009.

The team would also like to acknowledge the contributions of the Weather Risk Management Facility (WRMF), a WFP and IFAD collaboration sponsored by a planning grant from the Bill & Melinda Gates Foundation. We are indebted to the World Bank's Commodity Risk Management Group for their contributions to the report, which greatly enhanced the quality and the process.

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Climate, poverty and index insurance

Climate and poverty

The climate has always presented a challenge to those whose livelihoods depend on it. Moving away from such dependence is usually an early step in economic development, but many millions have not yet succeeded in taking that step. As climate variability and uncertainty increase with climate change, human development reversals are a distinct possibility (UNDP, 2007). Climate has thus become an urgent issue on the development agenda.

For poor people, a variable and unpredictable climate presents a risk that can critically restrict options and so limit development. The risk materializes at two levels: the direct effects of a weather shock, and the indirect effects due to the threat of a weather shock (whether it occurs or not).

When a weather shock occurs, poor people are vulnerable. Local coping strategies often break down. Poor people have few assets to fall back on, and may be forced to sell these in order to survive so that when the crisis is over they are in a much worse position than before. These impacts can last for years in the form of diminished productive capacity and weakened livelihoods. And climate change threatens both more frequent and more severe extreme events (IPCC, 2007).

The climate presents a challenge to small-scale farmers and can significantly limit their options; Scott Wallace/World Bank

Under the threat of a possible weather shock, poor people avoid taking risks (Rosenzweig and Wolpin, 1993). They shun innovations that could increase productivity, since these innovations may increase their vulnerability, for example by exhausting the assets they would need to survive a crisis or by requiring them to spend money without being sure of a return (Dercon, 1996). Creditors are unlikely to lend to farmers if drought (for example) might result in widespread defaults, even if loans can be paid back easily in most years. This lack of access to credit critically restricts access to agricultural inputs and technologies, such as improved seeds and fertilizers. Even though a drought (or a flood, or a hurricane) may happen only one year in five or six, the threat of the disaster is enough to block economic vitality, growth and wealth generation in all years – good or bad.

Poverty limits the capacity of people to manage weather risks, while these same risks contribute to keeping people poor. Climate change will greatly exacerbate this situation; and developing countries, which are least responsible for climate change, face its greatest impacts. New tools are urgently needed to help vulnerable people deal with climate change, and the uncertainty that accompanies this.

It is not only the poor who need such tools. After a climate-related disaster, governments struggle to finance relief and recovery efforts and maintain essential government services. Disaster response can be delayed for several months as humanitarian aid trickles in, which results in even higher human and economic costs (Goes and Skees, 2003).

Risk transfer approaches such as insurance have played a role in mitigating climate risk in many parts of the world. However, they have generally not been available in developing countries, where insurance markets are limited if they exist at all, and are not oriented towards the poor. A new type of insurance – index insurance – offers new opportunities for managing climate risk in developing countries. If designed and introduced carefully, it has the potential to contribute significantly to sustainable development, by addressing a gap in the existing climate risk management portfolio. However, this potential has yet to be proven; and there are some significant challenges that must first be addressed.

Index insurance can be applied across a diverse range of weather-related risk problems, from loss of crops due to drought, to loss of livestock in harsh winter conditions, to losses resulting from hurricanes. It can be purchased at different levels of society – at 'micro-level' by small-scale farmers, at 'meso-level' by input suppliers or banks, or at 'macro-level' by governments, for example. It is not a 'cure-all' and will be inappropriate in many situations; but it may be a useful option in many others. As awareness and knowledge of this new tool increase, and if the challenges described in this publication can be overcome, index insurance could become widely available as an additional option for those facing a weather risk.

The introduction of index insurance can bring together a new set of actors and new resources to address some of the more persistent problems associated with poverty. It also reflects a growing interest in, and a move towards, market-driven solutions to these problems. Shifting responsibilities from public agencies, which 'provide' interventions to 'beneficiaries', to market-based mechanisms where people choose the services and technologies they prefer, may offer the poor a more sustainable development model. Public–private partnerships and private-sector development are key to this approach, which must ultimately deliver what customers demand.

Climate risk management

Climate risk is not a new phenomenon, and climate risk management (CRM) in the broad sense has long been practised. Farmers anticipate the rains, using various indicators, and time their planting and inputs based on their best estimates; they install irrigation systems if they can; and they reduce risk exposure by diversifying their livelihoods as far as possible (Dercon, 1996; Ellis, 2000). Scientists have also sought ways to help manage the risk that climate presents. Agricultural research has developed crop varieties that are drought tolerant, for example, and soil management practices that increase soil moisture-holding capacity. Weather forecasts have been a major advance in helping people plan appropriately.

In recent years, advances in climate science have catalyzed the development of new CRM practices. The improved use of climate information in planning and resource management has contributed to robust advances in disaster risk reduction and climate change adaptation (Meza *et al.*, 2008; IFRC, 2008). The first publication in the Climate and Society series describes and analyses some examples of CRM in Africa (Hellmuth *et al.*, 2007).

Index insurance is proposed as a new CRM tool that may help people cope with current weather-related risks and, if designed properly, perhaps also future risks associated with climate change. Depending on their circumstances, people have a variety of risk management mechanisms available to them. Index insurance will not replace these options, but should find a role alongside them. It could fill the gap that occurs in the current portfolio of coping mechanisms when these break down in the face of a weather shock.

A brief introduction to index insurance

Index insurance is insurance that is linked to an index, such as rainfall, temperature, humidity or crop yields, rather than actual loss. This approach solves some of the problems that limit the application of traditional crop insurance in rural parts of developing countries. One key advantage is that the transaction costs are lower. In theory at least, this makes index insurance financially viable for private-sector insurers and affordable to small farmers. Another important advantage is that index insurance is subject to less adverse selection and moral hazard than traditional insurance.[1]

An example of index insurance, and the most common application in developing countries so far, is the use of an index of rainfall totals to insure against drought-related crop loss. Payouts occur when rainfall totals over an agreed period are below an agreed threshold that can be expected to result in crop loss. Unlike with traditional crop insurance, the insurance company does not need to visit farmers' fields to assess losses and determine payouts. Instead, it uses data from rain gauges near the farmer's field. If these data show the rainfall amount is below the threshold, the insurance pays out.

As well as reducing costs, this means that payouts can be made quickly – a feature that reduces or avoids distress sales of assets. This process also removes moral hazards such as the 'perverse incentives' of crop insurance, where under certain conditions farmers may actually prefer their crops to fail so that they receive a payout. With index insurance, the payout is not linked to the crop's survival or failure, so the farmer still has incentives to make the best decisions. Another feature that reduces moral hazard is that index insurance uses objective, publicly available data, so individuals are unable to distort a situation to their benefit.

Rapid payouts are the major advantage of index insurance when this is used as a disaster management tool. Again, time-consuming loss assessments are not needed, as payouts are based on objective data. With index insurance in place, governments and relief agencies can plan ahead of crises, knowing that funds will be available when they need them. Planning is also facilitated because governments and relief agencies can track the index and prepare an early response.

But several critical components need careful attention if index insurance is to be workable. Index insurance is new, and can be difficult for stakeholders to understand – time and resources must be invested in explaining how it works. It depends on the availability and reliability of quality data, which is a significant challenge in most developing countries. But perhaps most importantly, index insurance is vulnerable to basis risk. Simply put, basis risk is when insurance payouts do not match actual losses – either there are losses but no payout, or a payout is triggered even though there are no losses. Obviously, if either of these situations occurs too frequently, the insurance scheme will not be viable, and may even damage livelihoods (Skees, 2008). The contract design, and in particular the selection of an appropriate index, is crucially important in minimizing basis risk. Other factors that have implications for basis risk are proximity

1 Adverse selection occurs when potential borrowers or insurees have hidden information about their risk exposure that is not available to the lender or insurer, who then becomes more likely to erroneously assess the risk of the borrower or insuree. Moral hazard occurs when individuals engage in hidden activities that increase their exposure to risk as a result of borrowing or purchasing insurance. These hidden activities can leave the lender or insurer exposed to higher levels of risk than had been anticipated when interest or premium rates were established.

of the insured crop to a weather station, and availability of climate data (Carriquiry and Osgood, 2008).

The potential of index insurance has been demonstrated by a number of projects in various developing countries. A selection of these projects, representing different regions of the world and different applications of index insurance, are presented as case studies in this publication.

Index insurance is just one of a number of related index-based financial risk transfer products that work on the same principles (for details of others, see Skees *et al*., 2008b). In this publication, the term index insurance is used loosely to include the range of products. Some of the case studies, for example, use other related products such as weather derivatives, but for ease of reading we call them all index insurance. The reader should bear in mind that much of the discussion is relevant to the broader range of products. Also, the discussion refers mainly to index insurance for crop failure due to drought, since this is the most common application so far; but much of it is also relevant to applications beyond drought and crop failure.

Index insurance for development

Index insurance may be able to help people manage the weather risk that is partially responsible for keeping them in poverty traps. Poor people are not only at direct risk from extreme weather events, but even without bad weather they are at a disadvantage because the risk blocks their opportunities. Lenders, for example, may not extend credit to them. They are therefore unable to invest in inputs that would improve productivity in good-weather years. Evidence suggests that farmers often sacrifice 10–20% of income when using traditional risk management strategies (Gautam *et al*., 1994).

But if they can take out insurance, either individually or collectively (by farmer associations, for example), the picture may change. When lenders know that borrowers are covered by insurance, they may be more likely to extend credit to them. Farmers may then choose to make investments that may raise their productivity. If the weather is bad and crops fail, the insurance will pay out and, as a Malawian farmer put it, “I do not have to worry about paying back loans in addition to looking for food to feed my family” (Hellmuth *et al*., 2007). This insurance can be sold either at the micro-level – to individual farmers or households, or at the meso-level – to banks or cooperatives for example.

Many of the case studies illustrate this use of index insurance (Tables 1 and 2). ‘Unlocking development potential in Malawi’, on page 13, is a good example. Malawi is one of Africa’s poorest countries, with the majority of its workforce engaged in smallholder farming. Crops are mostly rainfed, and drought is an ever-present risk. These farmers have little or no access to formal financial credit to buy agricultural inputs, because the chance of them defaulting on loans is high (although, as the case study shows, not always because of drought). The case study illustrates how providing index insurance linked to loans may help them to invest in inputs for cash crops such as groundnuts and tobacco.

Of course, loan markets face many challenges, of which climate risk is only one. The Malawi case illustrates the importance of these other challenges, and highlights the need to identify the best role for insurance if it is to contribute to development.

Index insurance for disaster management

Several pilot projects have been exploring the use of index insurance as part of the disaster risk management portfolios of governments and relief agencies (Tables 1 and 2). Disaster risk reduction emphasizes preparedness ahead of disasters, in order to limit the lives, livelihoods and assets lost. Governments and relief agencies, which usually bear the costs of responding to large-scale disasters, have taken

Table 1. Some features of index insurance for development and for disaster relief

	Index insurance for development	Index insurance for disaster relief
Intended development uses that are being actively explored	Help farmers escape poverty by removing barriers preventing them from being more productive, e.g. enabling access to credit so that farmers can be more effective in 'good' weather years. Direct risk management. Protecting investments	Save lives and livelihoods through more cost-effective and timely disaster response. The timelier response may help prevent people from falling into poverty traps
Target group	Smallholder farmers and agricultural laborers with growth potential, or their suppliers and financers; institutions within the agricultural supply chain that work with farmers. Contract is held at meso- or micro-level by household, farmer group, cooperative, microfinance institution, NGO, or contract farming corporation	Those vulnerable to disaster, particularly those in chronic poverty. Contract is held at macro-level by government or relief agency
Subsidies?	Hotly debated! Subsidies can severely distort incentives and encourage the promotion of ineffective or inappropriate products. However, if used responsibly, subsidies may play an important role in launching products	Yes. Disaster relief programs are by definition subsidized. The insurance is a financing mechanism designed to ensure more effective use of these subsidies
Case studies	Ethiopia, Honduras, India, Jamaica, Malawi, Mongolia, Nicaragua, Peru, South Africa, Thailand, Ukraine, Vietnam	Brazil, Caribbean, Ethiopia, India, Malawi, Millennium Villages Project, Mexico

out insurance policies linked to weather indices that will pay out when extreme weather events precipitate a disaster. The key advantages are the speed of payout, which allows rapid response; and the ability to plan ahead of a disaster, in the knowledge that funds will be available when they are needed.

As in the case of index insurance products designed for development, integrating index insurance into disaster management strategies can help poor people whose livelihoods are closely linked to the weather and who are at risk of falling into poverty traps if a weather shock occurs. Such people have assets – animals or farming equipment, for example – but may be forced to sell them to survive a crisis, and then find themselves without the means to earn a living once the crisis is over (Baulch and Hoddinott, 2000; Barrett *et al*., 2001; McPeak and Barrett, 2001). Here, insurance is designed to enable prompt disaster response, allowing people to hold on to their assets and quickly recover after the crisis.

In Ethiopia, for example, the Government and the World Food Programme (WFP) have worked together on a pilot project that uses a rainfall index-based insurance contract to provide emergency relief (see 'Disaster insurance in Ethiopia' on page 17). Drought drives agricultural losses, which in turn result in food and income shortfalls and subsequently an increase in the number of food aid beneficiaries. Rainfall is used as a proxy for economic loss resulting from drought and serves as a simple, objective basis for the contract. Payouts are not dependent on time-consuming and often

Index insurance has potential to help people escape poverty; Eric Holthaus/IRI subjective needs assessments, and can therefore be made much more quickly. The rainfall-based drought index produced for this pilot project shows high correlation (around 80% for the period 1994–2004) between losses that would have been covered by the index and the number of food aid beneficiaries. As this type of project proceeds, it will be valuable to substantiate this correlation with direct measurements of crop yields and beneficiary livelihoods (WFP, 2007).

Climate change and index insurance

There is much debate about the implications of climate change for index insurance, centered around the following three questions. Can index insurance contribute to adaptation strategies in developing countries? Can it play a role in managing the uncertainty associated with climate change? And does climate change challenge the viability of index-based insurance products?

There are at least three ways in which index insurance might help build adaptive capacity: as a risk transfer mechanism within a comprehensive strategy for managing climate risk in the face of climate change; as a mechanism to help people access the resources needed to escape climate-related poverty; and as a mechanism to incentivize risk reduction.

A comprehensive strategy for adaptation in the agricultural sector, for example, could include adapted crop varieties, micro-irrigation, rainwater harvesting and improved soil conservation practices. However, a certain amount of risk would remain – and this remaining risk might be covered by index insurance.

The second way index insurance can contribute to adaptation is through building more resilient livelihoods by enabling access to increased credit, technology and inputs. Insured loans allow lenders to recuperate their money even in a year where the climate causes production losses. The loans allow people to invest in more intensive livelihood strategies which may help them to escape poverty traps. The increase in wealth and in economic resilience allows people to buffer themselves from the direct impacts of the climate.

Beyond this, a key challenge in designing insurance in the face of climate change is to incentivize risk reduction through price signals and risk management stipulations. For example, contracts could stipulate that certain risk reduction mechanisms, such as the adoption of wind-resistant cropping patterns or drought-tolerant crop varieties, must be in place if crops are to be covered. In Ethiopia, a pilot project is testing a scheme in which cash-constrained farmers pay for insurance premiums through their labor on community assets which reduce risk, such as water-harvesting structures. The cost of the premiums in this project contains a component that is a price signal to reflect long-term trends (Oxfam America, 2009; see 'A farmer-centric approach in Ethiopia' on page 44 and 'Climate variability and change and index insurance' on page 38).

Climate change has implications for index insurance design and pricing, but need not make such insurance non-viable. Contracts are typically drawn up for a single season or a few years at most, so they can be adapted as climate change takes hold. The challenge is to accommodate the added uncertainty due to climate change while keeping premiums affordable. Most of the pricing in insurance contracts at present reflects year-to-year variation, with only a small element allowing for longer term trends. If, over time or in some locations, incremental climate changes were to lead to prohibitively expensive insurance, that would signal the need to switch to more radical forms of adaptation, such as changing the crops grown or, in marginal areas, giving up crop production altogether and taking up livestock production, or migration. Climate science can play a role in reducing uncertainty through better understanding of the climate system and how climate is likely to change over the coming decades.

The climate variations experienced over the next few decades will include variations due to increasing greenhouse gases, but also variations arising from natural processes within climate systems. With the world's climate scientists largely focusing on the former, the latter are currently little understood. Yet these internal components are likely to have at least as much impact on the climate over the coming decades as increased emissions. This realization is leading to increased efforts to understand these decadal processes.

The box 'Climate variability and change and index insurance' on page 38 illustrates climate change issues and their implications for index insurance and the CRM portfolio.

Next steps – this publication

Most projects involving index insurance have so far been small-scale, with two notable exceptions in India and Mexico, which have successfully scaled up. The projects have tested the use of index insurance in a range of applications and for different groups, from supporting poor farmers in their efforts to protect and enhance their livelihoods to helping governments or relief agencies manage climate-related crises. It is still an open question whether index insurance can contribute significantly to sustainable development and to disaster management. If it is to do so, it will need to scale up to reach very many more people. This publication looks at the challenges – both technical and operational – that accompany this proposed scale-up.

At the same time it is acknowledged that scaling up may not be sufficient by itself to impact on poverty reduction and development and that index insurance may not be appropriate in many places. Impact studies are urgently needed to better understand under what conditions index insurance can play this role. These conditions may prove quite restricted.

Many of the pioneers of index insurance have contributed case studies to this

Index insurance is a tool that could be added to the existing portfolio of CRM options; Jason Hartell/GlobalAgRisk

publication, capturing the challenges they encountered and the lessons they learned. These case studies are found in three sections beginning on pages 13, 42 and 72.

The next section focuses on the index insurance product – the contract, including the index itself – and highlights the main issues that need attention if scale-up is to be successfully achieved. It draws on the case studies in explaining and discussing these issues; and it outlines new approaches that might help overcome some of the limitations currently facing index insurance contract design.

In the following section, the operational challenges encountered by many of the case studies are examined, particularly those associated with the development of new insurance markets in areas with little prior experience in weather index insurance.

Key messages and recommendations resulting from this study are then presented. This section is particularly aimed at those who would like to see index insurance realize its potential as a tool for sustainable development. It identifies where investment is needed to enable scale-up. Many donors have expressed an interest in index insurance and are keen to invest, but this must be done with care if insurance-based interventions are to achieve development objectives.

The final brief section looks at some of the ongoing and planned global initiatives that could support the development of index insurance markets.

Table 2. Case studies

Case study	Development or disaster relief?	Risk	Index	Target user	Year first implemented	No. of beneficiaries in 2008 (or most recent available figures)	Notes
Case study section I, starts on page 13							
Unlocking development potential in Malawi	Development	Drought	Rainfall	Tobacco farmers	2005–06	2500	Began targeting groundnut (and maize) farmers, but due to supply chain issues changed to support the stronger tobacco system
Disaster insurance in Ethiopia	Disaster relief	Drought	Rainfall	WFP operations in Ethiopia	2006	316,000 (2006)	No payout in 2006. Policy not renewed in following years. US$25 million contingency financing contract paid out in 2008. Scale up to US$250 million planned for 2010
Case study section II, starts on page 42							
National-level drought risk management in Malawi	Disaster relief	Drought	Rainfall (linked to maize production)	Government of Malawi	2008		Currently in first trial year
A farmer-centric approach in Ethiopia	Development	Drought	Rainfall	Teff farmers in Adi Ha	Under development		
Insurance for contract farming in India	Development	Late blight disease	Temperature and humidity	Potato farmers under contract to PepsiCo	2007	4575	
Disaster relief in Mexico	Disaster relief	Natural disasters impacting smallholder farmers, primarily drought and flood	Rainfall	State governments	2002	800,000	
Catastrophe risk insurance in the Caribbean	Disaster relief	Hurricanes and earthquakes	Wind speed and shaking	Caribbean country governments	2007	16 countries	
Insuring development goals in the Millennium Villages Project	Disaster relief	Drought	Combination of rainfall and vegetation remote sensing	Inhabitants of villages in the MVP	2007		Experimental product transacted in three MVP villages in Kenya, Ethiopia and Mali in 2007. Not repeated in 2008

Table 2. Case studies

Case study	Development or disaster relief?	Risk	Index	Target user	Year first implemented	No. of beneficiaries in 2008 (or most recent available figures)	Notes
Vietnam: Flood insurance in the Mekong Delta	Development	Early flooding of rice fields	River level	The state agricultural bank	Under development		Business interruption insurance contract currently being considered by the state agricultural bank
Case study section III, starts on page 72							
Central America – a different approach for launching index insurance	Development	Drought and excess rainfall	Rainfall	Commercial groundnut and rice farmers	2007	16 (400 anticipated in 2009)	
Barriers to implementation in the Ukraine	Development	Drought	Rainfall	Smallholder farmers of grain crops	2005	2 (2005)	One year only; project discontinued
The private sector builds a market in India	Development	Drought, flood, extreme temperatures, weather-linked crop diseases, fog, humidity	Various, mostly simple weather parameters	Farmers (small, medium and large)	2003	Estimated 150,000 in total	
Laying the foundations for farm-level insurance in Ethiopia	Development	Drought	Rainfall	Smallholder maize farmers	2006	28 (2006), 13 (2007)	Small pilot as part of feasibility study
Supporting farmers – and a government seed program – in Brazil	Disaster relief	Drought	Area yield	Maize farmers in government seed program	2001	c. 15,000	
Stakeholder communication is key in Thailand	Development	Drought	Rainfall	Smallholder maize farmers	2007	388	
Scaling up in India: the public sector	Disaster relief	Drought, excess rainfall	Rainfall	Farmers (small, medium and large)	2004	700,000	
Livestock insurance in Mongolia	Development	Large livestock losses due to severe weather	Area livestock mortality rate	Nomadic herders	2006	4100	

Case studies I

Unlocking development potential in Malawi

A pilot project in Malawi illustrates how index-based weather insurance can be used to strengthen supply chain relationships and support lending to small-scale farmers. This project has also revealed a number of operational challenges, with interesting lessons for others setting out on this path.

In Malawi, contract farming is becoming more common, but credit to the rural sector, which would allow small-scale farmers to take advantage of this opportunity by increasing their access to inputs, has been relatively limited. Index insurance can support such farmers as they become more market-oriented and take on higher levels of risk by buying improved seeds and fertilizers.

Managed by a partnership comprising the World Bank, the pro-poor international insurance group MicroEnsure and local stakeholders, the pilot project is now in its fourth year. The

The project supports small-scale farmers in Malawi; Janot-Reine Mendler de Suarez/GEF-IW:LEARN

International Research Institute for Climate and Society (IRI) has contributed technical support to this project. During the first year, the 2005–06 cropping season, 892 farmers located within 20 km of four weather stations purchased the insurance, which was bundled with a loan for groundnut production inputs. The groundnut sector was chosen for this pilot operation because (i) the crop is relatively drought sensitive, (ii) farmers had been unable to invest in new groundnut varieties due to their high cost, and (iii) the farmers' union had established a new marketing system for the crop, which envisaged loan recovery at the point of sale.

For the 2006–07 cropping season the pilot expanded, with the addition of maize and a fifth weather station, taking numbers up to 1710 farmers. The marketability of groundnuts was used to secure insurance and loans for maize, which is the main food crop in Malawi. Maize suffers from significant price volatility and fragmented marketing, so farmer loans are generally not available for maize inputs alone without some other collateral for the lender. By combining a loan (and weather insurance) for maize with a loan for a cash crop covered by insurance, lenders felt comfortable that the profits from the cash crop could be used to repay the loan for maize if necessary.

These pilots stimulated interest among banks, financiers and supply chain participants such as processing and trading companies and input suppliers. However, they also demonstrated that other risks within the supply chain can have a serious impact on loan recovery rates and on the sustainability of the supply chain itself, threatening the viability of a stand-alone index insurance scheme. For example, during the 2005–06 season there were problems due to poor seed quality. In addition, during the initial pilot operation, banks learned that the new marketing arrangements in the groundnut supply chain were not sufficiently organized to ensure loan recovery at the point of sale, leading to substantial side-selling and related failures and delays in loan repayments. This showed that to scale up the groundnut insurance would require an associated scaling up of the nascent marketing chain. The banks agreed that the weather insurance tool would be more useful in a commodity sector with stronger marketing arrangements and oversight of farmers, such as tobacco, and possibly paprika, tea, coffee and cotton, where similar marketing chains are developing.

Thus, during the 2007–08 season, the program moved to the tobacco sector and ceased operations in groundnuts. Malawi's tobacco sector currently represents the largest pool of recipients of credit in the country; demand for credit is high because of the input needs associated with tobacco production. Because all tobacco in Malawi is sold through auction, there is a constriction point that allows banks to recover loans directly before farmers receive their sales proceeds. This creates more certainty for lenders, who have an assured and trusted mechanism for recovering loans. Traditionally, maize inputs are also included in farmer tobacco loan packages.

In 2007–08, weather insurance covered a portfolio of loans jointly held by a tobacco processing/trading company, Alliance One, and the Opportunity International Bank of Malawi (OIBM), rather than individual loans held by farmers. OIBM bought an index-based weather insurance policy from the Insurance Association of Malawi (IAM) in November 2007. The policy covered Alliance One tobacco farmers within 30 km of Lilongwe and Kasungu weather stations. Though the policy was a portfolio policy designed to cover the OIBM and Alliance One's exposure, the contract was based on individual insurance so that the companies could easily associate payouts triggered by specific stations with specific farmer groups and crops. OIBM and Alliance One shared the cost of the insurance with the farmers, but did not engage in detailed communication with them on the nature of the product, given that this was a pilot. Since the value of the initial tobacco transaction was greater than the sums insured under previous pilots, the IAM was able to establish contracts with the international reinsurance market for these products for the first time. A portion of this risk was thus reinsured by IAM on the international risk markets in late 2007.

All of the companies involved, and several new players, expanded this program during the 2008–09 season. Both the portfolio approach pioneered in 2007 and a farmer-level approach were offered. While Alliance One chose to pursue a portfolio approach again, Limbe Leaf, a contract farming company, chose to offer the product directly to their farmers. In addition two more banks agreed to provide financing for these loans. The size of the program increased significantly, covering 2500 farmers and a total value of transactions exceeding US$2 million. There are plans to expand the program still further for the 2009–10 season.

Lessons

The groundnut pilot revealed that problems related to production, marketing and sales can undermine credit repayment and hence the effectiveness of the insurance policy. To make insurance viable for this sector, complementary investments are necessary to strengthen contractual relationships. These will likely feature additional flows of resources, improved farmer advice and oversight, and better links between input provision and commodity sale. Efforts to reduce side-marketing will also be important.

The conclusion for Malawi, therefore, is that insurance should be closely linked to more formal and better coordinated supply chains. The aims now are to scale up index insurance in conjunction with such chains, and to expand into new areas and crops only when these meet this criterion.

The low density of automated rainfall stations in the country is a limitation to scaling up in Malawi. For example, an estimated 110,000 smallholder tobacco growers curently cultivate close to a reliable weather station. If 53 new rain gauges were installed, an additional 200,000 farmers could be included in the program. A government program supported by the World Bank and Norway, the Agricultural Development Project – Support Program (ADP-SP), is currently investing in new weather stations and infrastructure.

The development of capacity and technical expertise in insurance will be critical for continued growth of the sector. The pilot program includes some training, but more will be needed. Specifically, national players will need to take a larger role in contract design and underwriting. To date, contract design has been carried out by the World Bank and its partner, MicroEnsure, with limited support from local experts. In the coming years, the IAM will need to take over responsibility in collaboration with experts from the Meteorological Services Department, the Ministry of Agriculture and Food Security, staff of participating commercial banks, contract farming companies and local research institutes. The ADP-SP provides funding for this activity.

For the pilot, nine insurance companies worked together to underwrite the risk. National regulatory approval was not required during the pilot phase, although the regulator closely observed the program's development. If the private sector is interested in expanding the program, it will need to engage the national regulatory authority so that it gains a better understanding of the risks being insured, and can make necessary changes or additions to existing regulation and policies. Support for the development of an appropriate legal and regulatory framework is also included in the ADP-SP.

Disaster insurance in Ethiopia

Some 5 million people in Ethiopia are directly at risk when a drought occurs; Daniel Osgood/IRI

Ethiopia provides an example of how index insurance is being used to revolutionize disaster response. The current response system waits for evidence that people are hungry before appealing to donors and eventually providing relief, which misses the opportunity to act in time to prevent famine. However, impending drought-related famine can be detected, and used to trigger an index insurance payout during the growing season. By acting quickly, disaster response can be much more effective at much lower cost.

The country's first national index-based disaster insurance program was implemented in 2006. Developed by a partnership of the World Food Programme (WFP) and the Government of Ethiopia, the pilot project attempted to demonstrate the transfer of national drought risk to the global insurance market. Although there was no payout that year, as rainfall was above average, the project successfully demonstrated the feasibility of the concept. The policy was not renewed in 2007 due to lack of donor support; however, scale-up is now under way, with a US$250 million contract planned for 2010.

The insurance targets a group described as the 'transiently food-insecure' – some 5 million people who are directly at risk when a drought occurs. The Ethiopian government has a Productive Safety Net Program (PSNP) that targets the chronically food-insecure, that is, the poorest people who face ongoing food insecurity whatever the weather. The transiently food-insecure, who are able to feed themselves in a good season but suffer when the rains fail, are largely overlooked. The emergency appeal system that should help them during extreme drought is usually too slow in its response to prevent distress sales of assets, and they then move into the chronically food-insecure group. Ultimately, this makes the PSNP unsustainable – unless the weather risk component can be addressed.

Index insurance provides the missing piece of the puzzle, allowing timely relief to come to those in need quickly when rains fail. In this way, the PSNP program can focus on its core task of supporting the chronically food-insecure. Another advantage is that the insurance product facilitates price discovery for Ethiopian drought risk in international financial markets. Putting a price on drought risk allows for better understanding of investment tradeoffs for mitigation/management of drought risk.

The reinsurance company AXA Re won the bid to provide the insurance for the pilot project. The premium was set at US$930,000, WFP signed the contract on behalf of the Government of Ethiopia, and United States Agency for International Development (USAID) paid most of the premium. The contract stipulated a maximum payout of US$7,100,000 in the event of severe drought. Although rainfall was above normal that year, the pilot demonstrated the feasibility of index insurance at this level. It included capacity building with government and local partners, strengthened the national meteorological reporting network, and demonstrated that there is sufficient quality meteorological data in Ethiopia for disaster index insurance.

The contract

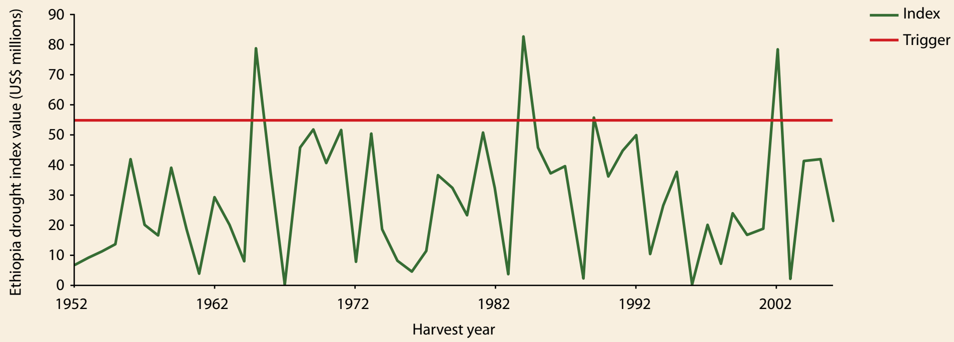
The Ethiopia Drought Index (EDI) was developed using historical rainfall data from the national meteorological agency, and a crop–water balance model. The index had an 80% correlation with the number of food aid beneficiaries from 1994 to 2004, indicating that it is a good proxy for human need when drought strikes.

As the 2006 agricultural season progressed, rainfall was monitored daily at 26 weather stations across the country. Extension officers in the field reported that the index effectively tracked rains and crop growth during the 2006 season; at the same time, areas where the index and approach could be improved were noted. Remote sensing of rainfall was used to ensure that there was no tampering with station-based rainfall data.

The EDI value at the end of the contract period, 31 October 2006, was well below the US$55 million trigger level, so there was no payout (see figure).

Some basis risk was evident within the contract. Standard Famine Early Warning System Network (FEWS-NET) sowing periods were used to calibrate the 2006 model, but these did not always correspond with actual farming practices. For example, the traditional cereal teff, used to make bread

The Ethiopia Drought Index, 1952–2006.



and for forage, was sown later than modeled. In some cases it experienced water stress because the rains ended early, but according to the model the crop had already been harvested and was not shown to be affected. Standard growing cycles from FEWS-NET and Food and Agriculture Organization of the United Nations (FAO) were also used, but in Ethiopia growing cycles vary greatly according to altitude and local crop variety; in some areas, for example, a 240-day variety of sorghum is grown, but the model assumed a standard 150-day variety. This also led to discrepancies. Information on actual sowing periods and growing cycles for the main crops in the different areas was being collected for future projects, to reduce this source of error.

LEAP

In preparation for the second phase of the Ethiopia drought insurance project, WFP and the World Bank have developed a piece of software called LEAP, which stands for Livelihoods, Early Assessment and Protection. Based on the FAO Water Requirement Satisfaction Index (WRSI), the software allows users to quantify and index the drought and excessive rainfall risk in a particular administrative unit in Ethiopia. LEAP can then be used to monitor this risk, and to guide disbursements for a PSNP scale-up.

LEAP uses ground and satellite rainfall data to cover the whole of Ethiopia, even areas where weather stations do not exist, so that every administrative unit in the country can be included. It runs localized models to convert rainfall data into crop or rangeland production estimates and subsequently into livelihood stress indicators for vulnerable populations. It then estimates the financial magnitude of the livelihood-saving interventions these people need in the event of a weather shock. Thus, LEAP provides a good proxy estimate of the funding needs of protecting transiently food-insecure people's livelihoods at a time of shock through an independent, objective, verifiable and replicable index of livelihood stress.

Scaling up index insurance: The contract

Scaling up index insurance presents many challenges. This section focuses on the issues surrounding the design of insurance contracts – issues that must be addressed if large-scale implementation is to be feasible. Getting the contract 'right' is critical – but there is no shortcut to doing this. What is largely an experimental product will require a great deal of adaptation and validation to meet the diverse applications and objectives that many expect of it.

Scaling up in context

Expectations are high for index insurance – perhaps unrealistically so. To successfully scale up insurance for development objectives, contracts are expected to be affordable and easy to understand; to have minimal basis risk; to provide extensive coverage in different areas; and to deliver this performance against a background of limited or non-existent markets, limited capacity, weak distribution and regulatory systems, and limited contract design skills.

Contracts developed for development-oriented pilot projects have usually been highly tailored prototypes, 'handcrafted' by experts and developed for very specific and local needs. The main challenge now is to efficiently develop contracts with basic design principles that are well understood and generalizable, so that they can be transferred and adapted to different places and conditions. And importantly, the task of the initial contract exploration, or 'seeding', and designing must be manageable at the local level, so that contracts genuinely respond to local demands and changing needs. Training, and innovative training technologies, will be vital.

Some of these challenges are less acute at the disaster relief level, since just one contract can address the risk for an entire nation. Nevertheless, improvements in methodology

Scaling up will require capacity building at the local level; Marjorie Victor/Oxfam America are needed, as there are many challenges faced at this level as well, particularly associated with integration into national disaster management programs and reaching the target beneficiaries. Malawi provides an example of how index insurance is being integrated into national risk management to support national food security (see 'National-level drought risk management in Malawi' on page 42).

A considerable problem is the shortage of historical and real-time data in the very regions of the world that are most in need of risk management solutions. Data are the essential building blocks of index insurance – they are needed in order to build a loss history, to link this to an index, and to work out loss probabilities as a basis for pricing. They are key to identifying and reducing basis risk. Solutions to the data problem may seem straightforward – it is relatively easy to install new rain gauges in remote areas, for example. But historical data are also essential, and these will still be lacking. There are potential solutions to this problem – historical datasets can be simulated with the help of existing weather stations, for example – but they are not always simple, and some depend on advancing current science and developing new technologies.

The benefits that index insurance offers for both development and disaster management have, not surprisingly, attracted the attention of professionals in these fields. Many are advocating scale-up as the next stage – but this must be accompanied by a caution. We do not yet fully understand the behavioral responses to index insurance, or the impacts it may ultimately have. There is an urgent need for impact studies, as discussed at the end of this section.

There is also a danger that eagerness to see benefits from index insurance may cause pilots to be scaled up too rapidly, before appropriate methodologies have been developed or before supporting markets and systems can be strengthened. While funding is needed to expand and replicate projects, investments must be made carefully, allowing products to scale up at a strong but realistic rate and to adapt as new knowledge is generated and shared. In parallel, time and resources must be invested in capacity building at the local level. It will be important to strengthen the innovation system as a whole, so that index insurance can play its part in a robust portfolio of responses to climate risk that include a range of management options.

The rest of this section looks at contract design against the backdrop of these challenges. It is structured according to the main tasks faced by the designers of index insurance contracts, namely:

- Identifying and quantifying the risk
- Measuring index parameters
- Establishing probabilities
- Estimating the price.

A final section discusses the need for evaluation studies to answer the many questions surrounding index insurance and its impacts.

Identifying and quantifying the risk

At the core of contract design is determining what risks should be addressed and how these might be addressed through an index. The contract design question is not how to cover every risk, but which risks can best be covered using this financial tool, and when this tool is more cost-effective than other options for managing a particular risk.

The 'right' risk that index insurance can address is one that is an important livelihood constraint, is not adequately addressed through other options, and can be closely correlated with an index that can be reliably measured. It is important to remember that there are many risks that cannot be addressed through index insurance. Also, the insurance must respond to customer needs and demands.

To identify the right risk for farmer-level projects, a unique blend of local knowledge and science is needed. Interaction between clients and insurance experts as well as good demand assessments are key. In Ethiopia, a pilot project implemented by Oxfam illustrates how the risk can be identified through extensive stakeholder interactions, and particularly by listening to farmers (see 'A farmer-centric approach in Ethiopia' on page 44).

Determining the right risk to meet client demands essentially involves analysis of the existing risk management portfolio – the coping mechanisms, management practices and technical or institutional innovations already available – and the gaps. Agricultural systems modeling can be useful as a way to integrate the multiple sources of information needed to understand risks, and to build an index that minimizes basis risk for crop- or livestock-related applications (see 'Agricultural systems modeling') As with any technology, it is important to use agricultural systems modeling appropriately, ensuring that models are well calibrated and validated. Ultimately, the client is the only person who possesses a detailed understanding of the risks they face and of their alternative risk management options, so communication efforts that facilitate the sharing of this knowledge are critical if contracts are to address clients' real needs. As projects prepare to scale up, a key lesson from experience so far is that a high level of stakeholder interaction needs to be ongoing to improve contract design. For example, in India the contract developed by BASIX and partners has been substantially altered following farmer feedback sessions.

For social protection and disaster management purposes, identification of key risks is somewhat easier. Major threats to lives and livelihoods at the local, regional and national scales are well known and are already the focus of national disaster management efforts. Thus identifying the risk falls upon the disaster management system.

In most of the farmer-level case studies, the task of identifying the risk and choosing the index has been addressed in part through a participatory stakeholder process. Index designers model potential indices

Agricultural systems modeling

Agricultural systems modeling was first developed in the 1960s and 1970s to help understand interactions between the environment and crop and livestock systems. It has evolved so that today very complex systems can be modeled. Indeed, systems modeling is not limited to biological processes but can also look at climate and livelihood systems, for example.

These models can be used to produce indices that better correlate with crop production than simple rainfall indices. This is because models better reflect the 'real-life' situation, where yields depend not simply on the amount of rain but on interactions between the weather, soil–water–nutrient dynamics, crop management and crop physiology. Better correlation reduces basis risk, making these models attractive for index insurance contract designers. Accuracy can be improved by incorporating remote sensing of vegetation conditions or soil surface moisture into modeling. Agricultural systems modeling offers an array of tools of varying complexity, from simple water balance models such as the FAO Water Requirement Satisfaction Index (WRSI) to sophisticated process-based models such as the Decision Support System for Agrotechnology Transfer (DSSAT) suite.

There are a few examples of agricultural systems models being used in index insurance. The Agriculture Insurance Company of India (AIC) used the INFOCROP model developed by the Indian Agricultural Research Institute (IARI) to model weather–yield relationships and design weather indices for different crops and locations in 2007–08 (see 'Scaling up in India: The public sector' on page 87). WRSI-related products have been used as indices in the Ethiopian government's disaster relief contract as well as some of the Millennium Villages Project (MVP) contracts. WRSI is based on a relatively simple model that predicts water-limited crop yields by looking at evapotranspiration (actual and potential) against crop sensitivity during the different growth stages. The WRSI is essentially a rainfall index, but one that also takes account of how crops respond to rainfall. At the other end of the complexity spectrum, an index insurance product based on DSSAT yield predictions has been used for maize production in southern Georgia, USA (Deng *et al*., 2008).

Agricultural systems modeling can also be useful in modeling the linkages between the index and the risk, as well as in understanding the role insurance might play among the suite of risk management options. Another use is to demonstrate the potential benefits of index insurance by modeling how improved access to resources such as fertilizer might impact production and income. Models can also estimate optimum levels of inputs to production systems, and hence levels of credit (or inputs) that might be usefully bundled with insurance. Finally, models can help to understand how seasonal forecasts may affect index insurance and agricultural management decisions (see box 'Seasonal forecasts' on page 35).

As with any tool, agricultural systems modeling is not a panacea, and it will produce unreliable results if used inappropriately. It is important not only to validate the model with past outcomes but also to physically verify the predictive capacity of the model during implementation. When considering use of a crop or forage model as the basis for an index, one should understand its capabilities and limitations, and also understand the system being modeled, consider the levels of accuracy needed, evaluate model performance for the given application, and ensure that calibration is performed if needed, ideally by an independent technical institution. Discussion of model assumptions and outputs with farmers and local experts can be very valuable in this process. For example, in Tanzania it was found through validation with stakeholders that the most vulnerable period for maize occurred a few weeks later than had been modeled. If the climate and agricultural knowledge of farmers and local experts had not been included, this could have led to contracts with a high level of basis risk. Closing the loop through responsible agricultural systems modeling and communications yielded a much improved product.

Adapted from Baethgen *et al*. (2008).

with stakeholders, allowing for feedback on critical issues, particularly trade-offs such as how much (if any) of the premium should be dedicated to addressing competing risks, or between payout size and payout frequency. Experimental approaches are being explored as possible methodologies for index selection. In Kenya, Malawi and Ethiopia, farmers have played games based on index contracts, using real money. The farmers select between the alternative versions of the index contract being considered by designers, under simulated weather conditions and events. During the game, the farmers are asked questions about how similar the game is to their own experiences, to quantify agreement and mismatches between farmer experience and other information sources (Patt *et al.*, 2008). For scale-up, methodologies will need to be established to perform this time-intensive exercise more systematically and efficiently.

The tailored approach to identifying and quantifying the risk has been effective in pilot projects but was at times very costly (see 'Participation: Key to farmer uptake?'). It is critical that efforts continue to streamline these procedures, relying more on local champions, to build more replicable indices. The challenge is to balance efforts to lower the costs of scaling with the need for reliable and effective contracts.

Measuring index parameters

Once a contract period has begun, the parameter indexed needs to be measured, with data that are reliable and tamper proof. Measurements need to be made close to the insured location so that they accurately reflect weather events at that location. With pilots, these requirements have been relatively easy to meet; with larger scale projects it is a different matter.

For a rainfall-based index insurance contract, data are typically obtained from a meteorological station. Requirements are that the station should be managed by the national meteorological service or a reliable private provider, should meet international weather measurement standards such as those set by the World Meteorological Organization (WMO), and should be secure, preferably

Collecting rainfall data; Stephane de Messieres/ Oxfam America

Participation: Key to farmer uptake?

Ultimately, scaling up of index insurance for poverty reduction and development will depend on a large number of farmers choosing to take up the insurance. This must be an informed choice based on a clear understanding of the insurance – what it covers, what it does not cover, and what it offers vis-à-vis other risk management options. This is no simple matter. Index insurance is new and can be complex, and farmers (as well as other stakeholders) have a difficult time understanding it. Farmer decision making is also not a simple process. The concern is that farmers may, for these reasons, make a decision that is against their own interests and miss an opportunity to reduce the risks they face.

Participation may be the key. By involving the potential beneficiaries of index insurance projects in design and implementation, it is hoped that their input and assistance will both improve the design and create greater support for the project within the target communities. The interactions during these stages should also enhance trust in the project and among its participants.

Many factors influence farmer decision-making; Eric Holthaus/IRI

All of the pilot projects invested a great deal of time in interaction between stakeholders. This has been a two-way process, helping implementers to understand the needs of farmers as well as helping farmers to understand the insurance and its potential benefits. At the same time, alongside some of the pilots, there has been research into farmer decision making. This has yielded some interesting and sometimes unexpected results, which have implications for scaling up.

Both economic and non-economic factors play a role in decisions whether to buy insurance. From an economic perspective, researchers found that farmers did not always make the 'obvious' choice – the one that would be most likely to benefit them economically in the long run. Instead, the decision depended on factors such as the cost of the premium, the timing of the premium and the payouts, and the bundling of the insurance with other inputs in a loan package. In Ethiopia, for example, farmers explained that they only had cash available to pay the premium just after the harvest, so efforts to sell premiums to them at other times would likely fail. Farmers in both Ethiopia and Malawi confirmed that it was important for them to receive payouts at roughly the same time that cash from crop sales would have materialized, as they had arranged their financial commitments around this period.

But researchers also found that non-economic factors often override economic considerations. Investigations in Malawi, Ethiopia and India all show trust to be a crucial factor in guiding people's decisions over insurance – trust in the product itself, and in the organizations involved in selling and managing it. People are more likely to buy insurance if they see other members of their community buying it; and their own prior experience with insurance is most important of all. In particular, this translates into willingness to buy if there has been experience of a payout.

There are many other factors that influence decision making, some at the individual or household level, for example a potential customer's perception of risk and degree of risk aversion. All of these factors will be very relevant in efforts to scale up index insurance. Indeed, the researchers who investigated decision making in the pilot studies strongly recommend that similar levels of interaction are included as projects are scaled up and out. They believe that participation has a crucial role in developing trust in the institutions involved, in the product, and also in the clients' own decisions to purchase the insurance – and without this trust there may not be sufficient uptake. Of course, a balance must be established between the level of interaction and the cost of interaction at large scales.

The same researchers also stress the importance of regulation, by the government, international bodies and the insurance industry itself. Regulation needs to ensure that contracts are fair, that they are accompanied by transparent information, and that claims will be paid promptly. It is crucial that the commercial actors in index insurance markets are honest players, and that their actions contribute to trust in the product, rather than destroying trust. A single bad example could, the researchers say, set index insurance development back by many years.

Adapted from Patt *et al.* (2008).

automated. To make the insurance product workable, insured farmers must usually be located close to such stations. However, it is a fact that there is a shortage of these stations, particularly in the regions of the world where index insurance might prove most useful for development and disaster relief. This needs to be addressed as a fundamental constraint to scale-up.

Projects in India and Mexico came up against a shortage of weather stations as they began to scale up (see 'Insurance for contract farming in India' and 'Disaster relief in Mexico', on pages 47 and 49). Both have addressed this problem by building new private stations. In India, some 1200 new stations have so far been set up, by private and public companies. In Mexico, Fundación Produce is building some 764 automated stations. Alongside the urgent need to expand the network of weather stations, whether through public or private sector efforts, capacity building and resources to manage both the stations and the data are also required.

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is currently investigating the feasibility of including rainfall in its catastrophe insurance, following Hurricane Noel which caused severe damage due to flooding that was not covered in existing contracts (see 'Catastrophe risk insurance in the Caribbean' on page 52). However, adequate rainfall data, both historical and current, are limited in the region. As a solution, a new 'extreme weather monitoring network' has been proposed which will record extreme rainfall and wind events and act as a verification mechanism.

There are other ways to address the lack of data, especially for disaster management applications. Remote sensing can be useful for verification purposes and perhaps even as a source of data for the insurance index (see box, 'Remote sensing', page 28). Remotely sensed data can either be blended with ground-collected data to improve overall data quality, or used alone, if they have already been validated and shown to reflect conditions on the ground accurately. In the Ethiopia disaster relief project, for example, remotely sensed rainfall data are used to extend the index to areas where there are insufficient ground data. In the Millennium Villages Project (MVP) remotely sensed greenness is used to enhance an index based on rainfall data (see 'Insuring development goals in the Millennium Villages Project' on page 56).

One advantage of remote sensing is that data cannot be tampered with by the client. Even when such data are not accurate enough to be directly used to measure the index, they can be very useful for validating ground measurements and confirming that the latter have not been tampered with. This validation is particularly important in national-level projects where an index measured by government weather stations may determine large payouts to that government.

Typically, products involving remotely sensed data have been used by governments or intermediaries rather than in farmer-level projects because it is difficult for farmers to relate the performance of their crops to such intangible indices. Farmers also may not trust the insurance company to use such data responsibly in calculating payouts. These concerns may change as farmers become more experienced with index products and the level of trust builds between the insurance company and the farmer. The micro-level Oxfam America-led project in Ethiopia is using remotely sensed rainfall for farmer-level contracts until newly installed rain gauges can be sufficiently calibrated; this project is devoting significant time and energy to engaging farmers and building trust and understanding of products.

Spatial basis risk – the failure of the index to represent individual losses because of differences across locations – is a major challenge to scale-up. It is correlated with the distance between the weather station and the insured location, but the acceptable distance varies according to factors such as homogeneity of the landscape. An arbitrary maximum distance of 20 km has often been used in pilots for rainfall index products,

Remote sensing

Data from satellites can be used in index insurance as an alternative or a supplement to ground-collected data. These remotely sensed data have several advantages. Data are independent and tamper-proof, for example, and are available across large areas of the Earth and in near real-time. They, and their derived products, are easily available via the internet. However, the data are not direct measures but proxy measures of, for example, rainfall or vegetation. This means they come with a level of uncertainty. The majority of data from satellites is relatively 'coarse', i.e. low quality and low resolution; the satellites with highest resolution often do not have global coverage and are usually very new. And many satellites are deployed for temporary research projects, so collection of long-term data may not be part of their program. Given these caveats, there is a great deal of promise in remote sensing if effort is taken to research, validate and improve products. Remotely sensed data may be particularly useful coupled with other types of information; and offer a valuable fallback option when a ground-based observation station fails during the contract period.

Rainfall

There are two main ways of estimating rainfall from satellites. One uses thermal infra-red imaging to look at storm clouds and their height. The assumption is that more rain falls from storm clouds with deeper vertical extent. The height is related to the temperature of the top of the cloud, which is obtained from the infra-red images. The colder the temperature, the higher the cloud top. Rainfall is estimated based on the length of time the cloud top is below a certain temperature.

Passive microwave measurement offers an alternative way of estimating rainfall. The sensors measure actual rainy areas rather than clouds, making this a more accurate method. However, these sensors are not currently available on geosynchronous satellites, so fewer data are available (in both time and space). (Geosynchronous satellites have orbits that match the earth's rotation, keeping them above the same spot on the earth all the time.)

Data from these two approaches may be merged to combine the better rainfall identification of the passive microwave method with the better sampling of data from the thermal infra-red images. These data can also be blended with rain gauge data to further improve accuracy.

Remotely sensed rainfall data are potentially very useful where there are limited rain gauge data, because of few weather stations or uneven distribution of gauges, for example. This is often the case in rural parts of developing countries – which are precisely the areas that index insurance is targeting with development objectives. However, the level of uncertainty with these data is high, and they often fail to adequately reflect the actual amount of rainfall. Thermal infra-red sensors do not allow for variation in rainfall intensity under the clouds; rain may fall from lower clouds, for example near coasts or in mountainous areas; and cirrus clouds may incorrectly indicate rainfall because of their height, whereas in fact they are not deep enough for rainfall to develop. Passive microwave limitations are mainly due to background emission from the land surface, which varies for different vegetation and soil water content, as well as to the relatively few data available, including historical data.

There are ongoing efforts to extend and enhance archived satellite rainfall data to produce useful time series. Other plans for the future include a satellite mission with advanced passive microwave and radar instruments, which should greatly improve satellite rainfall estimation (the Global Precipitation Measurement Mission, http://gpm.gsfc.nasa.gov/).

Adapted from Dinku *et al.* (2008).

Vegetation

The vegetation measure that is most commonly used for index insurance is the Normalized Difference Vegetation Index (NDVI) (although new, improved vegetation measures are on the way). The NDVI is derived from satellite measures of 'greenness', which reflect the level of photosynthesis in the vegetation on the ground. Higher values of NDVI indicate greater vigor and amounts of vegetation, and index insurance contracts generally insure against a decline in NDVI over an area, which would usually be due to drought.

The assumption with NDVI is that crop (or forage) production correlates with remotely measured vegetation vigor over a given area and over time. This usually works well for forage, but is less straightforward with food crops such as maize, soybean and wheat. Here, final crop yield (seed production) is affected by factors such as nutrient availability or water stress during critical growth stages, which may not be reflected in average 'greenness'.

Nonetheless, NDVI has been piloted for index insurance in different parts of the world, with some success. In the USA, where crops are grown on a large and uniform scale which enhances the NDVI correlation, the Vegetation Index Plan of Insurance is being trialed for pasture, rangeland and forage (http://www.rma.usda.gov/policies/pasturerangeforage). The Millennium Villages Project (MVP) has developed index insurance using NDVI combined with a rainfall index to insure against maize losses.

Where crops are mixed with natural vegetation, such as over much of Africa, monitoring crop status with the NDVI is more of a challenge. In this case, NDVI is often not used to measure yields directly, but rather to detect a drought that would cause losses. The MVP index used the average NDVI over a large region to detect the browning of natural vegetation during times of year when a lack of rainfall would severely damage crops.

Many NDVI products are now available through the internet. Some datasets extend from the early 1980s, providing very useful time series. Reprocessing of older data has improved resolution, while sensors with ever higher spatial resolution are also becoming available – currently down to 10 meters, allowing the identification of very precise areas with pasture or crop problems. The US Department of Agriculture is also developing an NDVI product with 9-hour latency and 500-meter resolution, which will enable rapid analysis of crop conditions.

Adapted from Ceccato *et al.* (2008).

The HARITA project in Ethiopia is using satellite data to complement ground data (see page 44); Google, LeadDog Consulting, MapData, TerraMetrics; prepared by Daniel Osgood and Chris Small/IRI and up to 50 km for products based on temperature and humidity; but analysis is lacking on how to establish such distances. Again, the implication is a need not only for more weather stations but also for improved understanding of the differences in climate between locations and across regions. Remote sensing may have a role here too, to give a sense of the magnitude of these differences.

The vulnerability of an index to spatial basis risk also depends on the index itself as well as the risk being targeted. Because of the nature of drought, for example, it is often relatively easy to develop indices for this risk that are robust. Since drought is a phenomenon that builds slowly over time, differences in daily rainfall between locations are often not critical; instead it is the longer term total which is important. The problem can be much more challenging for excess rainfall, flood, wind or frost insurance, in which a single highly localized event may drive the bulk of the loss. Where these risks must be dealt with in the course of scaling up, research is needed to quantify them in more detail. For a discussion of index insurance applications and challenges in water resources applications, see 'Applications for reservoir and flood management' on page 31, and 'Vietnam: Flood insurance in the Mekong Delta' on page 59. These challenges are particularly great for farmer-level projects. For disaster relief projects, contracts can be designed to pay out when large aggregate losses are likely to occur so that relief efforts can be financed without having to determine exactly where the losses occur.

Establishing probabilities

Getting the index 'right' depends on a solid understanding of the probabilities associated with a given risk. This typically depends on long datasets of acceptable quality, which enable the likelihood of an extreme event, the level of vulnerability and exposure, and the losses incurred to be reliably estimated. A key scale-up issue is the limited availability of data, both historical and current; and ways to circumvent this lack of data.

One common approach, known to insurance designers as 'historical burning cost analysis', is extremely transparent and can be easily communicated to stakeholders. For this analysis, the probability distribution of the indexed parameter is calculated entirely by observing past measurements. For example, for a rainfall index, the past several decades of rain gauge data are used to represent the set of possible rainfall events. These are then used to calculate possible payouts. Although useful, when applied without other analyses this approach has significant limitations. For example, one or two major events can distort the probabilities, while any event that has not happened in the historical record is not considered.

Because of the limitations of historical burn analysis, it is typically complimented with rainfall modeling and simulation (see 'Rainfall simulation', page 34). Using data that

Applications for reservoir and flood management

Index insurance has so far mostly been used to insure against drought, but it has promise beyond this. Its application to water resources, particularly reservoir and flood management, is attracting interest as an alternative or complementary strategy to traditional methods.

Reservoir index insurance can help smooth costs associated with shared demands on limited water resources. Where urban needs compete with irrigated agriculture, for example, payouts to farmers in dry years would compensate their losses. Experts envisage a combination of insurance, forecasting and adaptive operation strategies as the way forward – though they emphasize that success depends on water managers being open to new ways of working. Progress also depends on the development of effective indices, which is a significant challenge. Reservoir inflows have been used, but are susceptible to basis risk where there may be diversions upstream.

After drought, floods are the next biggest threat to agriculture – does index insurance have a role in managing flood risk? Work is still experimental, and flood is clearly more problematic than drought to link accurately to an index, but there is some potential.

Disasters arising from floods may also be managed using index insurance, with the same advantages – rapid payouts, not dependent on actual assessments of damage or destruction – as other disasters. Again, the challenge is to develop an appropriate and effective index.

Southeast Asia has the highest number of people affected by flooding, and studies to investigate the feasibility of index insurance have been carried out in Thailand and Vietnam. The Thailand project examined farmer-level insurance, and concluded that it was unlikely to be workable. Frequent, localized flooding in the river valley would lead to the scheme attracting only high-risk farmers and would also lead to very high premiums. Results from Vietnam were more promising. Rather than targeting farmers, this project looked at the feasibility of 'business interruption insurance', to be purchased by the Vietnam Bank for Agriculture and Rural Development. The bank would lend money to rice farmers and would cover itself against losses in the event of flooding early in the growing season. This may be trialed in the near future, with a contract based on recorded water levels at a main river gauge station (see 'Vietnam: Flood insurance in the Mekong Delta' on page 59).

These two studies provide some useful lessons for those working on the development of flood insurance. First, farmers do to some extent manage their own risk exposure to floods where these have some pattern. Insurance is only feasible for infrequent, unpredictable and widespread flooding. Second, there are significant technical issues that need to be addressed. Each floodplain is unique, and its specific characteristics need to be considered. Upstream development can affect flood events downstream, for example. Defining agricultural flood events requires a good understanding of various aspects of flooding – extent, duration, depth, etc – and their relationship to the different stages of crop growth. As a crop grows, the critical thresholds at which a flood event results in damage also change. This issue of timing makes modeling of flood risk for agriculture very challenging. However, remote sensing may be a useful tool here, enabling rapid and objective assessment of flood extent and duration, even at high resolution. Application of these technologies is most feasible for river inundation flood rather than flash flood events.

Farmer-level flood insurance has additional technical challenges because of highly localized variation in flood exposure and the potential for anti-selection against the insurer. Flood index insurance aimed at intermediaries such as banks, or at governments, therefore seems more promising in the current data and technological environment than schemes directly targeting farmers. Risk management projects need to take a more holistic approach in working with intermediary clients like agricultural banks. It is important to understand the credit risk management methodology used by these institutions, specifically related to how natural disaster risks are currently treated and the broader policy environment in which they operate. A flood insurance product can complement and support more formal procedures for credit risk management such as interest or principal repayment scheduling.

Flood risk mapping and remote sensing have additional applications. Notably, risk mapping can provide agricultural credit banks with an objective assessment of risks of default arising from such factors as flood timing and duration. Better mapping of flood risks, linked to geo-location of borrowing farmers, should enable banks to refine their lending policies and to plan risk transfer or loan rescheduling policy and pricing. It may support government departments in advising on farming practices, variety selection, etc. Further, detection of flooded areas using remote sensing can support objective ex-post compensation systems, where these exist.

Adapted from Block *et al.* (2008)

Index insurance for flooding faces technical challenges; V.J. Villafranca/IRIN are available, plus an understanding of the variables that influence rainfall, the modeling generates thousands of years of synthetic rainfall data, which include events that are possible but have not actually occurred in the past. This approach can be used to extend limited datasets, allowing more realistic indices to be developed. In Mexico, for example, rainfall and temperature simulations are being used to replace missing data and produce long time series for estimating probabilities when building indices. In 2008 these synthetic series were used with actual (though limited) data from 75 weather stations to insure farmers growing crops on some 250,000 hectares of land (see page 49).

Rainfall modeling has a range of complexity, from simple distributions for rainfall to sophisticated algorithms that factor in climate models, multiple stations and remote sensing. At any level of sophistication, modeling rainfall accurately enough for index insurance design and pricing is challenging, and research is necessary to address the many known problems.

For many locations where index insurance could be useful, there are few or no historical rainfall data to 'train' a model, and other approaches are needed to fill the historical data gap. Satellite-based remote sensing again can be useful here (see 'Remote sensing', page 28). Satellite imagery can be used to estimate average rainfall over a pixel as opposed to rainfall at a particular point, as measured by a station. Some datasets from satellites extend back as far as 30 years, and efforts are under way to enhance these. However, even enhanced satellite data are relatively crude estimates of rainfall, and work must be done to determine whether they can be used to build sufficiently robust indices.

One way of arriving at proxy historical rainfall and losses and of complementing existing datasets is to interview farmers and experts. Currently, most pilot projects hold focus group interviews even when historical data are good, to validate the link between client perceptions and what is measured at the rain gauge. Although the data from these interviews are qualitative rather than quantitative and may have a great deal of inaccuracy, they do provide an additional source of information on historical events. Again, the issue for scaling up purposes is whether this level of interaction is necessary on a large scale, and whether it can be replicated in large-scale projects.

Seasonal climate forecasts are relevant to index insurance because they may alter the probability of losses expected on the basis of other data (see 'Seasonal forecasts', page 35). There is a danger that seasonal forecasts might be used strategically by clients, undermining the financial stability of the products. However, if insurance contracts can integrate forecasts, the farmer can take advantage of the forecast while being insured against forecast inaccuracies. In theory, insurance contract and project designers could combine the use of forecasts with that of insurance to provide price incentives for conservative behavior

Rainfall simulation

Models that simulate rainfall are very useful where there are limited actual rainfall data. Using the data that do exist, and an understanding of the variables that influence rainfall, the modeling software generates thousands of years of synthetic rainfall, which includes events that are possible but may not have occurred in the past. Thus, the use of rainfall simulators can lead to more robust contracts and pricing.

Modeling also helps improve understanding of rainfall correlations between different locations within a region. This understanding has the potential to help insurers spread risks across areas (see page 36 and 'Spreading risk' on page 37). A third role for rainfall models is to incorporate seasonal forecasts, decadal trends, and climate change into index insurance contracts (see 'Seasonal forecasts' on page 35).

There are different types of rainfall models, and they vary in complexity. Generalized linear models are the simplest, and have the advantage that they can account for climate change over long timescales. Nonhomogeneous hidden Markov models are useful because of their ability to reflect real scientific phenomena, such as regional atmospheric conditions. Nonparametric models have the advantage of more flexibly describing relationships between rainfall and other variables, because they do not rely on standard probability distributions. Finally, mechanistic models are a relatively new approach to rainfall modeling in which the occurrence and movement of rain storms and rain cells are modeled explicitly.

The uncertainty inherent in rainfall simulations is reduced where more actual data are available and used to 'train' the model. Also, as understanding improves of the variables affecting rainfall, for example, El Niño–Southern Oscillation (ENSO) effects, models will become more reliable at predicting future rainfall.

As with any tool, rainfall models and simulations have their limitations, particularly since they were not developed for index insurance design. They often under-represent the true variation in rainfall, leading to indices and prices that underestimate risk. They are also bad at representing seasonality, the beginning of a rainy season, the end of a rainy season, dry spells and other features that are usually of importance in crop losses and index payouts. Since these tools are often applied in pricing and design, research is needed to improve their performance for these types of rainfall features.

Adapted from Shirley *et al.* (2008).

in years with forecasts of bad weather, and for productive investments in years where such investments face low levels of risk (Osgood *et al.*, 2008). However, a great deal of methodology must be developed before this combination can be implemented in practice. Similarly, long-term climate trends can also be built into index products – in theory. However, the current level of technology available for updating insurance probabilities and for distinguishing between short-term processes and long-term change are in their infancy and a great deal of work remains to be done to provide workable techniques for practical application.

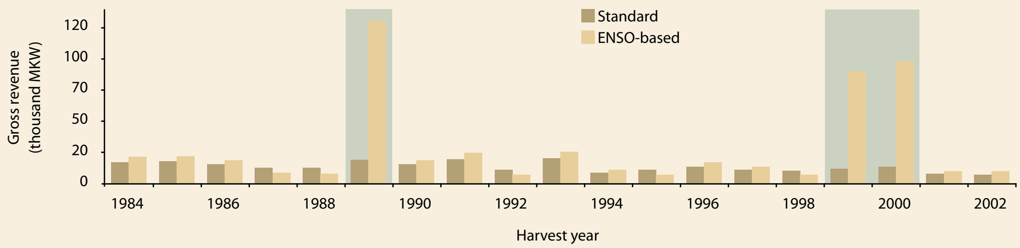
Estimating the price

The price of insurance reflects the probabilities of payouts, which are in turn driven by the probabilities of adverse weather events

Seasonal forecasts

Forecasts of the weather for the season ahead are becoming increasingly skilful, particularly in some tropical regions, and this has implications for index insurance. On the one hand, forecasts could undermine insurance schemes as farmers might decide to insure only when the forecast is for a bad season. On the other, if insurance contracts can be designed to incorporate the seasonal forecast, this could enhance decision making in response to the forecast. For example, where a seasonal forecast predicts a wetter than normal season ahead, a farmer might take advantage of the likely good growing conditions by purchasing inputs – but at the same time use insurance to protect against the lesser likelihood of a drier than normal season. In this way index insurance can help manage the uncertainty inherent in probabilistic forecasts.

The Malawi case study 'Unlocking development potential in Malawi' on page 13 helps to illustrate this. El Niño, La Niña and neutral years are identified using historical rainfall data, and insurance cost and size of the input loan are adjusted as if these had been forecast. Premiums decrease in La Niña years, when there is very little drought risk and farmers would have been able to cover a significantly larger loan. The figure shows how gross revenue can greatly increase due to these inputs in La Niña years.



This is a very simple example, and seasonal forecasts have not yet been integrated into index insurance contracts in practice (although planned contracts on sea surface temperatures in Peru will put some of the key pieces in place). More work is needed to better understand the effects of a forecast on the insurance, and especially people's behavior in the light of a forecast. Tools are also needed to help design and price insurance that integrates a forecast. Climate forecast products that can be readily applied to insurance would also facilitate integration.

Different strategies might be developed to address the issue of seasonal forecasts depending on the ability of clients to respond to the information in the forecasts. Where there is no potential to change activities in the light of a forecast, strategies include closing contract sales before forecasts are available, multiple-year contracts, or selling options on the right to purchase the insurance. But if farmers have the capacity to make better decisions based on the forecast it would be appropriate to integrate forecasts into contracts.

Rainfall simulation methods offer a way of integrating forecasts into insurance contracts. Forecasts are treated as variables, and rainfall is simulated for different forecasts. Contract design optimization and pricing can then be based on these simulations.

Agricultural systems modeling can be used to better understand how people might change their decisions in the light of a forecast. The assumption is that farmers would intensify production under anticipated favorable conditions and be more conservative under a forecast of adverse conditions. Models include additional farm-level factors that influence decision making, including farmers' goals, constraints and attitudes to risk. These models can help develop insurance packages that exploit forecasts to support farm management.

Adapted from Robertson *et al.* (2008).

reflected in the index. These probabilities must be accurately assessed so that prices are fair to both buyers and sellers and properly reflect the costs of transferring the risk. The challenges this entails have been discussed in in the previous section.

Arriving at a workable price is clearly critical to scale-up, where the aim is a product that will be bought and sold on the open market. Yet negotiating a price is particularly challenging because there is a great deal of uncertainty over probabilities. There is also intense pressure to provide products that have a great deal of coverage at a low price.

Ultimately, prices are determined through tough negotiation between clients, insurers and reinsurers. Deciding how uncertainties should be handled is thus a complex matter involving the perceptions, trust and negotiating skills of these actors. If these communications and trust are not built, large-scale projects may pose more problems than pilot projects, where the sums of money at stake are low and negotiations come under scrutiny from the international community. But even small-scale projects have had difficulties, notably in reaching agreement between insurer and reinsurer. Transparent and comprehensive documentation and improved methods for risk characterization for the reinsurer should reduce uncertainty and keep prices realistic.

Scaling up can open up options that reduce prices. From the risk-carrier's viewpoint, errors may cancel out, while aggregating and pooling risks can reduce variability for reinsurers, thereby reducing their need for a safety margin in pricing. Also, in scaling up it may be possible to access larger pools of capital, which can help cushion against poor profitability in the early stages.

In some cases, the climate itself can be sufficiently predictable to allow the price of insurance to be reduced. Particularly in the tropics, global processes such as the El Niño–Southern Oscillation (ENSO) often lead to strong spatial weather patterns. Drought in some parts of the world is often associated with ample rainfall in other regions. Experiences in the case studies show how this could work – for example, payouts in Southern and Eastern Africa typically occur in different years, linked to ENSO status. In effect, different regions can insure each other through a central pool, as the world's climate provides a natural hedge (see 'Spreading risk').

Spreading risk

Risk spreading by insurance (and reinsurance) companies makes index insurance more affordable. Scaling up will open up new risk-spreading opportunities, particularly as climate patterns and relationships across space and time become better understood.

Risk spreading across space – geographic risk spreading – is feasible where complementary climate patterns have been identified in different regions. In Africa, for example, a dry season in the eastern region is often associated with a wetter season in the southern region, and vice versa. This observation is linked to the ENSO phenomenon – la Niña events are associated with lower rainfall in eastern Africa and higher rainfall in southern Africa, while during El Niño the reverse pattern is often seen.

Insurance companies could take advantage of this pattern by developing programs that cover both regions: drought insurance contracts would be very unlikely to pay out simultaneously in both regions, thus reducing the company's risk exposure. Vicarelli (2008) illustrates the potential for premium savings through pooling of contracts from Malawi and Tanzania, while Hess and Syroka (2005) have estimated premium savings of 23% if the regions could be covered together in a single insurance portfolio.

Risk spreading may be particularly relevant with climate change ahead. Much of the damage from climate change is expected to occur through extreme events, but it is unlikely that these events will simultaneously blanket the earth; rather, they will occur in some places in some years and other places in other years, driven by processes similar to those we observe today. The global climate can thus self-insure against the risks of extremes from climate change.

From an institutional point of view, geographic risk spreading might translate into the development of large-scale (national and multi-national) risk mitigation strategies as well as partnerships between national governments and the insurance and reinsurance sector.

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is based on geographic risk spreading. Participating countries pool their country-specific risks into one, better diversified portfolio. Since natural disaster risks in any given year among the Caribbean islands are randomly distributed, the cost of coverage for the pooled portfolio is less than the sum of premiums that countries would have to pay individually for the same coverage. In practice, premiums are reduced by almost half (see 'Catastrophe risk insurance in the Caribbean' on page 52).

Adapted from Vicarelli (2008).

Climate processes, including climate change and decadal processes, have implications for pricing (see 'Climate variability and change and index insurance', page 38). For example, when analyzing climate risks, Swiss Re works to forecast future climate conditions by observing prices of weather risks that are traded in liquid markets and by modeling, such as splitting the time series into seasonal, climate change and residual variability. They also use seasonal forecasts to adjust pricing for conditions in the next few months. Increased understanding of the links between different climate systems and processes should feed into pricing in the coming decades.

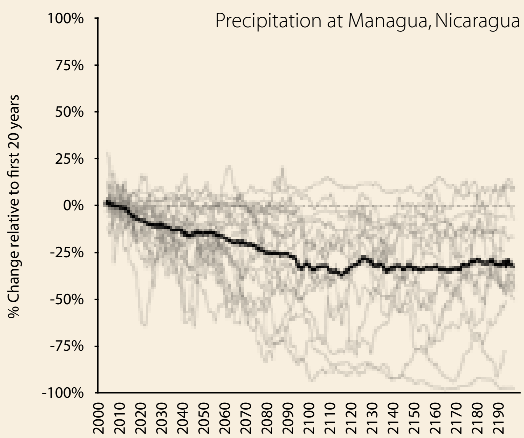
Climate variability and change and index insurance

To arrive at index insurance products that make effective adaptation tools – ones that are not undermined by climate processes – it is essential to remember that climate is more than a long-term trend. Climate is a complex system of anthropogenic and natural processes operating at yearly, decadal and long-term timescales. If climate science and index insurance methodologies continue to improve, addressing the complete spectrum of climate processes, it is likely that index insurance can be robust to climate variability and change and hence a useful part of societies' adaptation toolbox.

Today's insurance need not be built to cover a loss 100 years into the future. Instead, insurance addresses the coming year, and can therefore be adapted over time, improving as our understanding of climate improves. For a given year, short-term climate (and market) processes dominate, with long-term trends representing only a small fraction of the climate variability faced. However, over time, as the cumulative impacts of climate change start to materialize, they can be reflected in insurance in ways that incentivize gradual adaptation.

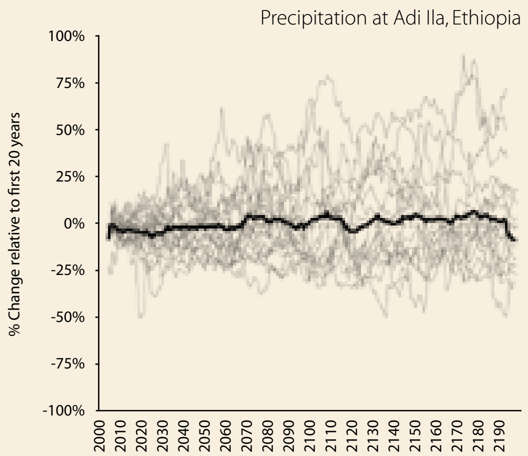
Because the dynamics of climate vary from region to region, the implications of climate processes for index insurance will not be uniform over the globe. For example, for the Sahel in West Africa, medium-term climate processes are particularly strong – more than a quarter of the variation in measured rainfall is on a decadal timescale (Greene *et al.*, 2008). In this region, it is especially important to build index insurance that is robust to decadal processes (Skees *et al.*, 2008a). For Sahel index insurance contracts in the MVP, substantial work had to be done to explore decadal scale insurance adaptation algorithms.

For the index insurance contracts in Nicaragua, the picture is different. The past 40 years of data do not suggest any trend in rainfall (Osgood *et al.*, 2009). However, climate predictions by the Intergovernmental Panel on Climate Change (IPCC) suggest that in Nicaragua there could be strong drying trends due to climate change. The figure below presents the individual IPCC models (light lines) as well as their average (heavy line) for this region. It can be seen that, over the next decade or so, the models provide little evidence of a drying trend. However, over the next 100 years, most (but not all) of the models predict a slow reduction in rainfall, roughly 0.25% per year.



Nicaragua illustrates that the timing of these processes must be taken into account when developing insurance contracts. In the near future, climate change is unlikely to affect the probability of a drought. For approximately the next decade, the yearly price of insurance can therefore be expected to be driven by year-to-year variability, because that is the climate risk faced. During this period, farmers should be able to use insurance to safeguard investments that increase their productivity. This should help them build wealth and acquire the assets needed to allow them to shift into other livelihoods if this becomes necessary. In the further future, the probability of drought increases slightly each year. As this trend unfolds, the price of the insurance should gradually increase. Over time, the cumulative rise could incentivize improvements in farming systems or a gradual transition to other livelihood activities.

For the projects in Ethiopia, the climate picture again looks different. IPCC predictions show little evidence of any trend in precipitation (see figure). If anything, the models suggest increases in rainfall. In contrast to the models, over the past decade, there are some sites in Ethiopia where the instrumental record shows decreased rainfall. This is the case for Adi Ha, where the Oxfam-led pilot is located. Here the observed trend, a decline of about 1% per year, is strong enough to have increased the insurance price.



The difference between observations and IPCC predictions is being debated by climate scientists as they work to understand what is likely to occur in the future, what is due to climate change and what is driven by other processes (Funk *et al*., 2005). Many scientists argue that the drying observed is not due to long-term climate change but is a decadal process. Research on this issue has fundamental implications for the design of index insurance and for the broader policy environment. If the drying is due to climate change, it could signal the importance of an eventual transition out of the insured activities, or of fundamental changes that enable these activities to be viable with less rainfall. In addition, if the drying is driven by greenhouse gas emissions, the burden faced by the farmers is directly due to those emitting the gases. However, if the drying is part of a decadal cycle, it will be more important for contracts to be built into climate risk strategies that protect against alternating decadal periods of drought and high rainfall.

Temperature is an additional, complicating element. There is a consensus that climate change will lead to higher temperatures in Ethiopia, as in much of sub-Saharan Africa. This anthropogenic temperature increase will increase the water needs of crops, leading to more severe and more frequent water stress. However, higher temperatures could also lead to higher yields in years with large amounts of rainfall. Thus, on top of any impacts climate change has on rainfall, its temperature impacts are likely to increase the variability faced by farmers and hence also increase the value of insurance.

Although science does not yet provide us with definitive answers to these questions, what is currently known is revealing important issues for index insurance design. Substantial effort needs to be put into advancing climate science and index insurance methods, so that these can keep pace with climate change.

Adapted from Greene *et al*. (2008).

Understanding impacts

Index insurance appears to be a promising tool for improving the management of climate risks. However, some fundamental questions about it remain to be answered.

What is the impact of index insurance on the incomes, assets and investment decisions of those insured? If there is an impact, what is its distribution in the population? Whom does index insurance benefit and for whom does it not work? How does the design of index insurance affect its impact? In summary, what role can we expect index insurance to play in development and disaster relief and how can we design index insurance for different socio-economic and physical conditions in order to maximize its beneficial impact?

To answer these questions, we need rigorous impact evaluations of index insurance programs and projects. Ideally, evaluations should be integrated into program or project implementation. Impacts of index insurance for development and for disaster management should both be addressed. Evaluation methods must be unbiased towards projects at different scales so that decisions based on the evaluations are not themselves biased.

Because insurance for development typically covers events that happen only once in five to ten years, it will be important to study impacts across different geographical areas in order to increase our understanding more quickly. While long-term data from one place will be extremely useful and would provide the most robust data for evaluation, even short-term impact evaluations – which combine analysis of limited data with models of the physical environment and of behavioral responses – can help to improve understanding. However, the limitations of impact evaluation methodology are often tested when applied to index insurance. Although it may not always be possible to disentangle the impacts of insurance from the interventions it is bundled with, it is important to at least understand the value of the bundle.

Some of the pilot projects have included evaluation, but this has usually focused on adoption rates rather than impacts, and in some cases the results have led to confusion. In Malawi, for example, researchers compared farmer take-up rates for two packages – a standard insurance and loan package, or a loan without insurance (Giné and Yang, 2007). The research project made the latter option available by itself guaranteeing the loan repayment to the bank. Take-up rates for the package with insurance were lower than for the loan only, reflecting either the fact that farmers do not expect real repercussions in case of default, or perhaps that farmers placed little value on the insurance beyond its originally intended role of giving access to credit. These findings have often been misinterpreted as showing the product to be unpopular or to have little impact, whereas in fact demand for the product was so high that it overwhelmed the project delivery resources and associated supply chains. The missing evaluation would have compared impacts between farmers who had access to loans because of the insurance and farmers who did not have access to either, so as to determine whether or not their livelihoods had improved.

In India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the World Bank conducted two large surveys with Swiss funding in 2004 and 2006, covering 1000 farmers, many of whom were repeat buyers of insurance who had started buying in 2003. The results showed that, while take-up rates had been high overall, the unsubsidized premiums to be paid up-front led to low amounts of insurance bought by the BASIX microfinance and livelihoods group, farmers and self-help groups. Thus, behavior and investment patterns did not change much. The survey also found that trust in BASIX as well as education levels mattered a great deal for the buying decision, whereas risk aversion did not matter much (Giné *et al.*, 2006). Studies of this kind will be essential in the future, to support scale-up.

Case studies II

National-level drought risk management in Malawi

Malawi provides an example of how index-based risk management can be used at the national level by governments and donors to manage weather exposure as part of an integrated and comprehensive approach to managing risk. As part of the risk management component of its Agricultural Development Programme (ADP), the Government of Malawi, with support from the World Bank and the UK's Department for International Development (DFID), initiated a pilot in October 2008 that transferred the financial risk of severe and catastrophic national drought to the international risk markets. This involved the purchase of a weather derivative contract from the World Bank Treasury, which simultaneously entered into a contract with a leading reinsurance company.

The ADP aims to strengthen maize markets in the country so that farmers and other stakeholders can respond effectively to price and production shocks. The transaction will provide predictable and early financing, in the form of a payout to the government, in the event of a severe national drought. The contract is based on rainfall measurements and does not depend on actual maize production. Payments can therefore be

The transaction will provide a payout to the Malawi Government if the maize crop in the country fails due to drought; Curt Carnemark/World Bank triggered as soon as the contract ends in April, rather than waiting for the harvest assessments in June.

The weather derivative contract is structured as a put option that is triggered by a rainfall index. The index links rainfall – its amount and distribution during the growing season – to the expected level of maize production in the country. If the index falls to 10% below the historical average, the government will receive a payout at the end of the season, up to a maximum of US$5 million. For the first trial year the sums were relatively small, but they may be increased in the future as experience is gained and the role of this tool within the government's broader risk management portfolio is better understood. The government plans to use any payout to buy an option to cap the import price of maize ahead of actual imports, potentially saving large sums of money if major imports are needed later in the year and prices on the international market rise. With future grain prices capped, the private sector is better placed to respond to domestic shortages by placing orders for commercial imports. Strengthening local market responses to production and price shocks in this way is a critical part of Malawi's overall risk management and food security strategy.

The index uses rainfall data from 23 weather stations throughout the country and is based on the government's own national maize yield assessment model. This is a water balance crop model, based on an FAO model, that the government has been using since 1992 to forecast maize production each season. It appears robust, having clearly picked up previous droughts in the country.

The World Bank Treasury's intermediation facilitated access to the international risk market. This arrangement reduced start-up costs for stakeholders and increased confidence in the transaction. The World Bank's intermediation role is temporary, and the goal is to build capacity in Malawi so as to enable future contracts to be negotiated directly between the country and the international financial markets.

Strategically, it is important to integrate an index-based weather risk management activity into a country's overall risk management strategy – that of the ADP, in the case of Malawi. Anchoring risk management activities within this type of larger investment program is critical to ensuring local ownership. Additionally, a connection with the larger investment program ensures integration with wider policy issues, while multi-donor coordination can help identify synergies with other programs and activities. It will also allow the initiative to transition from a pilot phase into a long-term, comprehensive, risk-management strategy for the government by supporting the development of an appropriate institutional framework for the optimal use of such tools over time.

A farmer-centric approach in Ethiopia

Farmers in Adi Ha; Eric Holthaus/IRI

Another index insurance pilot is being developed in Ethiopia by Oxfam America (OA) and Swiss Re, in collaboration with IRI, the Relief Society of Tigray (REST) and other partners. Still at a relatively early stage, this project is taking a farmer-centric approach, and is working to integrate index insurance with other risk reduction activities such as improved agronomic practices, conservation measures, and seasonal and daily weather forecasting. Project innovations include the extension of weather insurance to communities that are technically challenging to serve, and methods that allow cash-constrained farmers to pay for premiums with their labor.

Swiss Re's role is to review and adapt weather index insurance contracts for commercial viability and conformity to market standards. One of the world's leading reinsurance companies, Swiss Re has pioneered weather risk transfer instruments in developing countries; in 2007, the company launched the Climate Adaptation Development Programme (CADP) to develop and implement weather risk transfer solutions in non-OECD countries. OA's role is to convene the various stakeholders from the local to the global levels and facilitate a holistic risk management model. IRI provides technical expertise.

The project, which is called Horn of Africa Risk Transfer for Adaptation (HARITA), is initially targeting teff farmers in the village of Adi Ha in Tigray, with expansion to other villages and crops planned after 2009. OA and REST have been working with farmers in Adi Ha for more than a decade. HARITA began in late 2007 with visits by OA, IRI and REST to Adi Ha to explore the potential for microinsurance and gauge the community's interest in a pilot. OA commissioned an independent demand study in the community during the dry season of 2007–08. With farmers' backing, in early 2008 OA contracted IRI to draft a prototype weather index microinsurance contract, details of which are currently under review. The National Meteorological Agency (NMA) is collecting meteorological data in Adi Ha, aided by a new weather station purchased by OA and installed by NMA in August 2008.

Lack of delivery channels for reaching remote and inaccessible rural customers is often a major obstacle to offering microinsurance. To overcome this challenge, the financial institutions involved in the pilot will employ a partner–agent model. Dedebit Credit and Savings Institution (DECSI), the second largest microfinance institution in Ethiopia, will act as the insurance agent. DECSI has very extensive operations throughout Tigray, and will harness its strong community relationships and reputation to market and deliver insurance on behalf of Nyala Insurance, the primary insurance supplier.

A significant feature of HARITA is its efforts to engage farmers as partners in index insurance design. Many similar projects have struggled to engage farmers due to the technical nature of the index and time pressures to develop a commercial product in the first year. A team of five community members from Adi Ha was recruited to join the HARITA project management team. The project has conducted workshops with farmers in the village to build their financial literacy. Recently, it carried out experimental economic risk simulations ('games') with the farmers to understand their preferences for key parts of the insurance contract, such as coverage and frequency of payout.

The project is also working on ways of overcoming weather data limitations. IRI has led the exploration of new techniques to enhance sparse local datasets through a combination of satellite data, rainfall simulators and statistical tools that interpolate data from stations nearby. Satellite data will also be used to improve understanding of the correlation between rain gauge data and actual losses on farms. With this information, the project may be able to reduce basis risk by answering the difficult question of what is the maximum distance between farm and rain gauge for which the rain gauge measurement of precipitation is valid.

An advantage of this project is that it builds on established relationships. Oxfam has had a presence in Ethiopia since the 1960s, and thus has long-standing networks of trust and knowledge of the country. These relationships, together with Oxfam's history of high-profile successes in other development projects, paved the way for local partners' willingness to experiment with the 'radical' solution of weather index insurance. Other partners are also highly respected. REST has an outstanding track record in high-impact development, and communities place an unusually high degree of trust in REST following the life-saving assistance it provided to Tigray during and after the Ethiopian civil war.

The HARITA project complements Ethiopia's innovative social protection scheme, the PSNP. This reaches approximately 8 million vulnerable people, about 11% of Ethiopia's total population. The PSNP provides payments to participating households in exchange for labor to build community assets such as water harvesting structures. Such households tend to be chronically food- and resource-insecure, and are likely to be unable or unwilling to pay cash for insurance premiums, despite finding risk management highly relevant to their livelihood strategies. HARITA is exploring ways to build upon the PSNP model by enabling farmers to pay insurance premiums in kind rather than in cash. Under the scheme, farmers will have the option of working a few additional days in exchange for an insurance voucher that protects them against drought. OA's focus group interviews with farmers in communities across the country suggest that many more people may be willing to purchase larger amounts of insurance if premiums can be paid for in labor rather than cash.

Insurance for contract farming in India

In 1995, to secure its supply of potatoes for potato chips, PepsiCo started a contract farming program in India. PepsiCo distributes fertilizer, provides access to pesticides, and requires contracted farmers to use their potato seed. It also offers farmers technical advice on production practices through a network of agronomists, extension workers and local facilitators. In 2008, PepsiCo contracted with approximately 10,000 potato farmers across the country; it plans to increase that number to approximately 15,000 by the end of 2009.

Contracted farmers have the option of buying a weather index-based insurance product, which is sold by ICICI Lombard and managed by Weather Risk Management Services (WRMS). The product is intended to protect against losses caused by late blight, a fungal disease linked to temperature and humidity, and the index incorporates both of these variables. PepsiCo was motivated to add index insurance to its contract farming package in order to limit farmers' weather-related risk and establish longer term relationships with farmers.

Contract farming appears to be an effective way of involving Indian smallholders in a value chain. PepsiCo farmers produce 11–14 tonnes of potatoes per acre, compared with the average on-farm yield of 8–10 tonnes/acre. Farmers are offered price incentives: PepsiCo sets a base buyback price at the beginning of the season and offers per kilo increments according to the quality of potatoes, the use of fertilizers and pesticides, and the purchase of index insurance.

Designed by WRMS and available since 2007, the insurance pays out based on the number of consecutive days of average relative humidity greater than 90% and/or average temperatures between 10°C and 20°C. The product is designed to cover yield losses above 40%, with farmers bearing losses up to this point. Some 4250 farmers purchased the insurance in 2007, and 4575 in 2008; approximately 50% were smallholders, owning less than 5 acres (2.02 hectares) of land.

The first season of 2007 revealed a certain level of basis risk. In some locations the index showed 85% loss, whereas actual losses were roughly 50%; other locations received payouts without suffering any loss; while in still others the loss predicted by the index (45%) was less than the actual damage (50–60%). In response, more weather stations were installed near farms. In the second 2007 season, basis risk still occurred, but was reduced. Payouts matched the observed damage in two locations, though for another two the index showed lower levels than the actual losses. The first season of 2008 gave satisfactory results, primarily due to a further increase in the number of weather stations.

WRMS had installed 250 weather stations by the end of 2008, and aims to operate a total of 400 weather stations by year-end 2009. (In comparison, the Indian Meteorological Department operates 600 weather stations across India.) The cost of installing this new infrastructure will be recovered through revenue generated by the insurance program and sales of services to commercial farmers and to outlets such as newspapers, Reuters and television stations. WRMS also sends weather advisory messages and information on how to prevent crop loss directly to farmers via mobile phone. To cover all of India, WRMS estimates that an additional 10,000 weather stations would be needed, requiring an investment of approximately US$5–6 million.

The lack of historical data is more difficult to overcome, presenting a real obstacle to scaling up the program. Further challenges include designing products that balance good coverage with an affordable premium; securing delivery channels for product distribution; expanding the limited target market – limited because farmers who borrow from state banks are required to take out the government insurance; creating new indices that blend index insurance and area-based insurance; and using technology that more accurately captures weather events and trends, such as NDVI. The limited participation of reinsurers is another constraint to scale-up. Reinsurance companies are reluctant to enter the market due to the difficulty of estimating its size and their risk exposure.

Nonetheless, if these challenges can be addressed, the potential to apply this contract farming model to other crops and value chains seems high. Farmers integrated into a value chain have better potential for sustained growth in their income and improvements in their quality of life. They are also better positioned to take advantage of income-generating options that require up-front investment. Index insurance can play a key role in protecting these investments against weather shocks.

Surveys conducted by WRMS indicated that farmers trust the program for its capacity to reflect actual losses and provide timely claim settlements. Farmers also seem to have a good grasp of the likely impact of weather on yields. In many locations, farmers had calculated their claims and expected the forthcoming payouts, which allowed them to plan their future investments accordingly.

Disaster relief in Mexico

Mexico's subsistence farmers are vulnerable to both excess and lack of rainfall, as 78% of the country's arable land is non-irrigated, depending exclusively on the seasonal rains from May to November. When disaster strikes, the rural population is supported in part by federal assistance funds provided by the Climatologic Contingency Attention Programme (Programa de Atención a Contingencias Climatológicas, PACC). Paid exclusively from tax revenues, PACC is a costly and unsustainable attempt to manage risk after a disaster event.

An index insurance program for catastrophic risk was designed by Agroasemex, the state reinsurance company, with the purpose of improving PACC by increasing the efficiency, timeliness and distribution of federal funds to farmers following climate-related crop failure. The insurance is exclusively available to the federal and state governments, and it effectively transfers the risk from the government (and the Mexican tax payer) to the international reinsurance market.

PACC targets poor farmers – most of those benefiting have an income of less than US$74 per month, with none earning more than US$222 per month. Table A shows the levels of support provided through PACC for such farmers. PACC distributes support for post-disaster recovery for up to 5 hectares of land per farmer, to a maximum of US$410 for farmers growing annual and perennial crops and US$2275 for small-scale farmers growing high-value crops.

The index insurance package currently covers drought and flood (with plans to include frost soon). Insurance is purchased exclusively by state governments, or by the federal government for a specific state. Federal

Table A. PACC support to farmers for weather-related disasters

<table>
<tr><th>Type of crop/farmer</th><th>Area covered</th><th>Amount of the support</th></tr>
<tr><td>Annual/producers with less than 20 ha</td><td rowspan="3">Up to 5 ha per producer</td><td rowspan="2">US$ 82 dollars per ha</td></tr>
<tr><td>Perennial/producers with less than 5 ha</td></tr>
<tr><td>Fruits, coffee, nopal/producers with less than 5 ha</td><td>US$ 455 dollars per ha</td></tr>
</table>

Source: Rules for the Operation of PACC

funds are distributed to state governments according to the level of marginalization of the insured population: for municipalities characterized by a high level of marginalization, 90% of the insurance premium is covered by the federal government and only 10% by the state government; in less marginalized areas, federal funds pay 70% of the insurance premium.

On average over six years and across states, the premium has been 13% of the total sum insured. The insurance guarantees to pay at least the amounts promised by PACC, i.e. at least US$82 per hectare, in the event of extreme drought or flood. These funds become available to governments for distribution to farmers. However, since the insurance is contracted by the government, farmers do not participate in the decision to purchase coverage and, most of the time, are not even aware that they are insured. Agroasemex manages the program, and covers itself through reinsurance contracts. The index insurance product has been registered with Mexico's National Insurance Commission, as required by law.

The contract for drought uses a rainfall index, with triggers based on cumulative rainfall for the different crop development stages (sowing, flowering and harvesting). Triggers are highly specific to the crop, development stage and region, and are adjusted each year (Table B).

Agroasemex has indicated that the level of basis risk is low and therefore acceptable to its client, the government. However, since there have been no studies of the program's impact, it is not possible to determine how the current level of basis risk affects the smallholders who are ultimately covered by the program. There were some cases in 2005 where triggers caused payouts when farmers had not actually experienced crop damage; while the opposite occurred in 2006, when some farmers experienced crop losses but no payments were triggered. In the state of Guanajato in 2006, only one weather station

Table B. Average minimum and maximum triggers determined for drought (mm) in Mexico

Year/ Stage	Maize			Bean		
	Sowing	Flowering	Harvesting	Sowing	Flowering	Harvesting
2003	43	146	27			
2004	36–58	79–149	27–122			
2005	29–66	44–308	14–218	29–58	45–107	24–128
2006	31–66	44–351	14–218	33–58	45–107	25–128
2007	29–66	44–239	14–180	29–54	45–107	25–128
2008	29–66	49–239	26–180	26–58	45–107	24–128

out of 27 in the state triggered inadequate payouts. In this particular case, Agroasemex decided not to include this station in the following years, because it does not report on a daily basis.

In the event that the index insurance trigger fails to respond to a real loss, the government will step in and use contingency funding to cover the loss.

The program has grown considerably from 2002 (75,000 hectares and five weather stations) to 2008 (1.9 million hectares and 251 weather stations). In 2008, some 800,000 low-income farmers were covered, with a sum insured of US$132.3 million. In that year, the purchase of risk transfer instruments represented 61% of the PACC budget.

Although impressive, scale-up has been constrained by the limited number of weather stations producing useable data, and by limited technical capacity. Only half of the country's functioning 1200 weather stations have good enough real-time or semi-real-time data to build and monitor effective indices. A rural producers' association, Fundación Produce, is attempting to fill the gap by building a network of some 764 automated weather stations. When up and running, these will provide data to supplement those from government-run stations. Agroasemex is also experimenting with data from remote sensing, and in particular, incorporating the NDVI into its product.

The lack of historical data is also being addressed so that the program can continue to expand. Rainfall and temperature simulations are used to replace missing data and produce long time series as a basis for estimating probabilities when building indices. In 2008 these synthetic series were used with actual (though limited) data from 75 weather stations to extend coverage over 250,000 hectares. In 2009 a further 160 government-run stations and 100 Fundación Produce stations will be included, supported by simulated data series, allowing a further 2 million hectares to be covered.

Agroasemex is investigating expanding the program by marketing insurance to individual farmers, although delivery channels are likely to be a challenge. As a first step, microfinance institutions may serve as an intermediary. So far, the farmer-level insurance has been a fully subsidized state-run program, with no involvement of the private sector.

Catastrophe risk insurance in the Caribbean

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is unique, being the world's first multinational index insurance scheme, with 16 member countries. This spreads the risk (and costs) across the Caribbean region, making insurance much more affordable for individual countries (see figure). Since natural disaster risks in any given year are randomly distributed among the Caribbean islands, the cost of coverage for the pooled portfolio is less than the sum of individual coverages. The pooling of country-specific risks allows for a reduction of individual insurance premiums by almost half, compared with the cost if a government were to approach the reinsurance market independently.

Countries are insured against earthquakes and hurricanes, with rapid payout once the trigger (a specified level of shaking or wind speed respectively) is reached. The aim is to provide immediate cash to begin recovery efforts after a major natural disaster. In 2007, the first year of operation, contracts were designed to cover hurricane or earthquake events of a magnitude that would be expected less frequently than once in 20 years, with the exact level of cover being negotiated with the member countries individually. Contracts based on more frequent (less catastrophic)

1-in-200 year PML as a percentage of the aggregate individual country PMLs

Source: CCRIF Background Document, World Bank, 2007

Note: The PML is the probable maximum loss for a 1-in-200 year event. It can be interpreted as the risk capital requirements (including reserves and reinsurance) the Facility should hold if it is to survive such an event. The graph shows how the participation of each additional Caribbean country affects the level of risk capital needed by the Facility relative to the aggregate of the 200-year PML for each individual country. For example, the relative risk capital requirement by the CCRIF is reduced by 65% when seven countries participate. It is further reduced by 75% if the CCRIF portfolio includes 17 countries.

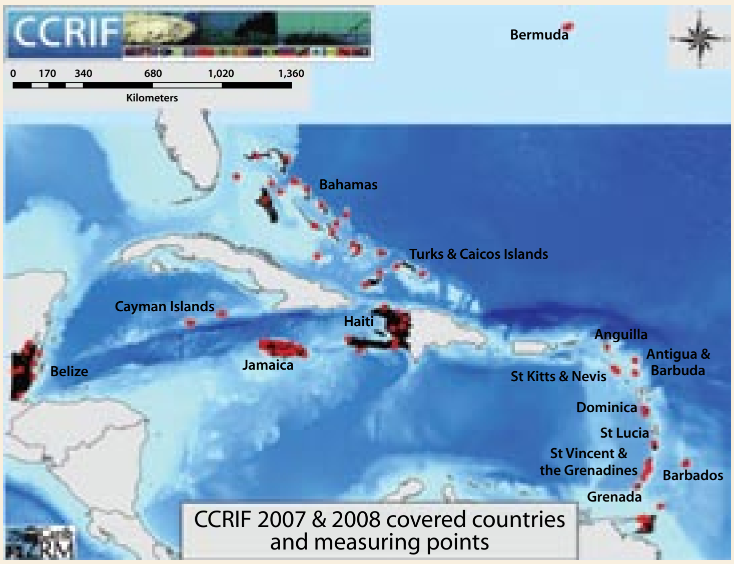
disasters would have required higher premiums than they were willing or able to pay. However, following experiences in the first year, an optional lower deductible (the part of the loss paid by the insured) was offered in the second year, taking coverage to an event that might occur once in 15 years.

The CCRIF is a not-for-profit Cayman Islands-registered insurance company owned by a Special Purpose Trust, with the participating countries as beneficiaries of the Trust. Core funding to set up the CCRIF was provided by international donors, and on joining each member country paid a participation fee. These amounts, together with income from premiums and reinsurance purchased on the international markets, provide the core capital for paying claims.

The contract

To develop the indices, catastrophe risk models were used to estimate probabilities and associated losses. Using historical hurricane and earthquake activity records and estimated losses for these past events, as well as scientific inputs, these models project hurricane and earthquake activity thousands of years into the future. With these figures, a country risk profile is created for each member country, around which indices are developed. The index for hurricanes is based on wind speed, while that for earthquakes uses level of shaking.

Over a season, the indices are tracked across the region at selected measuring points (see map). These points are weighted to give greater value to those representing areas of



greater economic value, so a country's capital and major economic centers will have a greater weight than undeveloped rural areas. This is so that the index acts as a good proxy for actual losses to governments.

Measurements are objective and transparent. For earthquakes, data from the global seismic data centre of the United States Geological Survey (USGS) are used to determine the level of shaking at the measuring points. Wind speed measurements are calculated using information published by the US National Hurricane Center (the WMO's regional reporting agency for tropical cyclones), and modeled using simplified wind models. When a trigger event occurs a preliminary calculation is made immediately after the event, but the final calculation is made 14 days later, to ensure that the best information is available from the reporting agencies. The payment for any given event is made based on a sliding scale relative to the scale of the loss. The limit of total payments to a country in a policy year is agreed with each country individually, although no country can purchase coverage worth more than US$100 million per hazard.

Experiences

In the first year that the CCRIF was operational, from 1 June 2007 to 31 May 2008, one earthquake triggered payouts. This occurred on 29 November 2007 in the eastern Caribbean, resulting in payouts in Dominica and St Lucia which were made on 13 December 2007. The earthquake also caused significant damage in Martinique, which is not a member of the CCRIF.

Six tropical storms reached hurricane status in the region during this period, but none triggered payouts. Hurricanes Noel and Dean caused the most impact in member countries. Hurricane Noel was at no more than tropical storm force when it was over member countries, so wind speeds were not excessive; however, it was accompanied by very heavy rains, which caused widespread flooding and damage in some member countries. Because the index is based on wind speed there were no payouts. The CCRIF is currently investigating adding rainfall to the product in future years. This would increase the premium, as premiums are calculated directly from the amount of risk being transferred. Obtaining adequate rainfall data, both historical and current, is a challenge, and the development of an 'extreme weather monitoring network' is proposed to support the required modeling and contract development.

Hurricane Dean affected the south of Jamaica. Because of its compact size only Category 1 winds were felt at the measuring points; and the measuring points affected were mostly in rural areas, which have low weighting. Agriculture was greatly affected, accounting for more than half the estimated costs of the hurricane, which totaled US$327 million. However, agricultural losses were excluded from the country risk profile as they do not have a short-term impact on government finances, and cover for such losses was not factored in when calculating the premium. Other losses from Dean fell within the deductible of the policy and so did not qualify for a payout. In future, the agricultural risk may be addressed through index insurance provided directly to farmers.

The lack of payouts following Hurricane Dean led to unfavorable publicity for the CCRIF and revealed a lack of understanding of the contracts and their coverage. The lesson learned here is that good communications and public relations are needed to improve awareness of the CCRIF and its purpose.

During the 2008 hurricane season, the CCRIF paid out nearly US$6.3 million to the Turks and Caicos Islands following Hurricane Ike. The payments provided much needed liquidity to the government to support the recovery effort.

For additional information see Caribbean Catastrophe Risk Insurance Facility (2008) and World Bank (2008).

Flooding in Haiti. The CCRIF may add rainfall to the product in the future, so that damage due to flooding is covered; Matthew Marek/American Red Cross

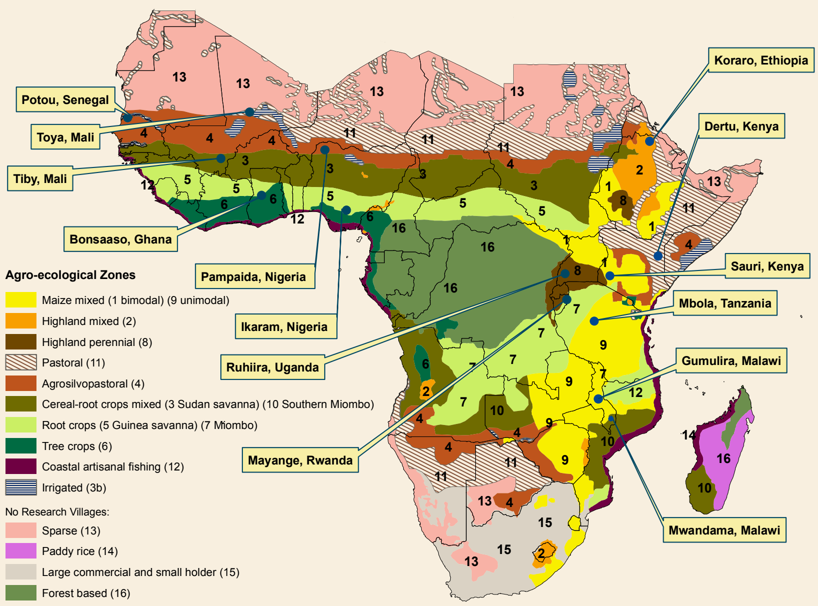
Insuring development goals in the Millennium Villages Project

At the Millennium Summit in 2000, the nations of the world agreed on a comprehensive set of Millennium Development Goals (MDGs) to reduce extreme poverty and other forms of deprivation in the developing world. In 2005, the Millennium Villages Project (MVP) was launched to achieve these goals in 12 'villages' across Africa, using an approach that combines science-based development initiatives with community participation. The sites were chosen to be representative of the continent's diverse agricultural regions (see map).

As part of this mission, in 2006 the MVP surveyed local development professionals in each village to obtain their opinions on the predominant risks to project goals. While all villages mentioned some form of climate risk as a primary threat to village livelihoods, 10 of the 12 mentioned drought as the number one long-term threat.

To manage this climate risk, the MVP has joined forces with IRI and Swiss Re to develop an index insurance scheme to insure the project's development goals. The aim of

Millennium Villages and agroecological zones.



Adapted from Dixon et al. 2001. Farming Systems and Poverty. FAO the partnership is to mitigate losses during catastrophic drought years that would otherwise lead to a major redirection of project resources and put the project in jeopardy. Payouts are tied to two risk levels – a moderate drought (defined by a 1 in 8 year trigger), and catastrophic drought (defined by a 1 in 20 year trigger). Indices have been designed for each of the 12 MVP locations, and in 2007 were transacted for three of these locations (one each in Kenya, Ethiopia and Mali).

In keeping with the aim to ensure project sustainability, it was specified that payouts from this scheme would be used to support core development interventions, such as subsidizing a school feeding program which provides a market for local farmers and encourages primary school attendance. Insurance payouts would also provide resources to replace agricultural inputs, which the project subsidizes for the local community. Thus this product aims to keep people from falling back into the poverty traps the project is working to remove.

The result is a unique development innovation. For the first time, a major development project has insured itself against a major climate risk – drought – which was identified by project participants as most likely to affect the project's achievement of its objectives. Equally as innovative, the project is working with insurance experts at Swiss Re to explore a combination index based on vegetative remote sensing and local rain gauges. The remote sensing component is used to diagnose large-scale regional drought, while data from rain gauges identifies more localized drought.

The contract

The index was designed to indicate moderate to catastrophic drought events, which recur at intervals of 8 to 20 years. The basis for the remote sensing portion of the index was NDVI, with an 8 km pixel resolution. The NDVI signal was aggregated using a spatial average of approximately 100 km × 100 km, an area roughly 100 times larger than the village. The index was designed to target the period in local cropping calendars between flowering and harvest, which showed the strongest relationship between local rainfall and historical yields (taking into account the lag time of vegetation response to rain). This large coverage area allowed the index to capture regional climate trends, which are more coherent than trends at smaller spatial scales. Research conducted by IRI showed that, for many of the MVP locations, when native vegetation shows signs of stress at this spatial scale, crop yields are typically greatly reduced.

To make the index still more robust, local rain gauge data were added in those locations which are less spatially coherent (such as humid forest, mountains and coastal ecosystems). These data were then weighted with the regional scale vegetation data to provide a greater sense of local climate variability. Regional scale vegetation only was considered sufficient to underpin contracts for the semi-arid regions of Senegal, Mali, Ethiopia, northern Nigeria and northeastern Kenya, while an index of vegetation combined with rainfall was recommended for the wetter (and less variable) climates of Uganda, Rwanda, Tanzania, Malawi and western Kenya. No drought index was recommended for villages in Ghana and southern Nigeria, as village surveys there showed a greater risk of flooding than drought.

The premiums were paid by MVP villages, through donor support.

Experiences

While none of the three transacted contracts resulted in a payout in the first year, the process of thinking through CRM strategies at the local, national and continental scale in the unique context of a major development project did provide many opportunities to refine working concepts of weather insurance and its interactions with development. In the villages that had contracts, local project managers were able to operate in a less risk-averse manner and were better able to take advantage of the good rains that were experienced, knowing that their input costs for fertilizer and improved seeds would be covered if a drought did occur. The experience also stimulated discussions of risk pooling mechanisms. In theory, for projects like MVP, self-insurance guided by CRM concepts could be an effective strategy for reducing the impact of moderate climate shocks. The project as a whole could then reinsure for high-impact climate shocks. Because the MVP is in transition from the initial donor provision of resources towards self-financing of activities, insurance strategies are evolving to reflect the changing structure of the project. This is part of a larger CRM assessment of the project. Following this transition, it is likely that the future of insurance in the MVP will be more targeted towards encouraging farmers' adoption of inputs.

The challenge of designing an index that can represent regional scale catastrophic drought was overcome by combining the remote sensing of vegetation with local rain gauge data, with weighting to capture drought impacts varying according to climatic zone.

Vietnam: Flood insurance in the Mekong Delta

An index-based flood insurance product has been offered to the Vietnam Bank of Agricultural and Rural Development (VBARD). The product is designed to pay for consequential losses that are suffered by VBARD when flooding creates problems for farmers in repaying loans. The contract is being offered by a Vietnamese insurance company, has support from a global reinsurer, and has been approved by the Vietnam regulatory authority. Flood insurance products are a challenge to develop and as such this project represents a significant contribution to the application of index-based risk transfer approaches.

Index insurance market development in Vietnam is being led by GlobalAgRisk, Inc., following a request by the Government of Vietnam for investigation of index-based solutions to agricultural risks. The project, which has received financial support from the Asian Development Bank and the Ford Foundation, seeks to expand rural financial markets by developing means to transfer

The offered product will protect the Vietnam Bank of Agricultural and Rural Development against loan defaults by rice farmers, when early flooding damages crops; Ariel Javellana/CPS, International Rice Research Institute catastrophic production risk out of agriculture. It comes at an important time of transition for Vietnam, which joined the World Trade Organization (WTO) in January 2007 – a move that is creating pressures for the country to adopt international standards on financial market behavior and regulation, including recapitalization of banks by the state.

During the early phases of risk assessment, GlobalAgRisk and local stakeholders identified flooding and flood impact on rice production as a primary concern in both the Mekong and Red River deltas. Feasibility and product design investigations have focused on Dong Thap province of the Mekong Delta, where the flood regime is influenced predominantly by upstream water flow and where delta-wide flood modeling has previously confirmed that downstream and overland flooding in the province is highly correlated with water levels measured at the Tan Chau water level gauging station on the upper Mekong River at the Vietnam–Cambodia border.

Flood occurs in the delta as part of a natural annual process that is critical for maintaining crop productivity. Rice farmers have adapted their cropping strategies to accommodate and benefit from the annual flood. However, the second season (summer–autumn) rice harvest is put at risk when the flood cycle begins earlier than normal. Early flooding leads to yield and quality losses as well as additional harvest and post-harvest handling costs. Water levels in excess of 2.5 meters at Tan Chau are known to begin causing downstream flooding and to interfere with the harvest when occurring in late June. Early flooding remains a risk despite infrastructure improvements, as confirmed through flood risk modeling and mapping which incorporates these improvements.

The financial strain on farmers from early flooding often translates into loan repayment difficulties. As a result, VBARD is exposed to significant direct and opportunity costs, or 'business interruption loss'.

The prototype index insurance contract, designed to offset these early flood-induced business interruption losses, is underwritten against recorded water levels. This is similar to weather index insurance using weather measurements at meteorological stations, but using river gauge data as a proxy for flood damage. The flood event index is calculated as the maximum 3-day moving average of daily water levels at the Tan Chau station during the period of cover, 20 June to 15 July. Indemnities are paid for each centimeter of water once the river level index reaches the 2.8 meter threshold, with maximum payout occurring when the index reaches 3.5 meters. Early flooding that exceeds 2.8 meters is empirically estimated to occur approximately 1 in 7 years, a recurrence rate that represents a commercially insurable risk.

The product was fully priced and loaded by a domestic insurance company, Bao Minh Insurance Corporation, which then sought and obtained reinsurance against its exposure from the international company Paris Re.

No subsidies were involved in the price for underwriting. A contract for a sum insured of US$1 million sum was first offered to VBARD in 2008. This represents a maximum insurable loss that is approximately 14% of the maximum possible loss. The product was offered toward the end of the sales closing period, allowing too little time for the serious consideration needed before purchasing this new insurance. It is being offered again in 2009, and VBARD is currently assessing the option to purchase.

The accomplishments of this project – (i) designing a unique index-based insurance against flood in a developing economy; (ii) accessing global risk capital through reinsurance against the early flood risk; and (iii) achieving regulatory approval of the product – represent considerable advances that will benefit index insurance development worldwide. This project also illustrates the limitations of developing a product for a single client – in this instance VBARD, which is still partially publicly supported and can be recapitalized by the government in the case of portfolio and business interruption losses. Thus, the main motivation for participation hinges on a desire to demonstrate leadership and to learn how to assess and manage risk exposure using new financial products, with an eye to the future.

Several additional investments are needed to continue the development of this insurance product in Vietnam. First, considerable education and outreach is needed to create greater stakeholder recognition of residual flood risk, even in the presence of improved infrastructure. Second, a next step in the regulatory process is to investigate whether these forms of index insurance product can serve as a type of credit warranty that reduces the level of required reserves. Finally, the meso-level product, while a stand-alone policy, is a first step toward finding workable solutions at the micro-level, since even if the bank is protected, very careful thinking is still needed on how to deal with bad debt. While rescheduling debt rather than debt forgiveness improves the commercial viability of VBARD, rescheduled debt does little to help financially stressed producers – the primary target market of VBARD – recover from a natural disaster.

Scaling up index insurance: Operational issues

This section examines critical operational issues that could frustrate the scaling up of index insurance if not addressed. Our discussion is drawn from the pilot projects, whose community of implementers has acquired considerable experience of these issues. Here, we draw attention to the main issues, while more detail can be obtained directly from the implementers (World Bank, 2005; Hess, 2007; UNDESA, 2007). We have structured the discussion according to broad headings that capture the main recurrent themes: demand for index insurance products, local ownership of products, legal and regulatory issues, and the complex question of subsidies.

Demand for the product

Demand for index insurance is the most fundamental issue confronting scaling up efforts. For a product to be successful it must be worthwhile, address an important risk to the clients and basis risk must not be too high.

Index insurance is not a viable proposition in all situations. Also, it is essential that client

Groundnut farming in Nicaragua (see case study on page 72); Eric Niu expectations are reflected in product design. It is therefore important to perform basic risk assessment exercises prior to designing a product, and to undertake demand assessments of product prototypes to determine if they address demands and expectations, and how they might be improved to be more effective (UNDESA, 2007). WFP, for example, carried out a large-scale demand assessment including a survey of target client risk perceptions and needs. Clients must be active participants in the development and implementation process.

To ensure that demand is sustained, products must be adapted and improved as implementation proceeds. Several of the case studies modified products after dry runs or in response to initial performance gaps. In the Caribbean CCRIF case, for example, changes to the index are being considered to better capture flooding risk associated with hurricanes (see 'Catastrophe risk insurance in the Caribbean' on page 52). Validation and robustness investigations begun during contract design must be continued during implementation, with improvements made in response to the issues uncovered. This is particularly important in places like India, where there are competing index products being offered by different companies, which have payouts under different conditions.

To be worth buying, the insurance must represent a value proposition to the client, that is, the product must be seen to yield a benefit that exceeds its cost. When subsidies are being considered for index insurance, it needs to be established whether the benefits exceed the *unsubsidized* cost. If they do not, it is likely that the product does not address an important need and that the subsidy money would be better used in other ways.

When evaluating demand it is important to consider other interventions that may be available, for example subsidized crop insurance, bank credit guarantees or relief programs. These will often reduce the demand for index insurance. The case studies in Nicaragua, Malawi, Ukraine and India all faced challenges of this kind (see 'Central America – a different approach for launching index insurance' on page 72 and 'Barriers to implementation in the Ukraine' on page 74).

The insurance must be affordable. Index insurance should not be used to insure against high frequency risks with big losses, since the pure risk cost is likely to be too high. The cost must also be competitive with the alternatives for managing the risk.

Weather index insurance makes sense only where weather is one of the major risks confronting households, banks or relief agencies. In many cases market risks may be greater for farmers and bankers, while the risk of war or conflict may be greater for relief agencies.

Local ownership and capacity

Insurance markets

When projects seek to address the needs of the poor, it is essential that local partners have strong ownership from the outset.

Implementations that are not championed by local institutions cannot gain the traction necessary to have meaningful impacts, scale or be sustained. At the scaling up stage, it is vital that local markets are strong enough to support widespread implementation. However weather insurance markets are virtually non-existent throughout the developing world, and other markets are weak as well. Unless addressed, this limits the scope for local partners to participate.

India forms a marked exception, with local markets well developed in urban areas and even in some more remote rural areas (see 'The private sector builds a market in India' on page 76). Indeed, much of the dramatic scaling up of index insurance in India is due to the dynamism of local markets. Highly active brokers have strong ownership of the products they offer, competing keenly with each other to reach the farming community with affordable and attractive products. There is a high level of local expertise due to the government's historical mandate that micro-insurance be made available in rural areas. Thus, the starting point in developing weather insurance markets is often to lay the knowledge foundations.

In India, BASIX take the message to farmers in mobile units; Sridhar Reddy/BASIX

Skills

It can be challenging to find good contract designers at the international level – such people must combine mathematical skills with a knowledge of climate science and experience with agro-meteorological models. At the local level, this challenge is even greater. In addition to specialized index design skills, local partners need insurance selling skills. These need to be especially highly developed in areas where weather insurance products are new and have to be explained to the farming community. All this means that public investment is vital at project start-up, to ensure the necessary knowledge and skills are firmly established by the time scale-up gets under way. This has been forthcoming: the World Bank Climate Risk Management Group and World Bank Institute have developed training courses to build capacity in the wide range of tasks necessary in index insurance; they have also created online contract development tools in partnership with IRI and others. Despite these efforts, more needs to be done if scaling is to be developed and sustained.

Delivery channels

Closely related to the issue of local ownership and capacity is that of delivery – the challenge of making sure that the farming community knows about index insurance products and has access to them. This challenge is the same for all types of agricultural insurance and other financial products targeting rural farmers. Many projects have relied on intermediate institutions to overcome this challenge. When these institutions are involved, it is important their staff have a thorough understanding of the insurance product, are able to market it with enthusiasm, and are competent at handling the complex financial transactions it may involve.

In Ethiopia the development of cooperatives is being strongly encouraged by the government as a means to facilitate service delivery for agricultural inputs, extension advice, processing and marketing, and to improve the ability of farmers to market their products. This avenue was used to reach farmers with index insurance products (see 'Laying the foundations for farm-level insurance in Ethiopia' on page 79). In Brazil, insurance providers are taking advantage of a network of distribution points under a government seed program (see 'Supporting farmers – and a government seed program – in Brazil' on page 82).

A new delivery concept for index insurance in disaster management is the early recovery assistance voucher. These vouchers are intended to achieve more timely and better targeted recovery support for those affected by natural disasters such as droughts, floods or hurricanes. Still in the proposal stage, the concept is that vouchers would be distributed to people in vulnerable areas ahead of disasters and would be redeemable after them. A voucher would give the right to, say, US$200 worth of food or cash at local shops, trading stations, post offices and other public outlets. When eligible people obtain vouchers they would also be able to register their residence and leave their cell phone number to receive localized early warnings as well as payment notifications (Hess and Portegies, 2009).

Risk takers

Risk takers – local insurance companies willing to underwrite index insurance contracts or intermediate the risk to the international market – are essential. Given that index insurance is a nascent industry, insurance companies must often build expertise at the same time as they implement pilot projects, a factor that increases the level of risk they face in the short term. Some of the pilots have taken 'dry runs', which allow for the company to gain experience and trust and for contracts to be adjusted before the product is launched 'for real' on the open market (see 'Stakeholder communication is key in Thailand' on page 85). Government policies, such as those in Ethiopia and India, which stipulate more emphasis on microinsurance products or support a range of agricultural insurance options, may encourage risk takers to get involved. However, in some situations they may have the opposite effect, either by crowding out index products through other interventions or by creating administrative burdens that risk takers may not be comfortable carrying.

Data

Constraints concerning the measurement and validation of data, which are key design issues, must also be actively addressed during the operational phase. The Agricultural Insurance Company of India (AIC), for example, conducted a study of paired automated weather stations operating on the same premises across a range of zones, to test the reliability of data. It found significant short-term differences between the stations. If these differences cause problems for the insurance products, either the products need to be improved or the data measurements must become more accurate (see 'Scaling up in India: The public sector' on page 87).

Measurements must be reliable, timely and resistant to tampering, with fallback options formally specified when there are data problems. Capacity building may be needed to ensure that these criteria are met. And local meteorological stations and the national meteorological service must be included in the list of national partners needing to take ownership of index insurance projects. This can be difficult to achieve where already overstretched national services do not see the project as a priority. Data issues are discussed in detail in the previous section.

Trust

The importance of trust is a theme running through all the pilots. The glue that binds partners together, trust is a vital element in the willingness and ability of local providers to take projects over and continue them after the pilot phase. Because the relationships between players often become strained during the intense interactions that can take place over insurance, these relationships must be underpinned by substantial levels of trust, which tends to be stronger if established through collaboration that predates the insurance project. In the India contract farming case study, surveys indicated that farmers trust the program because of its timely settlement of claims (see 'Insurance for contract farming in India' on page 47). This is consistent with the experience of BASIX, a microfinance institution that first introduced rainfall index-based insurance to farmers in India together with the International Finance Corporation (IFC) of the World Bank (see 'The private sector builds a market in India' on page 76). Oxfam's long-standing presence in Ethiopia, combined with high levels of respect and trust for the local partner NGO, the Relief Society of Tigray (REST), made farmers willing to explore weather index insurance (see 'A farmer-centric approach in Ethiopia' on page 44). Feedback from Thai farmers suggested that the primary motivation for purchasing insurance was trust in the Bank for Agriculture and Agricultural Cooperatives (BAAC), an institution that has long-term relationships with the farmers (see 'Stakeholder communication is key in Thailand' on page 85). The

Building trust is critical; Janot-Reine Mendler de Suarez/GEF-IW:LEARN

lesson is clear: identifying partner organizations that farmers already trust is critical to successful scale-up.

Legal and regulatory issues

Often legal and regulatory frameworks must be developed or improved so that they address the new issues raised by the introduction of index insurance. The International Association of Insurance Supervisors (IAIS) has yet to produce guidance on how insurance laws, regulations and practices may need to be adapted to ensure that index-based insurance is regulated and supervised in accordance with international standards. However, a number of pilot projects have shown that index insurance can fit within existing national legal and regulatory frameworks while at the same time adhering to the basic principles underlying international standards. Regulators are generally supportive of efforts to develop index insurance once properly informed about its potential social benefits. They are also much more comfortable when they know that other countries have successfully developed contracts for this new class of insurance.

In general, regulators have two primary responsibilities. First, they must protect the consumer from any form of misconduct that can emerge when this new form of insurance is developed and sold. Second, they must protect the insurance provider from the financial exposure that can follow when offering insurance against events that have highly correlated losses, requiring many payouts in the same year (Skees and Collier, 2008). By doing the latter, the regulator is also ensuring that the consumer will be paid when he or she does suffer losses. A central mechanism for this protection, found in most of the case studies, is the purchase of reinsurance from international markets. The Mongolia case study shows an alternative way of providing protection, using donor support (see 'Livestock insurance in Mongolia' on page 90)

One significant regulatory issue is whether index products should be classified as derivatives or insurance. Insurance contracts are intended to cover losses, whereas derivatives are purely finance market contracts. Derivatives are financial instruments whose values are derived from the value of something else (known as the underlying value). The underlying value can be an asset, an index (e.g. interest rates or exchange rates), weather conditions or other items. The option taken depends on the application.

For programs aiming at development, insurance is the preferred classification as it is simpler to regulate. This is because the regulatory framework for insurance is well suited to protect the interests of a large number of smaller clients, with regulations focused not only on honoring contracts, but also guaranteeing protection against losses. It is also a widely accepted financial instrument, often with existing delivery chains that currently reach intended clients.

Derivatives are more common as negotiated deals between two large entities, each with a substantial capacity for analysis. Because of this, disaster relief contracts are typically transacted as derivatives.

The laws of most countries require that, to be considered insurance, a risk transfer product must have certain key characteristics. The two characteristics that offer the greatest challenge for an index-based product are: (i) an insurance contract must indemnify or compensate the insured for loss sustained due to the occurrence of the insured risk; and (ii) the insured must have an insurable interest in the subject insured. If the index is a sufficiently good proxy for the loss, there is a clear link between loss and payout and the first condition can be satisfied. Although there may be some basis risk, this is also the case for traditional insurance products, even where the loss is assessed by a loss adjuster (Barnett *et al.*, 2005). In some cases, framing the index insurance product as a form of business interruption insurance also eases the regulator's concerns about basis risk, by allowing the insurance to target risks it can cover more transparently. The second condition is less of a challenge when products are developed with exposed users in mind as it is relatively easy to make the case that the insured has an insurable interest. In some cases, limits may be needed on the sum insured, so as to ease the regulator's concerns that users might take on larger financial commitments due to the availability of insurance and thereby increase their risk exposure rather than reduce it. The second condition can make it challenging to offer insurance to laborers or merchants who do not own cropland but who are impacted by the crop losses of others.

Regulators should be involved from the beginning of the product development process, as specific aspects of the contract design may determine whether or not it meets regulatory conditions. Likewise, if contingent capital is required, potential reinsurers should be involved in contract design to make sure that the risk can be transferred into reinsurance markets.

The challenge of subsidies

Issues surrounding subsidies are very different for the two major kinds of application – disaster relief and development. Since disaster relief programs are themselves funded by subsidies, the insurance is simply a financing mechanism to make more effective use of these subsidies. Responsibility for addressing the subsidy-related problems of distortions, delivery issues and perverse incentives falls to the relief program as opposed to the index insurance provider.

When the objective is to address poverty and development, the very poor may be excluded because they cannot afford risk-based premiums. Some therefore argue that premiums should be subsidized, so that a higher proportion of this group will be reached. However, when insurance is part of a package that promises significant income gains – for example, a package that includes credit and inputs – subsidies may be less justified. When an inability to pay is not a problem of insufficient wealth or productivity but instead a cash constraint at the beginning of the season, loans that cover the premium as well as the inputs may be the answer, not subsidies.

It is important that the insurance leads to societal benefits that exceed its opportunity costs; that is, the benefits that would have accrued had the subsidy been used differently. Once participating households have achieved higher levels of productivity, the subsidy should be withdrawn. Proponents argue that premium subsidies can thus be used to channel social benefits to the poor in a structured and controlled way.

Another argument for subsidies is that they 'prime the pump' for insurance markets by offsetting high start-up costs until the market expands, economies of scale are realized, and prices decline. In this approach, the government or donor guarantees the deficit in the initial years, thereby instilling confidence in the insurer and allowing time for the insurance-buying habit to become established in the farming community. The premiums can gradually be brought into line with 'commercial reality', turning the deficit into a profit. It would be foolish to experiment with a product that is not priced to the risk, but it does make sense to exclude the development costs and to predicate the economies of scale and the benefits of reinsurance that will apply only once a scheme is fully scaled up.

It is also argued that premium subsidies can stimulate adoption by encouraging farmers to use insurance and learn about its benefits (World Bank, 2007). However, care should be taken to ensure that subsidies are *not* used to encourage the adoption of ineffective products.

There is a significant school of thought that directly subsidizing premiums distorts the insurance process and makes it counterproductive, encouraging people to engage in overly risky behavior (Skees *et al.*, 1999; Siamwalla and Valdes, 1986). Opponents of direct premium subsidies note that farmers may take out insurance because it is cheap rather than because it targets a risk they are facing. Subsidies may directly challenge the development objectives of index insurance. Because the common mechanism for direct premium subsidies is to make them a percentage of the premium, subsidies tend to be captured by the imprudent or those who take out large amounts of insurance simply to obtain the subsidy, eroding the poverty objectives of index insurance. Also, it may become more difficult to obtain client feedback to determine if a product is useful if the client is merely seeking a subsidy. Finally, subsidies may encourage clients to over-insure, which can lead to insurance that increases the level of income variability, making the insurance payments the source of variability instead of the crop loss.

As an alternative to direct premium subsidies, governments and/or donors may agree to pay for the most extreme risk layers, covering catastrophic losses, while other layers of risk are covered by the commercial market (World Bank, 2005; see also 'Livestock insurance in Mongolia' on page 90). For example, for an extreme rainfall insurance contract, the commercial sector may set an upper limit, with the government and/or donors covering the risk above that limit. Using this approach, a commercial layer of risk can be fully priced to allow the insurance market to expand. Should the cost of covering the subsidized catastrophic layer of risk become too great, a commercial market would stand a much greater chance of remaining in place when governments or donors decide to abandon the subsidy. The balance between direct relief, insurance and hybrid approaches is complex. For example, there are arguments that providing the poor with post-disaster assistance directly may be more distorting than subsidized insurance (Bayer and Mechler, 2007).

Governments need to consider carefully whether subsidies for insurance are the most cost-effective option for achieving the desired social objective, compared with such alternatives as food aid, better extension services and cash transfers (World Bank, 2007). Whenever possible, it is important to use a subsidy to remove the cause of a high premium instead of subsidizing the premium itself.

Instead of direct subsidies, governments and the donors could also invest in making the provision of insurance more efficient and effective, by, for example, creating new weather stations, setting up weather index insurance standards, providing technical assistance to the insurance sector, extending delivery mechanisms, benchmarking and evaluating impact, building capacity and raising awareness of insurance. There is a public good problem in establishing the initial products and infrastructure associated with insurance. It is expensive to create a new product and the infrastructure to support the product. And it is difficult for a private firm to recoup these expenses, since competitors may use both the product and the infrastructure as a basis for developing and offering their own products without having to pay the start-up costs. Because of this free rider problem, there is a role for subsidies to cover many of the costs associated with initial product development and the introduction of pilots.

If the premium itself must be subsidized, the subsidy should be used primarily to reduce excess premiums due to data uncertainty. It should not be so large that it reduces the premium below the actuarially fair cost of risk (World Bank, 2005).

Damage following Hurricane Ike; Marko Kokic/ International Federation of Red Cross and Red Crescent Societies

Case studies III

Central America – a different approach for launching index insurance

Different strategies have been pursued to explore the best approaches for launching development-oriented index. These strategies have included directly approaching smallholder farmers, or approaching contract farming corporations that work with smallholder farmers. In Central America a third strategy has been followed. Instead of beginning with smallholder farmers, insurers worked first with medium- and large-scale farmers to quickly build a commercial product that can later be extended to a wider clientele, including small-scale farmers. In addition, this project was a collaborative effort involving several countries in the region, encouraging the spread of ideas and the pooling of efforts. These efforts were combined with a great deal of capacity building, with strong leadership from local insurance companies.

Projects in India and Mexico aroused interest in index insurance in Central America, and the Latin American Federation of Insurers asked the Commodity Risk Management Group (CRMG) of the World Bank to explore opportunities for supporting insurance market development in the region. A regional workshop held in Guatemala in May 2005 attracted participants from all countries in Central America plus Mexico. Building on this enthusiasm, the World Bank formed a partnership with the Inter-American Development Bank and the Central American Bank for Economic Integration and began financing activities to strengthen the agricultural insurance market. Among these activities were training, work on regulatory issues, efforts to improve access to reliable weather data, and the launching of pilot index insurance projects in Nicaragua and Honduras. The Nicaraguan pilot began selling contracts in 2007, while the Honduras pilot is still at the development stage.

In Nicaragua, the project team worked from 2005 to 2007, laying the foundations for the pilots. The team consulted widely, began building stakeholder interactions, and started capacity building among the primary partners, particularly the public Nicaraguan insurer, the Instituto Nicaragüense de Seguros (INSER), which agreed to be the implementing partner. At the same time, CRMG and IRI worked on technical aspects of the contracts. Nicaragua has good and accessible weather data, which facilitated the progress of the pilots. The national meteorological service was supportive, providing data for the indices.

Initial design activities were not consciously targeted to large farmers, but these farmers demanded the products and provided enough data to tailor the products to their needs. Because of the scale of the farmers, the information available was substantially different to that in a pilot focusing solely on smallholders. Farmers had multiple plots at different distances from the weather station. They measured precipitation at each of their plots, and had computerized records of rainfall and historical yields, allowing them to directly validate and provide feedback on index contract options. Their data and feedback led to the possibility of addressing risks that are more challenging to model than drought, such as excess rainfall. In addition to the feedback offered by these farmers, the farm size helped jump-start the index insurance by providing a larger, more viable base for the project.

In 2007 INSER sold two contracts to groundnut farmers, protecting an area of 181 hectares, with average premiums of 4.9% of the insured value. The contracts were offered for any combination of three weather risks: (i) excess rainfall at sowing; (ii) drought during growth; and (iii) excess rainfall during harvest. The contracts were designed with a flexible start date to accommodate areas with different sowing periods. The contracts triggered payouts and INSER paid indemnity losses equal to approximately 32% of the total premiums.

In 2008 INSER sold 12 contracts for groundnuts and four contracts for rainfed rice, protecting a total area of 1,774 hectares, with premiums averaging 5.5% of the total insured sum of US$1.7 million. Contracts for both crops covered any combination of the three risks above, plus rainfall excess throughout the season, with a flexible start date. Due to unusually heavy and prolonged rains during the country's 2008 growing season, INSER received claims equivalent to 86% of the total collected premiums for groundnuts.

Though insurers' profits for both years have been small, INSER believes that the contracts have provided an excellent demonstration and primed the market for the next season, when it plans to launch a more aggressive marketing campaign for the products. The expectation for the 2009 season is that approximately 400 farmers will participate and 16,000 hectares will be covered, to a total value of up to US$10 million.

As anticipated, the project has attracted interest from the Ministry of Agriculture and the Fondo de Credito Rural (FCR). In the coming years, FCR plans to work with INSER to bring index insurance to some of its small-scale farmer clients.

Barriers to implementation in the Ukraine

An index insurance pilot project in Ukraine in 2005 built on some good preparatory work, but sold just two contracts and has not been continued. Reflecting on the experience, several key obstacles are evident. The insurance industry in the country was not 'ready' for the new product and was therefore not sufficiently engaged. The index product was competing with a subsidized crop insurance program. Regulatory hurdles limited the product to direct coverage of individual farmers only, eliminating potentially successful options involving the targeting of other groups, such as agribusiness and finance institutions. There may, however, be a role for index insurance in the future in Ukraine, particularly as farmers move towards growing more high-value crops.

Planning and preparation

A role for index insurance was proposed because of the weather risks to agriculture in the country. Multi-peril crop insurance was available, but the loss adjustment procedures were unclear and payouts were often delayed for up to 6 months.

The pilot project team consulted six insurance companies, but only one – Credo-Classic – agreed to join the project; the others cited lack of funds for the development of new products and a desire to focus on the government's subsidized crop insurance program.

Partners in the project team included the World Bank's CRMG, Credo-Classic and the IFC's Agribusiness Development Project. Starting in 2003, the team worked to develop an index insurance contract. It carried out extensive consultations with stakeholders, including farmers, local officials and scientists. Approximately 400 producers were questioned during stakeholder events.

The pilot site was chosen around two weather stations, at Kherson and Behtery. Weather data were provided by the Ukrainian Hydrometeorological Center (UHC), which maintains 187 weather stations across Ukraine. Historical weather data were available for the past 30 years. UHC also provided a vegetation and risk-sensitivity report for grain crops (wheat, rye and barley). Computer simulation models were carried out, and consultations with farmers revealed that they were most concerned about the period from early May until mid-June, when high temperatures and lack of rain could damage grain crops.

Based on this work, the team developed an index insurance contract to protect grain crops from drought. The contract covered the period 15 April to 15 June and captured low rainfall as a cumulative amount over the period (less than 70% of the normal 80 mm). Another contract was developed to capture high temperatures (+30°C or excessive accumulated temperatures).

Problems

Marketing was in the hands of Credo-Classic, but unfortunately the company did not register the index insurance product until the end of March 2005, which did not allow sufficient time for effective marketing. The insurer managed to sell only two cumulative rainfall contracts for Behtery and none for Kherson. However, it should be noted that the company sold only six of the multi-peril contracts in the same season. Also, regulations in Ukraine mean that only primary producers of agricultural commodities can purchase index insurance; the product could not, therefore, be marketed to input suppliers, processors or loan providers to insure their agricultural portfolio.

More problems followed. The insurance company decided to extend the coverage to 30 June, but they made no recalculation of the product and did not notify the other partners on the project team. The total amount of rainfall during the new contract period, 15 April to 30 June, was 81.8 mm, which is close to the 30 years' average (87 mm), so the farmers received no payouts. However, the weather station at Behtery recorded very low rainfall in April, May and the first half of June, with most of the rainfall occurring in the second half of June, when the farmers did not need rain. In fact, the last day of June delivered 27 mm of rainfall and this strongly affected the index value.

Thus this pilot project was not a success for several reasons, including competition with other products, lack of awareness of index insurance among insurance companies, insufficient marketing, and lack of expertise to manage the contract properly. But there is still potential for index insurance in Ukraine, if these basic obstacles – and some others, such as too few weather stations and charging for weather data – can be overcome. The agricultural sector is developing rapidly, and the insurance products currently available do not meet the needs of producers. The country has generally good quality data on weather and crop yields, and scientific and practical expertise that could be applied to developing index insurance. National legislation is in place to facilitate insurance for agricultural applications. There is also interest from the government in catastrophe risk management through index insurance.

The private sector builds a market in India

Index insurance was offered to farmers for the first time in India in 2003 by a private insurance company. Since then, both the private and public sector have developed index insurance programs, and several of these have scaled up and out, with a total of more than 2 million clients across the subcontinent.

ICICI Lombard General Insurance Company – a joint venture between one of India's largest banks and a large Canadian financial holdings company – piloted the country's first rainfall insurance product in the state of Andhra Pradesh, with support from the World Bank, the IFC and BASIX – a Hyderabad-based microfinance group of companies that aims to promote sustainable rural livelihoods through financial and technical services (Hess, 2003). Reinsurance was provided by the ACE Group, an international reinsurance company. The insurance was sold to 154 groundnut farmers and 76 castor farmers. The pilot was characterized by intensive interactions with clients, both to help them understand the product and to get detailed feedback from them after the first season, in order to improve the product. Over the next few years there was a steady increase in contracts sold, until 2006 when 11,500 customers bought the insurance. The product evolved over this time, and in 2005 a generic product was introduced to cover a range of crops. This simplified product was easier to explain to clients, reducing costs and time for the insurance company. In 2007 the minimum sums that could be insured were increased to reduce the number of very small contracts and thereby reduce costs. This also reduced the number of farmers reached but made the program more sustainable. Sales subsequently recovered, with more than 9000 contracts sold in 2008.

Several other private insurance companies followed ICICI Lombard and introduced similar index insurance products in India. For example, IFCCO-Tokio, another joint venture insurance company, launched several products in 2004, selling more than 3000 policies to farmers that year, and increasing to over 46,000 farmers in the 2008–09 season. ICICI Lombard has expanded its program through a number of partnerships, for example with the Indian conglomerate ITC Ltd, which allowed it to sell policies through ITC's *e-choupals* (Internet kiosks). ICICI Lombard also joined forces with the government of Rajasthan to launch a program in that state in 2004, insuring 783 orange farmers and 1036 coriander farmers from insufficient rainfall. One program linked weather insurance policies to seed sales, whereby the seed costs would be refunded to the farmer if there was insufficient rainfall during the germination period. All this was scaled up to include more crops and farmers in 2005. ICICI Lombard's

Index insurance was first offered to farmers in India in 2003; Ray Witlin/World Bank

agricultural weather insurance sales reached approximately 108,000 farmers in 2006, and currently (in 2008) covers around 45,000 farmers.

The private sector now offers contracts across many states, for many crops, covering many agricultural problems: insufficient rainfall, excessive rainfall, extreme temperatures, weather-linked crop diseases, fog and humidity. Most contracts use a simple index linking the weather parameter the production shortfall. The reinsurers Swiss Re, Tokio Marine, Endurance Re and SIRIUS Re as well as hedge funds have been all participating in the market.

Farmers have seen some benefits of index insurance over the government's conventional crop insurance, which is offered through the National Agriculture Insurance Scheme (NAIS) – but also some drawbacks. Claims are usually settled within 45–60 days of the end of the contract, which is significantly faster than payouts from NAIS. However, basis risk has been a problem because of the limited number of weather stations and insufficient weather data. To address this, private data providers have set up over 500 automatic weather stations on behalf of insurance companies, across the country. However, the network needs to be substantially increased if weather index insurance is to be offered widely (see discussion below).

Another problem was that premiums for private contracts were not subsidized and were therefore higher than for NAIS contracts (6–14% of the sum insured versus 2–3.5%). To address this price discrepancy, in 2007 a few state governments began subsidizing index insurance products offered by private insurance companies, paying 40–50% of the premium. The subsidy applied only to products bought by farmers voluntarily and not to products bundled with loans. In 2008 the Government of India also began making subsidies available to private weather index insurers, in addition to channeling subsidies to the public Agriculture Insurance Company (AIC), which had also started selling weather index insurance. These subsidies will likely increase uptake significantly from the current level of around 150,000 farmers annually.

Distribution channels have been key in the scale-up of these projects. The private insurance providers have joined with partners such as companies involved in contract farming or agricultural input supply in order to take advantage of their existing links with farmers. IFCCO-Tokio, for example, sells the bulk of its policies through the extensive cooperative network of its parent company, IFFCO Fertilizers. ICICI Lombard has worked with ITC as described above, taking advantage of ITC's Internet kiosks. ICICI Lombard is also working with contract farming operations such as that of PepsiCo for potatoes (see page 47), to take advantage of their well-established distribution networks.

The BASIX and PepsiCo programs, together with a Bt cotton seed program, are all private unsubsidized index insurance programs that have successfully targeted small-scale farmers, have proved sustainable and have scaled up to some extent. According to BASIX, the main reasons for its success are: (i) efforts during the pilot stage to work intensively with clients at the village level, to raise awareness and improve product design; and (ii) strong delivery channels, enabling it to reach small-scale rural clients (in 2007 BASIX had 1281 staff in more than 10,026 villages in seven states across India).

The BASIX program has identified the following needs for further expansion of the insurance market in India:

- Provide subsidized premium financing to farmers, to ensure that cash-constrained smallholders can participate
- Develop a multiyear continuity plan to ensure speed and energy in business expansion
- Build partnerships with multiple insurance companies to overcome the underwriting limitations incurred by reliance on a single company
- Increase investment (both private and public) in the network of weather stations throughout the country, especially in rural areas
- Improve product design for better correlation between indices and crop losses; yet ensure products remain simple enough to be understood by farmers and other stakeholders.

Laying the foundations for farm-level insurance in Ethiopia

Feasibility research was carried out in Ethiopia on index-based weather insurance for farmers, starting in 2006. This work, carried out by the World Bank's Commodity Risk Management Group (CRMG), included a small farmer-level pilot program, and aimed to determine if the basic conditions were in place to implement micro-level weather risk management more widely. As part of this work, CRMG joined forces with the Ethiopian Insurance Corporation (EIC) to develop and implement a small pilot to protect small-scale maize farmers against drought. These feasibility studies also laid the foundations for future index insurance work through local awareness raising and capacity building.

Feasibility study

CRMG's feasibility research focused on the three areas that were believed, from previous experience, to be the main prerequisites for implementing an index-based weather insurance program. These were (i) weather data and analysis of where index-based insurance might be feasible; (ii) identifying a risk taker to underwrite or intermediate the insurance contracts; and (iii) finding a company or institution to deliver the contract to farmers.

Ethiopia has some 600 weather stations, which are controlled and monitored by the National Meteorological Agency (NMA) in Addis Ababa. Of these, only 17 are 24-hour synoptic (SYNOP) stations, which report every 3 hours to the WMO Global Telecommunication System (GTS), when conditions permit. An additional 50–60 stations report daily to the Addis Ababa office. In summary, there were a limited number of stations that could be used to develop insurance products for rural communities in Ethiopia.

To address the second prerequisite, it was necessary to identify a local insurance company and/or an international counterpart that would be willing to underwrite the contracts or intermediate the risk to the international market. Ethiopian law required the participation of at least one insurer. However, the Ethiopian insurance sector had minimal experience with agricultural insurance and had yet to develop the technical know-how to develop index-based products. Nonetheless, three insurance companies showed interest in index-based weather insurance. One of these companies was the state-owned EIC, which had been researching new products to market in the agricultural sector. The two others were private companies, but at the time of the pilot they had little outreach in the rural sector[2]. Ultimately, EIC's high level of enthusiasm, together with its mandate from government to look for agricultural insurance options and

2 Since this work was initiated one of the companies, Nyala Insurance, has begun building expertise in index-based weather insurance.

its capacity in this area, made it a natural 'risk off-taker' for the pilot program.

The third prerequisite is an institution sufficiently embedded in the agricultural sector to deliver the product to a wide number of clients. Due to poor infrastructure and communications, it would have been extremely costly to develop a new delivery channel. The partners therefore sought to use existing institutions with outreach to rural areas, and cooperatives were identified as the best option. In Ethiopia, the development of cooperatives is being strongly encouraged by the government to facilitate service delivery for extension advice, inputs, processing and marketing. The major constraint to working with cooperatives is the lack of technical skills and expertise needed to manage the delivery of insurance, which is a new product for most of the staff involved. Financial institutions were also a natural candidate for this role, but at the time the government had a lending guarantee program through the banks for fertilizer credit that minimized the incentives of banks to pursue weather risk management products.

Pilot project

EIC and CRMG worked together to develop the pilot project. This involved identifying pilot areas, crops and cooperatives; carrying out market research to determine the major risks and the demand for insurance; designing contracts to meet the needs of farmers; testing the contracts; marketing them; establishing agreements between participants; and finally implementing and monitoring the project. Weather data, yield data, input from farmers and agronomic information on the crops were used to design a weather index that closely predicted yield losses.

Before the product was offered to farmers, CRMG hosted a number of training sessions with local and national EIC employees and a local agent from the Ministry of Agriculture. These sessions aimed to 'train the trainers' on the product and to provide guidance on marketing it to their potential clientele. EIC relied on these trainees and on farmer cooperative leaders to market the product. Twenty-eight farmers subsequently bought the insurance as a stand-alone product.

Once contracts were under way, weekly weather data were received from the local meteorological department and were used to measure the index. In 2006 the rainfall in Alaba, where the pilot was carried out, was sufficient for maize growth and there was no payout from the contract. Following the pilot, EIC offered index insurance to farmers the following year but there was minimal take-up, with only 13 farmers participating. The product is under revision and may be offered again. Meanwhile, Nyala Insurance recently offered an innovative 'double trigger' index insurance contract to farmers that uses multiple sources of information to trigger payouts.

Challenges for market development in Ethiopia

Key challenges for scaling up a farmer-level index insurance scheme in Ethiopia were broadly identified as lack of data, weak delivery channels, limited linkages to finance and to inputs for farmers, and a lack of capacity within Ethiopian insurance companies and banks.

Preliminary research conducted during the pilot found that the number of stations whose data could be used to develop insurance products was very limited. Only 31 stations had under 10% of their data missing.

Effective delivery channels are critical to successful scale-up. In Ethiopia it has been difficult to identify organizations that combine outreach to farmers with the technical capacity to serve as the partner and market intermediary for delivering index insurance products. Farmer cooperatives, which were used in the pilot, have varying levels of capacity and, in many cases, would require significant capacity building to offer the product to farmers. Possible alternatives explored for this role included financial institutions, service providers for agricultural inputs, insurers and other retail agents, but none of these had incentives or the ability to provide this service to farmers. Financial institutions are the prime candidates for marketing this product, but were unmotivated due to the government guarantee for fertilizer credit that addressed the risks in loan repayment that the insurance might have otherwise targeted. Changes to this arrangement could create an opportunity to expand the use of weather insurance products linked to lending.

In order to implement a weather risk management program in Ethiopia on a large scale, capacity building would need to include a larger number of insurance companies and banks. In addition to expanding agricultural insurance products, banks could use the risk assessment components of the contract design process to improve their credit risk analysis. This type of initiative could allow banks to better assess the risks related to agricultural lending and expand their portfolio in an informed way.

Supporting farmers – and a government seed program – in Brazil

This case study from the Rio Grande do Sul region of Brazil shows how an index insurance program can be developed by a public–private partnership and used to complement other agricultural programs, in this case a seed distribution program. Rio Grande do Sul is one of Brazil's biggest producers and exporters of grains. Weather risks are mainly related to the El Niño phenomenon and its sister effect, La Niña: El Niño often causes floods, while La Niña is characterized by dry spells and droughts.

The state government of Rio Grande do Sul set up a seed distribution program in 1989 to help farmers grow maize for animal feed. The program supplies farmers with certified maize seed, with payment for the seed delayed until after the harvest. Thus when the harvest fails the government loses money; repeated failure, might render the program no longer viable.

The government was therefore interested in an insurance scheme to transfer and spread this risk. It invited partners to develop and implement a scheme that could be offered to all farmers who were eligible for the seed program – some 170,000 low-income farmers. AgroBrasil, a private agricultural risk management agency took the lead and proposed an area–yield index-based product that it had already developed. The partners have worked with several private insurance and reinsurance companies over the past few years to provide cover to farmers using an adapted version of this product. From 2001 to 2008, between 15,000 and 46,000 households took out the insurance each season (see the table). The insurance is

Aggregate data on the insurance scheme offered to farmers participating in the Rio Grande do Sul seed distribution program

Crop year	Families insured	Sum insured (R$)	Premium (R$)	Claims	Indemnities paid (R$)
2001/2002	25,068	17,834,385	1,978,154	17,590	4,247,742
2002/2003	38,620	28,445,320	4,174,436	59	5,550
2003/2004	20,122	14,993,630	2,278,775	4,254	1,063,611
2004/2005	24,151	19,320,800	2,749,323	23,248	10,364,084
2005/2006	46,175	36,940,000	6,139,370	9,547	1,914,202
2006/2007	25,071	20,056,800	3,343,580	129	30,461
2007/2008	14,893	11,914,400	2,037,171	2,951	593,551
Total	**194,100**	**149,505,335**	**22,700,810**	**57,778**	**18,219,201**

Source: Agrobrasil Seguros (2008).

only available to farmers in the seed distribution program, and its adoption is voluntary.

The area-yield index insurance scheme protects insured farmers against any risk that decreases the average yield for a defined area, compared to the productive history of the crop within the same area. Triggers were set at 10% deviation from average regional yield for the first year of operation, but changed in the following years to a 20% deviation.

The premium paid by farmers is subsidized by about 90%. The government pays the entire premium directly to the insurers at the beginning of the season, and collects the cost of the insurance minus the subsidy, together with payment for the seeds, from the farmers after the harvest.

Promotion and delivery of the product were strengths in this case study. A cartoon booklet was developed, 'Mr Chico and agricultural insurance', to explain the insurance to farmers (see below). More than 60,000 booklets were distributed during the first year of the scheme. AgroBrasil also promoted the insurance via radio and other media. Marketing activities had its own dedicated team of about 45 people, which included ground staff located close to distribution points. To deliver the product, the insurance providers took advantage of the established seed program and its more than 600 seed distribution points. When a farmer came to collect seed, the insurance was explained and offered at the same time. These efforts led to

good uptake, although uptake rates were also affected by events of the previous season (see table). Contract sales increased following a season in which claims were high; while fewer contracts were sold following a 'good' year when claims were low.

A new software program called AgroNet was developed to keep track of contract sales, sums insured and farmers' details. The software was installed at seed distribution points so that data could easily be collected. The data are used to produce a daily report, which is made available on the Internet and can be accessed by the marketing team, insurers and reinsurers. This makes for a relatively high level of transparency, although the system does depend on the release of official yield data by the government.

The insurance has been successful in reaching low-income smallholders participating in the government seed program. However, there are barriers that need to be addressed if the scheme is to be scaled up and to prove sustainable in the longer term. The main one is that the scheme currently uses the seed program as its only delivery channel; this means it is dependent on the seed program and the government's support. AgroBrasil is interested in extending the scheme to other regions and has proposed including it in the programs of other states. The participation of more private companies in the initiative could also offer more distribution channels.

For additional information see Neves (2008).

Stakeholder communication is key in Thailand

The Thailand case study demonstrates how careful pilot project management within a conducive external environment contributes to success. Thailand has a relatively developed, commercially oriented agricultural sector and a strong agricultural bank with extensive outreach activities, which facilitated project development and implementation. The pilot put considerable effort into communication between farmers, the technical team and local partners. Over the past three years, the project has developed a product that reflects feedback from clients and continues to be adjusted to suit local risk characteristics in new areas as the pilot expands. The project has also laid the foundations for further market expansion by building capacity, raising awareness at different levels, and engaging the government in dialogue over policy needs.

Despite earlier efforts by the government to introduce it, agricultural insurance had failed to find a market in Thailand. The opportunity for an index insurance pilot arose when the CRMG, which had been working on a similar project in India, was requested by Thai stakeholders to assist with a pilot in Thailand. The pilot was set up in the Pak Chong district of Nakorn Ratchasrima Province. It was aimed at maize farmers and addressed the drought risk. The district has high-quality historical weather data and reliable real-time data from the nearby meteorological station. The station also had approximately 40 years of rainfall data for use in contract design and premium pricing.

Preparatory technical work for the pilot involved collecting rainfall, yield and other key agro-meteorological data; interviewing farmers about the amount of rainfall and the losses they have suffered due to rainfall deficit; running crop models to derive quantitative relationships between maize yield and rainfall; and designing a prototype rainfall index insurance contact.

The Bank for Agriculture and Agricultural Cooperatives (BAAC) was the operational partner in the pilot, while CRMG provided technical expertise. Nine national insurance companies jointly underwrote the contracts under the coordination of the country's General Insurance Association. BAAC's role was to lead the fieldwork and data collection, act as agent/intermediary for the insurance companies, conduct (with the companies) farmer education sessions, and carry out marketing and sales of the insurance contracts. BAAC was also responsible for collecting and transferring premiums to insurers, distributing insurance certificates, creating databases of participating farmers, and distributing daily rainfall information to insured farmers during the period of insurance coverage. The World Bank funded and provided guidance for designing the index for the prototype insurance contract for Pak Chong. The contract was later fine-tuned by the local insurance team based on feedback received from farmers, BAAC and a local maize expert. Premium pricing was also done by the local insurance team based on standard international methodology.

A 'dry run' of the pilot was carried out in 2006 in Pak Chong. The clientele consisted of BAAC clients who grew maize within a 20 km radius of the Pak Chong Agro-meteorological Station. The insurance was introduced as a voluntary unsubsidized product, and was not bundled with credit. The dry run allowed project partners to practice product marketing and customer enrolment, and to set up a rainfall monitoring system to measure the index. It also provided the pilot team with input from farmers to improve the prototype rainfall index. The dry run revealed that the simple cumulative rainfall index did not reflect the disproportional impact on yield of prolonged water stress during the vegetative phase. This critical information resulted in changes to the product for the next phase.

With the refined product, the partners implemented the first year of the full-scale pilot during the 2007 growing season. In order to expand the geographical coverage within the Pak Chong district, the insurers funded the installation of a new automatic weather station. A relatively small sum of US$42,400 was insured in the two locations in the Pak Chong district. Following the 2007 season, the partners decided to expand the project to other locations. In the 2008 season the project covered 388 farmers near 11 weather stations in five provinces. The insurance companies also offered farmers more contract variations, including choices in contract start date, sum insured and premium. A total of US$300,000 was insured in this second year. After the season a group of farmers around one weather station received a large payout due to rainfall deficit measured during the first phase of the contract.

Even with the limited experience of just two seasons, the project has had a significant demonstration effect and has generated wide interest from other institutions in Southeast Asia, as well as international reinsurers. The primary constraint to expansion is the lack of local capacity to design index insurance contracts. This is due, in particular, to the current lack of a local agro-meteorological team to work with the insurance team. Continued investment in weather stations, and ongoing cooperation between the insurance sector, BAAC and the government, are also important for expansion.

Feedback from the farmers suggested that trust plays a key role in product take-up. From qualitative interviews after the pilot seasons, farmers stated motivations for purchasing insurance included risk management, experimentation and word-of-mouth from peers, but most importantly, trust in BAAC – an institution with long-term relationships with the farmers.

Scaling up in India: The public sector

The Indian government has offered various crop insurance options to farmers since the late 1970s. In 2002 it set up the Agriculture Insurance Company of India (AIC) to facilitate this service. At that time the main crop insurance on offer was the NAIS scheme, an area-yield-based insurance that was first offered in 1985. AIC's mandate was to develop new options in addition to NAIS, and in 2004 it launched a pilot weather index insurance scheme to this end.

AIC's pilot insured field crops against losses due to inadequate rainfall. The policy targeted three risks: inadequate rainfall over the entire cropping cycle; inadequate rainfall during critical stages of crop development; and sowing failure due to inadequate rainfall at the start of the season. In 2004 the scheme covered 20 districts in four states, reaching nearly 1100 farmers. In 2005 it was extended to over 125 locations in 10 states and reached as many as 125,000 farmers. By 2008 more than 700,000 farmers were insured through this program.

Over the years AIC has developed further index insurance products for a broader range of crops as well as expanding its geographical coverage. In 2005, for example, with technical inputs from the Coffee Board and Central Coffee Research Institute, AIC developed a product for coffee farmers, protecting against inadequate and excess rainfall during critical growing periods. Since 2007 the Coffee Board has offered a 50% subsidy on premiums for this product for small-scale growers. Another product introduced in 2005 targeted wheat in parts of Haryana and Punjab states, and used the remotely sensed Normalized Difference Vegetation Index (NDVI) as a proxy for crop health. However this has encountered problems due to cloud cover during critical crop growth periods. A generic (non-crop-specific) product was also developed, in 2006. Contracts for this product were sold through the ITC *e-choupal* network in the states of Madhya Pradesh, Uttar Pradesh, Rajasthan and Maharashtra. Crops covered were potato, mustard, chickpea, barley and wheat, which were protected against low and high temperature as well as unseasonal rainfall. By 2008, AIC had developed products for about 30 different crops, including perennial horticultural crops such as cashew nut, grapes, mango and apple.

To begin with AIC sold contracts directly or through cooperatives and NGOs. To do this it recruited staff called 'agri-preneurs'. These were agriculture graduates who toured rural areas calling on village heads, farmers' associations, NGOs etc, explaining the product, distributing product literature and enrolling interested farmers. As part of its scaling up efforts, in 2006 AIC began using insurance intermediaries to help deliver the product, such as insurance brokers, corporate agents and, from 2008, micro-insurance agents. At the same time, pamphlets, posters, radio advertisements and short films were used to raise awareness.

The Weather Based Crop Insurance Scheme (WBCIS) was launched in 2007, with government support in the form of subsidies. This project aims to use the best scientific and technical inputs available to develop products that are less prone to basis risk. It has focused on improvements in three areas: (i) cleaning and simulation of historical weather data; (ii) developing a crop growth simulation model to capture the yield–weather relationship; and (ii) expanding the network of private-sector automatic weather stations.

Reinsurers working with the public sector in India include the national company GIC Re and the international companies Paris Re, Scor Re, Endurance Re and Swiss Re. About 50% of the total coverage is placed in the international market.

The Indian Ministry of Agriculture has now recommended that some states replace the NAIS product with index insurance in select locations. This is a major step towards mainstreaming index insurance in India; however, expanding coverage still faces data and other challenges.

Weather data

Historical and current weather data are provided by the India Meteorological Department (IMD). About 25–30 years of historical daily weather data are available for about 500 locations in the country. For rainfall data alone the situation is better, with about 3500 stations having good historical data. However, there are significant gaps and this is a limitation for the expansion of index insurance. It is estimated that, to minimize basis risk, India needs at least 5000 automatic weather stations and 20,000 automatic rain gauges.

There have been delays in receiving data from IMD stations, which have held up insurance payouts. To facilitate index insurance some private companies have set up weather stations and rain gauges where these were lacking, and they sell data to AIC. National Collateral Management Services Limited, for example, has a network of over 400 automatic weather stations across 17 states, of which nearly 300 provide data for AIC's weather insurance products; Weather Risk Management Services operates some 75 weather stations; Agrocom also has about 50 weather stations in the state of Maharashtra; and Karnataka State Natural Disaster Monitoring Centre has about 600 rain gauges in the state of Karnataka. State governments have also begun investing in automatic weather stations; for example, the state of Tamil Nadu is investing about US$5 million in the installation of 225 stations.

Other challenges

Beyond data limitations, several other challenges need to be met if further scaling up is to proceed smoothly. Benchmarking is needed, to help clients better understand and compare the different products available. For example, besides AIC, two insurers from the private sector are currently providing weather index insurance with the same level of support from the government. These insurers are selling products with different trigger values, so that, for the same crop in the same location, one product may pay out while the other may not. Benchmarking set up by the government, with an appraisal mechanism and established standards, would enable clients to better understand and ultimately to trust these products.

The pricing of index insurance products has been a subject of contention, as in some cases (mostly private insurers) the price is decided by the reinsurer and may be up to 200% of burning cost (the cost determined strictly on the basis of historical data). Although the numbers of contracts sold in India have greatly increased over recent years, geographic spread has been limited, as many states are not convinced that a weather index can be superior to a yield index, as the latter is almost 'all-risk' insurance. This reduces opportunities for risk spreading and reducing costs.

The calibration of automatic weather stations is a pressing need, as most of these stations are producing data which are not consistent with historical data. For example, in 2008 AIC carried out a validation of data from automatic weather stations for 12 different locations across different agro-climatic zones and found discrepancies with the data from 'ag-met observatories' run by agricultural universities or research institutes.

Explaining how insurance works has been a challenge. Farmers often expect the product to give them regular payouts, but with premiums typically at around 6–8% of the sum insured the actual rate will be one full payout in 20–25 years or partial payouts once every 6–8 years. This misunderstanding has meant that contracts are often not renewed, especially if the initial years are without payout – there is evidence that repeat buyers decline with each payout-free year. Concerted efforts in insurance education are needed to overcome this challenge, which can also be met by designing products that combine savings with weather insurance.

Indeed, one of the most important reasons for low take-up of weather insurance is that the product is too complex and/or is not properly understood by stakeholders, especially farmers. Capacity building at different levels (including government and facilitators) and simple and clear product communication will be key for further scaling up.

In some places, high premium subsidies have led to farmers using index insurance to 'gamble'. They may buy weather insurance for crops they are not actually growing, or buy more units of coverage than the area they have. Market practices, such as across-the-table policy issuance without even checking basic information about the supplier, are encouraging these tendencies.

Reinsurers' expectations have been difficult to meet and have pushed up costs. For example, some companies want to receive weather data on a near 'real-time' basis and require regular updates of how contracts are performing each week. This is obviously labor- and resource-intensive and insurers often find it difficult or impossible to comply.

Livestock insurance in Mongolia

Livestock herding has played a vital role in the culture of Mongolia for thousands of years and continues to contribute significantly to its economy. The livestock sector accounts for 17% of Mongolia's gross domestic product (GDP) and employs 33% of its workforce. The country's human population totals 2.6 million and, according to the 2007 livestock census, there are close to 40 million head of livestock.

The dissolution of the Soviet Union in 1991 had a significant effect on Mongolia. The government switched from a socialist system to a democratic enterprise economy. Herder households shifted from collective farming to family-based herding. Due to lack of jobs in the cities, many families moved to the countryside to take up herding. From 1990 to 1997, the number of households engaged in herding doubled and the overall livestock population grew from 25 million to 31 million.

While episodic drought and harsh winters have always been a fact of life for herders in Mongolia, conditions happened to be largely benign during the early years of economic transition in the 1990s. From 2000 to 2002, however, severe winter conditions created *dzud* – sudden-onset winter storms that include bitterly cold temperatures and can create ice that prevents livestock from foraging. These events occurred during a period when many novice herders were placing increased pressure on the natural resource base at precisely the same time that state-supported risk mitigation systems (providing forage and groundwater wells) were breaking down. Some 11 million animals perished during the winters of 2000, 2001 and 2002. Weak insurance companies defaulted on payments to herders, families returned to the city, the general economy was adversely affected, and a national debate was initiated regarding the introduction of mandatory livestock insurance.

Even before the crisis, the World Bank had been actively involved in Mongolia, developing a Sustainable Livelihoods Program that emphasized pastoral risk management. This included improved early warning systems and risk preparedness actions, access to supplementary feed and grazing reserves, coordination of pasture-land use, and conflict management. These measures were combined with efforts to extend the outreach of microfinance services to herders and to encourage investments in basic infrastructure, identified as priorities by communities. Taken together, these complementary interventions strengthened the wider risk management framework, thereby reducing herders' vulnerability to climate and non-climate hazards.

As part of its support for the Sustainable Livelihoods Program, the World Bank was invited to assist the Government of Mongolia in its debate on mandatory livestock insurance. It was clear that it would be impossible to implement a traditional livestock insurance program that performed loss assessments in the vast spaces of Mongolia in the midst of harsh winter conditions, so alternative methods for measuring livestock losses were sought. Mongolia had been conducting a census of animals every December since the early 1920s, which provided estimates of mortality rates of animals by species and by *sum* (rural district). It was proposed to use these data as a basis for making payments under a new insurance program. Policy makers and others understood that paying out according to *sum*-level mortality rates would retain the incentives for herders to work hard to save their animals during a *dzud.*

In 2005, the Government of Mongolia entered into a credit agreement with the World Bank to begin a pilot program on Index-Based Livestock Insurance (IBLI). The first sales season was 2006. The goal of the IBLI is to provide an insurance product for catastrophic livestock mortality events within a region, recognizing that smaller, individual livestock mortality risks are better addressed through appropriate household-level risk management strategies.

The IBLI pilot program consists of a public–private partnership and includes a commercial insurance product, the Base Insurance Product (BIP), and a Disaster Response Product (DRP), designed to compensate herders when major livestock losses occur. The BIP pays out when *sum* mortality rates exceed 6%. Losses beyond 30% are managed by the DRP and are currently paid using a contingent loan from the World Bank, with the intention that this component will be financed by the Government of Mongolia after the pilot ends. Thus, the commercial exposure (BIP) is for the layer between 6% and 30% mortality and the social component (DRP) is for losses exceeding 30% mortality. Herders are allowed to select their sum insured based on an aggregate value of all their animals belonging to a given species. Typically, herders have been insuring about 30% of the estimated value of their animals. Herders have the option to pay a small fee to obtain the DRP product, with a sum insured representing 50% of the value of their animals. They can do this whether or not they purchase the BIP policy.

The sales season begins in mid-March and ends in mid-June, before signs of an early or harsh winter start to materialize, thereby preventing adverse selection on the part of herders. If sales were extended into July and August, the knowledge herders have of pasture conditions and the health of their animals could cause them to buy only when the likelihood of a loss increases. Payments are based on estimates of *sum*-level livestock mortality rates from January through May. Payments are generally made in late July or early August, after mortality estimates are obtained from the latest mid-year livestock survey (conducted in late May and early June). As of 2009, the IBLI program is being piloted in four provinces: Bayankhongor, Khentii, Uvs and Sukhbaatar.

Livestock insurance can support herders when they face harsh winter conditions; Mark Rosenwald

Financing structure

The IBLI pilot program has a unique financing structure that was designed to account for the lack of access to commercial reinsurance, the large financial exposure associated with correlated livestock losses, and the insurers' and regulator's lack of experience with this class of insurance. This is the first time an index insurance product has been used in Mongolia (and the first time for livestock anywhere). The structure follows best practices by establishing layers of risk financing. Insurance companies retain some portion of the risk, pool risk with other companies, pay reinsurance premiums to the government, and are protected from the most extreme losses by a combination of (i) the BIP reinsurance reserve (which accumulates from reinsurance premiums paid using the herder premium) and (ii) a contingent loan from the World Bank, which covers the most severe losses. Note that the BIP reinsurance reserve is only used to pay for losses from the commercial layer of risk. It is used as the first line of defense, before the World Bank contingent loan is used.

The Livestock Insurance Indemnity Pool (LIIP) is the foundation of the risk financing structure. The LIIP is a risk-sharing arrangement in which insurance companies pool their risk: all insurance companies participating in IBLI pay into the pool, and the indemnities from all BIP policies are paid from the aggregate funds in the pool.

The LIIP is regulated to ensure that insurance companies have their complete capital at risk available for quick payments should there be losses. Participating insurance companies are required to deposit their capital at risk into the LIIP account, which is owned by the government. This ensures that herders will be paid even if an insurance company goes bankrupt. Insurance companies own the right to a share of underwriting gains from the LIIP account. Shares are based on the premium sales made by the insurance company.

Pilot performance

In general, the IBLI program has exceeded the expectations and performance goals set for it when the project started. Two insurance cycles have been completed, the third is ongoing, and the sales season for the fourth has been launched. Four insurance companies are currently participating. In 2006, some 2400 policies were sold; this rose to over 3700 policies in 2007 and to 4100 policies in 2008, representing 14% of herders in the pilot provinces. In mid-August 2008, following high livestock losses, MNT 389 million (US$340,000) was paid out to 1783 herders. All financing systems worked as planned; a small amount was drawn from the contingent debt facility.

Lenders have offered lower interest rates and better terms for loans to insured herders; and the National Statistics Office has successfully implemented a mid-year census to facilitate timely payments after losses, most of which occur in the first 5 months of the year.

Lessons learned and challenges ahead

Mongolia represents a novel approach to the development of index insurance using a public–private partnership. The most extreme events (above 30% mortality), which are costly to insure against, are completely financed by the government. If these risks had to be priced in the market, the resulting package would be far too expensive for most herders. Index insurance products provide the unique opportunity to layer risk in this way. Mongolia represents one of the strongest cases of mixing social and commercial insurance in a carefully designed project that meets both needs. Should the government decide it can no longer afford to take the extreme risks, a commercial product will still be firmly in place. At that stage it might even be possible for the insurance companies to increase their exposure to at least some of the extreme risk through reinsurance markets.

The IBLI program is designed to avoid many of the incentive problems faced by government efforts to support agricultural insurance. The program's financing and regulatory structure, which pools risk among insurance companies, is designed to strengthen trust among herders, participating companies, the government and the global reinsurance market.

Among the most significant challenges for IBLI is to make it a sustainable program with a system for data collection and analysis, product delivery and contract administration that can be paid from herder premiums. Performing a mid-year survey is an added cost. Delivering insurance products to herders in the vast expanses of rural Mongolia is also proving to be costly. These are micro-products with small premiums, issued to individual herders. Linking the products to herder loans will be an important next step, reducing delivery cost. Despite these challenges, the delivery and administrative costs should be manageable as the premium base grows.

Above all, it is important to view this initiative as one element within a wider risk management framework. Mutually supportive interventions across a number of areas – including disaster risk preparedness, reduction and response; financial intermediation; supporting infrastructure; and social safety nets – are all needed to address the interlocking forms of vulnerability that Mongolian herders face in the unpredictable and often harsh environment where they earn their living.

Lessons learned and recommendations

Climate variability can amplify poverty, especially in the developing world (Dercon, 2004; Hansen *et al.*, 2004). The potential of index insurance to help manage climate variability – to enable economic development despite it and to manage the disasters that result from it – is being tested in a growing number of developing country settings. The case studies presented in this report provide a wealth of practical experience and knowledge which must be drawn on if this new tool is to be successfully scaled up so that it has widespread impact. This section is an attempt to distill the lessons learned thus far – and so to provide guidance to donor agencies and others planning to invest in index insurance in the future.

What is the potential of index insurance for development and disaster management?

In this publication, index insurance has been examined under two broad categories:

- Index insurance for development (farmer and community scales), and
- Index insurance for disaster relief (national and multinational scales).

For both purposes, index insurance has unleashed new capital, ideas and approaches. It has led to new research on how to address risk, new methods for risk pooling and transfer, and new roles for national insurance companies.

At the farmer and community scales, index insurance has brought access to credit and insurance for high-risk populations previously considered uninsurable. Some farmers have received credit for the first time, allowing them to buy and use critical agricultural inputs and technologies such as improved seeds and fertilizers. Index insurance makes this possible by lowering the transaction costs of designing and managing contracts and payouts, thereby making it viable to sell insurance with low premiums that are affordable even to poor farmers. To be successful, the transaction costs will have to be kept low without diminishing the quality of the insurance coverage as it is scaled up. This concern underlies many of the issues discussed below.

At the national and multinational scales, experience shows that index insurance within a comprehensive disaster management framework can play a role in providing more timely and reliable relief.

Lessons learned and recommendations

■ Low data quality and quantity restricts the implementation and scale-up of index insurance. It is important to improve data systems and explore new technologies to fill data gaps

Lack of data is a fundamental issue in most of the pilot cases. Developing regions are at a distinct disadvantage – Africa, for example, has 23% of the world's land but only 11% of its climate observations (WMO, 2005). Meteorological, crop, loss and socioeconomic data are all essential. The fair and sustainable pricing of insurance – and its usefulness – depend on understanding the likelihood of the insured event occurring, which requires historical data.

Installing new weather stations is a straightforward investment to support data collection for index insurance scale-up, and it is happening in some countries – for example Malawi, India and Ethiopia (see case studies on pages 42, 47 and 44). Such expansion of observation systems will be critical in the coming years, not only for insurance purposes. Weather stations need ongoing maintenance, as well as skilled staff to operate them, and these needs must be factored into investments. New weather stations cannot, however, provide historical data.

There are technologies that can help overcome the limited data availability. Technologies tested in pilots include remote sensing (of rainfall and vegetation), rainfall modeling and simulation, seasonal forecasting, techniques for modeling risk over time and space, modeling of long-term processes and trends, systematic communications tools, agricultural systems modeling, and water resource techniques (see earlier text boxes, and papers at http://iri.columbia.edu/csp/issue2/workshop). Not initially designed for index insurance, many of these technologies are nonetheless performing well in this application. However, each also has documented failings. It is important to understand the uses and limitations of these technologies, and this will require systematic testing. At the same time, research and development of new technologies to help overcome data barriers is advocated.

Insurance has stimulated new markets for weather data. In some cases private companies are stepping in to fill the void – in India, for example, there is an active private-sector effort to build new weather stations and sell the data to insurance providers. This has demonstrated that there can be a useful role for the private sector; however, public investment is likely to be far more important in most developing countries. Governments need to support their meteorological services so that quality data can be collected, processed and made available.

■ Premium subsidies for development-oriented projects need to be carefully thought through. Investments in public goods may reap more benefits and result in more sustainable markets over the long term

Subsidies are a complex area and there are many questions surrounding their use. In practice, in India for example, subsidies for development index insurance products have resulted in products reaching larger numbers of poor people. However the long-term impacts on livelihoods are largely unknown. Without subsidies, premiums more accurately reflect the cost of the risk, and this helps the farmer decide whether it is a risk worth taking. With a subsidy, a farmer might take risks she should not take, increasing her vulnerability. Historically, subsidized agricultural insurance has been used in many countries as part of welfare programs. While these programs have often been politically expedient and popular, they may perpetuate poverty and have long-term negative impacts on the rural poor who adapt their livelihoods around seeking and using subsidies. There is a risk that subsidized index insurance could have the same negative impacts on livelihoods.

There are investment alternatives to premium subsidies that appear less likely to have these unintended consequences. In the case studies, donors often subsidized the design and development costs of products, for example. Other public goods investments that might contribute to the development of sustainable markets include improvements in data systems and data collection, and promotion and capacity building. Governments should take the lead in establishing a regulatory framework and ensuring that certain public goods, such as meteorological data, are available. Donors can help strengthen local financial systems in a variety of ways, from technical assistance to capacity building, insurance education and awareness raising, developing product benchmarking standards, creating a pool of historical weather data, providing generic software for designing products and supporting public–private partnerships. The latter will be key as markets expand. Strengthening the global market for reinsurance is another key investment that governments can make in order to allow insurance to be more affordable at the local level (see following section on global initiatives on financial risk transfer).

Index insurance works best when integrated into broader programs for development and disaster management. It should form part of a comprehensive risk management package with complementary resources targeted to other components of the package

Index insurance is not a stand-alone solution, but is one tool in the risk management portfolio. It works most effectively where it is addressing a clear and defined risk, with other risks covered by other risk management options.

There are also many practical reasons why index insurance works best when integrated into broader development and disaster management strategies. In the case studies, the best targeted and designed products, and the most cost-effective implementations, were those where insurance programs worked with existing networks and programs for rural development. National cooperative movements, farmer credit access programs, contract farming and rural development programs, for example, all acted as platforms for index insurance. Access to delivery channels, facilitation of marketing, and promotion of local ownership are some of the advantages that were seen in these collaborative arrangements.

In these integrated settings it is important that equal or even greater attention should be paid to the interventions the insurance is complementing. The insurance should be built to address the risks remaining when these other interventions have been developed.

Investments in capacity building and marketing are needed to support the scaling up of index insurance

Index insurance is new to many stakeholders in developing countries. The potential client needs to understand the product – and so too do all the organizations involved in contract development, product marketing and the management of transactions. Capacity building must be focused on the full range of stakeholders as successful scaling up depends on the knowledgeable participation of all groups. It is particularly important to strengthen local capacity to design contracts that respond to local needs.

Significant marketing efforts are also needed for successful scaling up. Many of the pilots demonstrated innovative ways of marketing the product. In Brazil, a cartoon character was created to explain index insurance in an entertaining way. In India, mobile units and short video films were used to bring the product to a broad audience. Awareness raising should also address the full range of potential stakeholders, from insurance companies and other financial groups, through potential clients, to policy makers.

There are obvious investment opportunities here for donors interested in promoting index insurance. Efforts already under way include an online tool developed by the World Bank and IRI.

Evaluation is needed to find out if there is a real impact on poverty, and to improve the products. Evaluation and impact studies should be built into future project design and implementation

Even where index insurance markets are beginning to flourish, it is not yet known exactly what impacts the insurance may be having. Impact evaluations of index insurance projects are thus essential, but have not been systematically included in project design or implementation. Quantitative evidence indicating the economic benefits and investment tradeoffs is imperative to understand the added value of index insurance. Faced with competing needs and limited resources, it is in the donor's best interest to meet this critical need. It is vital to determine whether index insurance should be prioritized in development and disaster management strategies.

Understanding the impacts of index insurance would stimulate the creation of new and better targeted products and services. A better understanding of the development impacts can also stimulate scale-up, promote access to government support, and open doors to new and additional resources.

Because many of the questions around implementation are about the appropriate scale of intervention, evaluation strategies should provide unbiased scrutiny across all scales. Pre-implementation strategies must be further developed to better understand and target demand, and the appropriate role of insurance in the context of other interventions and traditional practices.

There is major scope for donor contributions in this area. Learning on impact should feed into an international index insurance product development community of practice (see below). It will be important to persuade private-sector companies to share their knowledge of what works and what does not.

■ Insurance must be demand driven and locally owned. Risk and needs assessments should be carried out before designing and implementing a project

This lesson may seem obvious, but it is all too often overlooked. If insurance is not designed to meet a demand that is keenly felt by clients it is unlikely to work, regardless of its price. No level of technical sophistication or subsidy can rescue a product that does not offer a clear and concrete benefit to its potential clients and is not wanted by them. Index insurance projects that are driven from the top down by NGOs, governments or the financial sector have not been successful.

Most donor-funded projects conduct needs or risk assessments before going ahead with a new project, but other stakeholders may be tempted to cut this preliminary step, either to save costs or because they think they know the answers. All potential partners in a new index insurance project should keep an open mind during the early stages, and even the product champion should be prepared not to go ahead with a project if the needs assessment does not indicate a clear need for it.

■ Index insurance can help vulnerable populations better manage climate risk, and could be a useful strategy for climate change adaptation. Index insurance should be investigated as an adaptation strategy

Whether it targets development or disaster management, index insurance is designed to help vulnerable people, communities or governments manage climate risk. The scale-up seen in India and in Mexico shows that this tool can indeed play this role, alongside other risk management options.

As a climate change adaptation tool, index insurance has three potential uses. It can work as a risk transfer mechanism within a comprehensive strategy for managing climate risk in the face of climate change; as a mechanism to help people access the resources needed to escape climate-related poverty; and as a mechanism to incentivize risk reduction.

However, the uncertainty linked to climate change threatens the affordability of premiums. The challenge is to accommodate the added uncertainty due to climate change while keeping premiums affordable. Insurance companies increase the price of the product if they think there is significant uncertainty or an emerging trend that needs to be built in; but in fact most of the pricing of contracts at present reflects year-to-year variation. Longer term processes represent just a small component, but one that may become more important over the years.

There is growing consensus that index insurance can play a role in facilitating disaster risk reduction and adaptation to climate change. As a tool designed to help the most vulnerable manage climate risks, there is much potential for its use within a broader adaptation strategy. Initiatives such as the Munich Climate Insurance Initiative (MCII) proposal (see next section) examine ways of formally including and financially supporting index insurance in the Copenhagen Agreed Outcome, the follow-up to the Kyoto Protocol. Such proposals merit strong support.

Governments should prioritize the development of a strong legal and regulatory system for index insurance

Strict regulation is an important element in avoiding abuses and building trust. As such, it is vital to have a robust regulatory system in place before scaling up is attempted. Regulators must be actively involved in developing the market for index insurance, making sure that products, and the ways in which they are managed, are fair to both buyers and sellers. Because payouts are not necessarily correlated with actual losses, a robust regulatory system is needed to mitigate the legal and other risks that can emerge with the introduction of index insurance. This is why insurers often choose to develop these products collectively, for example through their insurer association, as occurred in Malawi.

Capacity-building for regulators is a critical investment, needed at an early stage of a country's involvement in index insurance. Experiences in several projects – Malawi, Mongolia, Ukraine – showed that regulators need time to gain familiarity with index insurance before they are in a position to approve its promotion on the open market. Policies and regulations may need to be fine-tuned to accommodate this new kind of product and barriers to its introduction lifted. Explicit support may be needed to promote the process of assimilation and this is only rarely provided at present. However, once regulators appreciate the advantages of index insurance, they may move quickly to approve new products. The case study in Vietnam shows this process at work.

- **Index insurance players could benefit from each other's knowledge. A network forum for sharing information and experiences is needed**

All the case studies contain elements of good practice, innovative approaches and solutions to challenges that commonly arise when index insurance is introduced. It is important to share knowledge of these, so as to replicate successes and avoid repeating mistakes.

Interest in index insurance as a tool for development and disaster management is growing, and as the community of practice grows it will be increasingly valuable – and difficult – to manage and share the knowledge acquired by different players. To ensure that knowledge is transferred as the community grows, a network or forum for sharing ideas and experiences is essential. Processes which engage the community of experts are useful, but the knowledge generated needs to be more widely accessible. Establishment of a knowledge management system is recommended to promote the rapid and effective uptake of innovative practices, technologies and research results.

Global initiatives on financial risk transfer

With climate issues high on the global agenda, interest in insurance as a CRM tool is growing. The potential role of insurance in development, in disaster risk reduction and in climate change adaptation is attracting widespread attention among governments and donor agencies. Various initiatives are under way or at the planning stage that aim to bring together interested groups, resources and expertise to support the development of financial risk transfer methods, including index insurance. This section describes these initiatives. It will be important for the different groups to coordinate their efforts and work together to build a framework in which these tools can realize their potential.

Index insurance is also being formally considered as a climate change adaptation tool in negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) (see 'Insurance and the climate change negotiations'). Support is growing amongst policy makers to incorporate index insurance into the agreement that is to succeed the Kyoto Protocol (the Copenhagen Agreed Outcome), particularly as evidence from pilot projects in developing countries starts to demonstrate its benefits. Two proposals were presented to delegates at the UNFCCC talks in Poznan in 2008 (COP 14), from the Alliance of Small Island States (AOSIS) and the Munich

Insurance and the climate change negotiations

Insurance is mentioned as a CRM tool in the 1992 UNFCCC (Article 3.14), the 1997 Kyoto Protocol (Article 4.8), and the 2007 Bali Action Plan (adopted at COP13). The Bali Action Plan calls for "consideration of risk sharing and transfer mechanisms, such as insurance" to address loss and damage in developing countries particularly vulnerable to climate change (Decision -/CP.13, Bali Action Plan). At the 2008 climate talks in Poznan, Poland, insurance was one of the major items of discussion on the adaptation agenda, promoted in proposals by Parties (notably AOSIS) and Observers (such as MCII). Insurance was mentioned over two dozen times in the draft text, which served as a starting point for negotiators.

The many elements proposed between Bali and Poznan must now be combined into a coherent framework that will become the agreement on how the international community mitigates and adapts to climate change after 2012, when the current Kyoto Protocol commitment period ends. The essentials of this agreement are to be hammered out at the UN Climate Change Conference (COP15), to be held in Copenhagen in December 2009. A UNFCCC pre-negotiation text called for Parties to consider the establishment of an insurance mechanism to facilitate disaster risk reduction and climate adaptation, to identify funds to pay for such insurance activities, and to identify a suitable operational arrangement for implementing insurance solutions (UNFCCC 2009).

Discussing index insurance at COP14 in Poznan in 2008; Koko Warner/MCII

Climate Insurance Initiative (MCII). The next round of climate talks, culminating in a new climate agreement in Copenhagen in December 2009, is expected to include index insurance as part of a wider climate risk management strategy.

Weather Risk Management Facility

The International Fund for Agricultural Development (IFAD) and WFP are developing technical collaboration through the Weather Risk Management Facility, which aims to facilitate access to weather index-based risk management tools and to develop replicable models that are sustainable and have potential for being scaled up. The focus is the rural poor. Early activities are taking place in China and Africa, with the aim of demonstrating the feasibility of index insurance and learning from pilot projects. This knowledge, along with expert inputs, will be used to develop a long-term strategy for the Facility.

Specifically, the Facility is working to build the market for weather index-based insurance by supporting: (i) the establishment of weather infrastructure and data collection and analysis; (ii) the provision of technical assistance to insurance companies, to enable these to develop and deliver index-based products (this includes training in contract design, pricing and marketing); (iii) the use of science and technology (e.g. remote sensing, crop models) to ensure robust contract design; and (iv) the development of enabling regulatory environments for weather index insurance that encourage growth and allow for bundling with credit, savings and other financial products.

Global Index Insurance Facility

The Global Index Insurance Facility has been set up by the IFC with the support of donors, to develop and promote index insurance for weather and other natural disaster risks in developing countries. The Facility is establishing an international commercial reinsurance company to support local insurance companies by underwriting index insurance contracts, thereby protecting clients, including governments, private companies, financial intermediaries and farmers. The Facility also includes a trust fund to provide technical assistance and capacity building, and premium cost-sharing funds to promote the growth of markets.

Climate Risk Transfer Facility

The United Nations Development Programme (UNDP) is considering options for supporting index-based insurance and other risk-transfer mechanisms in the developing world. One option is a Climate Risk Transfer Facility, which would assist public authorities in implementing development- and risk-reduction-oriented climate risk transfer mechanisms at the local and regional levels. Such a facility could have many functions, such as delivering knowledge services (e.g. expertise on risk assessment), implementing pilots to test and demonstrate the feasibility of proposed approaches, and promoting national and global policy dialogues, in order to expand access to financial risk transfer and pooling mechanisms.

Global Facility for Disaster Reduction and Recovery

The Global Facility for Disaster Reduction and Recovery is a long-term global partnership under the United Nations International Strategy for Disaster Reduction (UNISDR), aimed at reversing the trend of rising disaster losses by 2015. It operates on three tracks: (i) global and regional advocacy, partnerships, knowledge management and standardization of disaster risk management tools; (ii) country-level programs on institutional development, innovative hazard mitigation projects, and learning, research and knowledge management; and (iii) a standby recovery financing facility for low-income countries stricken by natural disasters, to be implemented through the World Bank's International Development Association (IDA). Index insurance is being explored as one of many options for managing climate risks, and exploratory work is being carried out in Vietnam on index-based flood risk insurance.

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Acronyms

ADP	Agricultural Development Programme (of Malawi)
ADP-SP	Agricultural Development Project – Support Program (Malawi)
AIC	Agriculture Insurance Company of India
AOSIS	Alliance of Small Island States
BAAC	Bank for Agriculture and Agricultural Cooperatives (Thailand)
BASIX	Hyderabad-based microfinance group of companies that aims to promote sustainable rural livelihoods through financial and technical services
BIP	Base Insurance Product
CADP	Climate Adaptation Development Programme
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CRM	Climate risk management
CRMG	Commodity Risk Management Group (of the World Bank)
DECSI	Dedebit Credit and Savings Institution
DFID	Department for International Development (UK)
DRP	Disaster Response Product
DSSAT	Decision Support System for Agrotechnology Transfer
EDI	Ethiopia Drought Index
EIC	Ethiopian Insurance Corporation
ENSO	El Niño-Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
FCR	Fondo de Credito Rural (Nicaragua)
FEWS-NET	Famine Early Warning System Network
GTS	Global Telecommunication System (of the WMO)
HARITA	Horn of Africa Risk Transfer for Adaptation
IAIS	International Association of Insurance Supervisors
IAM	Insurance Association of Malawi
IARI	Indian Agricultural Research Institute
IBLI	Index-Based Livestock Insurance
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Association (of the World Bank)
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation (of the World Bank)

IMD	India Meteorological Department
INSER	Instituto Nicaragüense de Seguros
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
LEAP	Livelihoods, Early Assessment and Protection
LIIP	Livestock Insurance Indemnity Pool
MCII	Munich Climate Insurance Initiative
MDG	Millennium Development Goal
MVP	Millennium Villages Project
NAIS	National Agriculture Insurance Scheme
NDVI	Normalized Difference Vegetation Index
NGO	Nongovernmental organization
NMA	National Meteorological Agency (in Ethiopia)
NOAA	National Oceanic and Atmospheric Administration
OA	Oxfam America
OECD	Organisation for Economic Co-operation and Development
OIBM	Opportunity International Bank of Malawi
PACC	Programa de Atención a Contingencias Climatológicas (Mexico)
PSNP	Productive Safety Net Program (in Ethiopia)
REST	Relief Society of Tigray
UHC	Ukrainian Hydrometeorological Center
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
USGS	United States Geological Survey
VBARD	Vietnam Bank of Agricultural and Rural Development
WBCIS	Weather Based Crop Insurance Scheme
WFP	World Food Programme
WMO	World Meteorological Organization
WRMS	Weather Risk Management Services
WRSI	Water Requirement Satisfaction Index
WTO	World Trade Organization

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