February 17, 2009

The Role of Markets for Managing Agricultural Risks in Developing Countries

Peter Hazell

Introduction

Agricultural production is typically a risky business. Farmers face a variety of price, yield and resource risks that make their incomes unstable and unpredictable from year to year. In many cases, farmers are also confronted by the risk of catastrophe. For example, crops may be totally destroyed by hurricane, fire, drought, pests or diseases, and product prices may plummet because of adjustments in local or world markets. The type and severity of the risks confronting farmers vary with the farming system and with the climatological, policy and institutional setting. Nevertheless, agricultural risks seem to be prevalent throughout the world. They are particularly burdensome to the small-scale farmers of the developing world.

From the farmers' perspective, risk can reduce welfare in several important ways. It can lead to a reduction in average productivity (and hence average income) because of forecasting errors that lead farmers to use resources sub-optimally and because they may need to adopt on-farm risk-reduction strategies (e.g., crop diversification) that are less productive on average than are strategies that can ignore risk *per se*. Farmers may also be concerned about their ability to repay loans, meet family food and living expenses, and protect key assets in catastrophic years. Risk may also constrain their access to credit and hence their ability to invest in new technologies or to access and improve land and other natural resources.

Confronted with these realties, farm households and rural communities have, over many generations, developed a plethora of traditional methods for managing risk. These methods work best for managing independent rather than covariate risks, and losses that are small relative to household and community assets. For larger and covariate losses, rural communities have had to look for outside help. Historically, feudal and tribal authorities helped fill that need, but recent decades saw the introduction of government sponsored interventions such as price stabilization schemes, crop insurance programs and drought relief. With few exceptions, these public interventions have proven expensive and inefficient, and many were removed during the structural adjustment and market liberalization era of the late 1980s and early 1990s. The vacuum that has been left has contributed to an explosion in publicly funded social safety net programs to provide relief in times of need. These expenditures are not only increasingly costly as population pressure exacerbate losses from natural disasters, but contribute little to economic growth and long term poverty reduction. New hopes lie in market mediated approaches to risk management, and recent years have seen considerable innovation and experimentation in this regard. However, market mediated approaches have not yet achieved the scale that is needed.

This paper briefly reviews the context for market mediated interventions, and then discusses the more important types of instruments that have been tried and the experience and lessons to date.

Traditional Risk Management Approaches

How Farmers and Rural Communities Manage Risk

Farm households and rural communities pursue a plethora of well honed strategies for reducing their exposure to risk and for coping with losses when they occur.

The first line of defense is on-farm, risk management. This has been well documented and includes risk reducing and risk coping strategies (e.g. Walker and Jodha, 1986). Risk reducing strategies include: a) diversification amongst crops, trees and livestock, different crop varieties and animal breeds; b) inter-cropping and staggered planting dates; c) fragmentation of the farm to include plots that have different risk exposures in the landscape; d) investing in water harvesting and small scale irrigation; and e) diversification into non-farm sources of income (e.g. non-farm business activity or employment, and seasonal migration). Risk coping strategies include: carrying food stocks, and extra animals and other assets (e.g. jewelry and trees) that can be easily sold in times of need; borrowing credit and engaging in temporary migration for employment.

The second line of defense is risk pooling within rural communities. Accumulated social capital in the form of religious groups, credit groups, and kin-support networks enables risks to be pooled by assisting individuals in times of crisis on a reciprocal basis (e.g. Sommerfeld et al., 2002). In Ghana, village chiefs have traditionally managed community grain stocks (Keyzer et al., 2007). Sharecropping contracts also emerged in many societies as a way of sharing risks between landlords and tenants (Newbery and Stiglitz, 1979; Otsuka and Hayami, 1993). In pastoral areas, reciprocal arrangements often extend to reach large numbers of spatially dispersed communities, enabling mobile or transhumant grazing practices that reduce the risk of having insufficient forage in any one location, and maintaining reciprocal grazing arrangement with more distant communities for use in drought years (McCarthy et al., 1999).

Limitations of Traditional Risk Management

These kinds of traditional risk management strategies have proven effective in helping rural communities survive for countless generations, including in many drought prone environments. But they are not without their costs and limitations.

On-farm diversification strategies mean that farmers cannot fully exploit their comparative advantage by specializing in the most profitable enterprises. This leads to a reduction in farm income on average, though also a more stable one. Studies of drought-prone areas in India and Burkina Faso suggest that farmers sacrifice between 12 and 15% of average income through risk avoidance strategies within their existing farming systems (Gautam, Hazell and Halderman1994; Sakauri and Reardon, 1997). Farm and regional level studies using mathematical programming models show that the tradeoff in average income increases exponentially with the level of risk aversion (Hazell and Norton, 1986).

Farmers may also be reluctant to invest in improved seeds and fertilizers or to make long term investments in trees, small-scale irrigation and animal fattening because they cannot recover their costs and repay any credit they may have borrowed in bad years. Financial institutions are also less willing to lend to farmers for productivity improving investments when the risk of default is exacerbated by important weather and market hazards. The problem is compounded by lack of suitable collateral that can be easily liquidated to meet debt payments in crisis years. In pastoral areas where mobility and transhumant grazing practices remain the primary strategy for managing drought risk, communities must retain large areas of land as common properties and respect reciprocal grazing arrangements

with other communities for use in drought years. This can impede investment in land improvements and the development of more intensive and settled farming systems.

Traditional risk management arrangements frequently fail to provide an adequate safety net for the poor. Poor people have limited assets and hence less options for coping with significant income losses. They are also more exposed to food price increases that may follow local production shocks, and they are more exposed to any contraction in local employment opportunities and wages. There is a growing literature showing that repeated income shocks and asset losses can conspire to keep poor households trapped in poverty. Credit, which might offer a viable pathway out of poverty, is also much less likely to be available to small farmers caught in poverty traps (Carter and Barrett, 2006).

Traditional risk management arrangements are generally better at managing independent risks that affect a few farmers at a time (e.g. accidents, fires, theft) than large and covariate risks that affect many people simultaneously. This limitation is greatest for catastrophic losses associated with extreme weather events, new pest outbreaks or a collapse in market prices. The aggregate losses associated with these types of events can easily overwhelm community risk sharing arrangements, dry up informal credit, reduce asset prices and agricultural wages, and force many people into poverty. Moreover, covariate shocks to farm output and income also reduce the demand for nonfood goods and services, including agricultural marketing and processing services and rural consumer

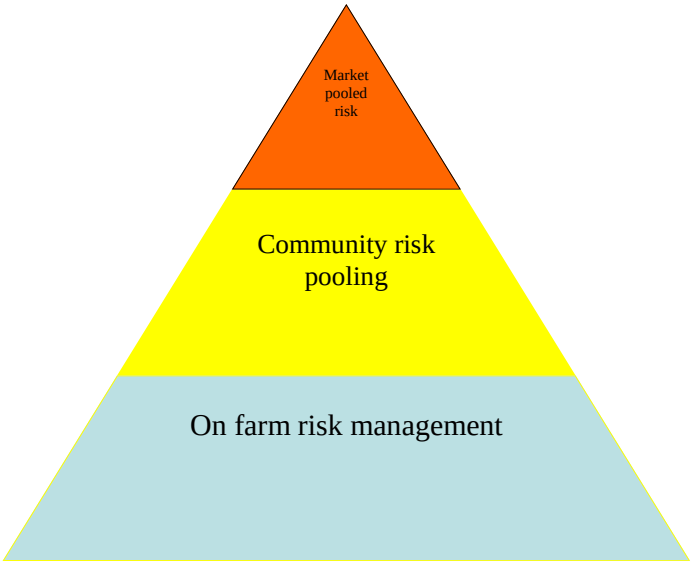
demands for a wide range of household goods and services. Since many of these nonfarm goods and services are produced or traded within rural areas, this can lead to a knock-on effect for income earnings in the rural nonfarm economy. The rural poor, including many small farmers, can be badly affected because many obtain significant shares of their total household income from local nonfarm sources.

Some of the most dramatic evidence of the failure of traditional risk management arrangements in handling covariate risk comes from studies of drought. For example, detailed studies of the impact of droughts in Ethiopia, (Webb and von Braun, 1994) and eastern India (Pandey, Bhandari and Hardy, 2007) show that in percentage terms, income losses can exceed initial production losses because of a collapse in local agricultural and nonfarm employment, wages and asset prices. Most households in drought hit areas suffer consumption shocks with the impact being most severe for the poor.

What is missing in most developing countries is a third line of defense in risk management, namely mechanisms to enable farmers and rural communities to pool large and covariate risks at more aggregate levels (i.e. the top layer of the pyramid in Figure 1). In developed countries, formal financial institutions play an important role in pooling risks at more aggregate levels, and hence overcoming many of the problems discussed above. But financial institutions still play only a

minor role in smoothing rural incomes and consumption in most developing countries.

Figure 1: Three Tiers of Risk Pooling



Past Experience with Public Interventions

Recognizing the limitations of traditional risk management institutions, many governments have intervened with a range of risk management programs for farmers, including crop insurance, price stabilization, livestock feed subsidies, and emergency relief. Unfortunately, most have proved an expensive drain on the public purse with little evidence to show that they have generated any sizeable net social benefits. We review some of these experiences below.

Crop Insurance

Publicly provided crop yield insurance has been implemented in many countries (Hazell, Pomareda, and Valdes, 1986). Most programs have been multiple peril or all-risk programs, meaning that the insurance compensates all yield losses, regardless of cause. Although insured hazards are often enumerated, the lists of covered hazards are so comprehensive that uninsured hazards cannot be excluded in practice. Indemnities are typically based on the difference between actual yield and a pre-specified target yield, not on actual crop damage or input costs lost. Setting the target yield has proven difficult given poor or non-existent historical records for individual farms. Some programs included deductibles so as to help control for adverse selection and moral hazard problems. In many countries the insurance has been tied to loans from a state operated agricultural development bank with the bank paying the premium and collecting the indemnities. In some countries the insurance has been made compulsory for all farmers growing the insured crops or borrowing from a state bank.

The financial experience with publicly-provided, multiple-peril crop insurance has been ruinous. Without exception, programs have been heavily subsidized with governments paying part of the farmers' premium and a share of the administration costs. Often the government has also had to pick up part of the indemnity payment in years when the insurer had insufficient reserves. To make a profit without government support, an insurer needs to structure its price its contracts so that over time the total premiums

collected from farmers exceed the total payouts made (indemnities plus administrative costs). Hazell (1991) analyzed the experience with public crop insurance programs in seven countries with 5 or more years of available financial data and found that in all cases the total payouts exceeded the premiums collected from farmers by a factor of 2. He also found that the premium rates paid by farmers would need to be more than tripled for the insurers to break even without government subsidies.

Despite these high costs, there is little evidence to show that crop insurance had any positive impacts on agricultural lending, agricultural production or farm income. For example, social cost-benefit analyses of the Mexican and Japanese schemes show negligible social returns in relation to their high costs (Bassoco et al., 1986; Tsujii, 1986). Pomareda (1986) found that a small increase in interest rates would have been just as beneficial to the agricultural development bank in Panama as the compulsory crop insurance program for its borrowers. Crop insurance, when heavily subsidized, can even have important negative social impacts by encouraging farmers to grow unsuitable crops in risky environments.

Why has public crop insurance failed so badly? There are several prominent reasons:

- Many of the risks covered by multiple risk insurance were open to moral hazard problems. Since there was rarely any attempt to limit the kinds of losses covered or to attribute cause, farmers could receive compensation even when part of the damage was due to their own negligence. Lack of data to quantify yield risks at farm levels

also lead to unrealistic setting of yield targets and inflated estimates of crop losses. These conditions lead to greater losses than necessary, increase the risk exposure of the insurer, and making “fair” actuarial calculations of those risks almost impossible.

- Premium rates were typically fixed by government and at the same rate for large groups of farmers, leading to adverse selection problems.

- Public insurers were often mandated to extend their insurance to small farms, and this added significantly to their administration costs.

- Inappropriate incentive problems arise within insurance institutions when the government underwrites most of their programs. When insurers know that the government will automatically cover most losses, they have little incentive to pursue sound insurance practices when assessing losses. In fact, they may find it profitable to collude with farmers in filing exaggerated or falsified claims. Hazell (1991) reports that in Mexico prior to the closing of the national agricultural insurance agency, it was not uncommon for inspectors to receive bribes of about 30 percent of the value of the indemnity payments made to farmers. When the insurer underwrites the loans of an agricultural development bank these incentive problems can easily infect the bank too, leading to a serious loss of discipline in banking practices. Why, for example, should bank staff try to collect loans from tardy borrowers if they can more easily obtain repayment from the state insurer?

- Governments have undermined public insurers for political reasons. Hazell (1991) gives examples where insurers have had to pay out against exaggerated losses in election years. Also, governments have sometimes undermined their crop insurance programs by providing direct assistance to producers in disaster areas (Goodwin and Smith, 1995). Why should farmers purchase crop insurance against major calamities (including drought) if they know that farm lobbies can usually apply the necessary political pressure to obtain direct assistance for them in times of need at little financial cost?

- Many crop insurance programs also became too specialized, focusing on specific crops, regions and types of farmers, particularly when the insurance was tied to the loans of an agricultural development bank that had a mandate to serve particular target groups identified by the government. Without a well-diversified insurance portfolio, crop insurers are susceptible to the covariate risk problem, and face the prospect of sizeable losses in some years. Since public insurers are rarely able to obtain commercial insurance or contingent loan arrangements, this specialization increases their dependence on the government.

Public crop insurance programs became hugely expensive to governments and most of the programs in developing countries have been phased out since the 1980s. Private crop insurance has since grown in a number of developing countries, but to avoid the pitfalls of the public programs, private insurers typically only offer contracts against specific

perils (e.g. hail or frost damage) and sell mostly to commercial farmers growing higher value crops (Hazell, 1992).

Price Stabilization

Price stabilization affects food prices for consumers as well as farm gate prices for producers and hence has been widely implemented by governments as much to protect consumers from price spikes as to protect farmers from market price collapses.

The theoretical literature suggests that the aggregate social welfare gains from price stabilization are likely to be small (e.g. Newbery and Stiglitz, 1981; Wright. 1988). But the separate impacts on producers and consumers can be larger -- though offsetting, and the circumstances under which group gains and which loses has been the subject of an extensive literature (Newbery and Stiglitz, 1981). But these theoretical results do not consider the important dynamic gains to be had if price stabilization contributes to the widespread adoption of more productive technologies. Cummings, Rashid and Gulati (2006) argue that because price stabilization schemes corrected some important market failures and helped create an enabling economic environment for the Asian Green revolution, then it contributed to the generation of enormous economic and social benefits.

One limitation of stabilization schemes is that they effectively impose the same level of price insurance on all farmers growing a commodity, irrespective of individual risk

preferences or whether or not their price and yields are negatively correlated. This can actually make some farmers worse off than if they were left exposed to the market (Newbery, 1989). There is also a potential moral hazard problem if farmers receive the same minimum price regardless of the quality of the product they deliver.

Like public crop insurance, price stabilization schemes managed by state agencies became very expensive. This was partly because of high administration and storage costs, but also because of built in subsidies when prices are distorted from border prices in the favor of consumers or producers. Many price stabilization schemes were phased out as part of the market liberalization programs of the late 1980s and 1990s. The surviving institutions are nearly all in Asia.

Key problems that contributed to their demise are as follows:

- It is difficult to set the price band within which prices are to be stabilized. Structural changes in production technology, consumer demand and world markets need to be recognized or markets cease to efficiently guide resource allocation within the agricultural sector.

- Price bands are open to political manipulation. In Africa, many marketing boards used price stabilization schemes to tax farmers (Newbery, 1989). In Asia, price stabilization schemes were often used to improve the terms of trade for farmers or to offset macroeconomic biases against agriculture, at least during the Green Revolution

era (Cummings et al., 2006). When stabilization programs distort average or trend prices for consumers, producers or both, they soon lead to high subsidy costs and to economic inefficiencies by sending farmers and consumers the wrong market signals.

- Market price interventions driven by social and political agendas undermine private storage and trade.

Feed Subsides

Feed subsidies have been an important public intervention for managing drought risks in many pastoral farming systems. In the West Asia and North Africa (WANA) region, feed subsidy programs have been widely used to provide supplementary feed to safeguard livestock in drought years, with the predominant expenditure going for subsidies toward the costs and distribution of concentrates and other feeds, especially barley (Hazell, Oram and Chaherli, 2001). These programs have been quite successful in protecting livestock numbers and production during droughts, but they have also encouraged unsustainable farming practices. In particular, they have:

- Accelerated rangeland degradation in the long term by undermining the traditional process of adjusting flock size to inter-annual climatic variations. Herd sizes have increased sharply since the introduction of feed subsidies, and grazing practices have changed so that many of the animals no longer leave the rangeland areas during the dry season but have their feed and water trucked in. This practice leads to overgrazing during the dry season, reduces the natural seeding of annual

pasture species, disturbs the soil, and contributes to wind erosion, particularly in areas near water and feed supply points.

- Led to high government procurement prices for barley that has encouraged the mechanized encroachment of barley cultivation onto rangeland areas where it causes serious soil erosion and cannot be sustained.

Although typically introduced as a relief measure in severe droughts, once established feed subsidies have tended to become permanent and expensive to governments, and they have proved difficult to target, with the lion's share of the subsidized concentrates going to large herders and to commercial farms. Total costs became high and they were scaled back in most countries as part of market liberalization programs.

Relief Programs

Many governments have found it necessary to provide direct disaster assistance to relieve the problems of rural areas stricken with catastrophic losses caused by natural hazards like drought, flood, and hurricane. For many small, risk prone countries, such government assistance can be extremely costly and may represent a high percentage of GNP when the disaster is large. This cost detracts from the resources available for agricultural development, and increases a country's dependence on donor assistance. These costs may escalate in the future as more people live in vulnerable areas and as global climate change increases the frequency and severity of many natural disasters.

Relief programs are driven by humanitarian rather than development agendas and their primary value is in saving lives and rebuilding assets. However, they have run into a number of problems:

- It is difficult to target relief aid to the truly needy and large leakages to others are common.
- Relief can distort incentives for development e.g. food aid can depress local prices for farmers.
- Emergency relief often arrives too late.
- Once disaster assistance has been institutionalized and people know they can count on it, it has many of the longer term effects of an insurance subsidy that inadvertently worsens future problems by encouraging people to increase their exposure to potential losses. For example, compensation for flood or hurricane damage to homes can lead to the building of more houses in flood and hurricane prone areas. Similarly, compensation for crop losses in drought prone areas encourages farmers to grow more of the compensated crops even when they are more vulnerable to drought than alternative crops or land uses.

General Lessons from Past Public Interventions

A common problem with many public risk management interventions is that they lead to moral hazard problems and people may not take reasonable precautions to prevent or minimize losses. This is most obvious in the case of multiple-risk crop insurance, but

similar disincentive problems have arisen with livestock feed subsidies and public relief programs. They can also arise with price stabilization if the purchasing agency does not adjust the minimum price for the quality of the product delivered.

Once they are entrenched, sustained subsidies for risk management interventions can distort economic incentives. Subsidies for risk management have similar effects as subsidies on any other input; they encourage over use of that input. In this case the "overuse of the input" is the adoption of farming practices and livelihood strategies that lead to a growing dependence on government assistance. For example, compensation for repeated flood or hurricane damage to homes can lead to the building of more houses in flood and hurricane prone areas. Compensation for crop losses in drought prone areas encourages farmers to grow more of the compensated crops. Feed subsidies have encouraged the encroachment of barley production onto the steppe in the WANA region.

Governments have tried to manage too much risk. It is simply too costly to try and pool all the price, yield or income fluctuations confronting farmers and rural communities, even just the downside risks. Many of these risks are too open to moral hazard and asymmetric information problems and occur with too high a frequency to be insurable at reasonable cost. Most households and rural communities have already proved that they are quite capable of managing independent risks and small covariate risks. It is the catastrophic risks in the lower tail of the loss distribution that are more problematic and need to be addressed.

There has been inadequate differentiation of the needs of vulnerable people who cannot afford to insure from the more general population that can. This is equivalent to a failure to separate a social from a development (or growth) agenda. Some household types are quite capable of bearing and managing most of the risks they face if suitable commercial risk management instruments are available and, except in the event of major disasters, do not need access to subsidized government interventions. But there are many vulnerable households who do not have this capacity, and for whom all risk management interventions serve primarily as social safety nets. The later can only be provided on a heavily subsidized basis. Mixing these two types of needs leads to the design of public interventions that are heavily subsidized for all, and which end up being very costly both in terms of their direct government cost and the economic inefficiencies they create through distorted incentives. If the needs of these two types of households can be differentiated, then more efficient and targeted instruments could be designed.

Recent years have seen two important developments. The first has been the termination or downsizing of many heavily subsidized, public risk management interventions like crop insurance, price stabilization and feed subsidies. The second has been the rapid growth in the use of safety net programs, with real advances in their design and implementation to improve targeting and reduce costs. These developments have provided an opportunity to take a more rationale approach to risk management in agriculture, assigning the social agenda to the safety net programs and allowing risk management interventions to focus on the development agenda. This has spawned a great deal of interest in market mediated approaches to risk management.

A Role for Markets to Manage Risk

In countries with well developed financial systems, the banking system offers an efficient way for many farmers to cushion inter-seasonal shocks in income and consumption. But banking services are much less accessible to farmers in developing countries, and credit for consumption purposes is limited to traditional sources that are costly and suffer from the covariate risk problem.

Alternative market based instruments are therefore needed that deal more directly with important price and production risks. The most promising developments so far are area-based index insurance and futures markets.

Area-Based Index Insurance

Area-based index insurance is an attractive instrument for managing the kinds of covariate and catastrophic risks that local communities cannot manage on their own. The essential principle of this kind of insurance is that contracts are written against specific perils or events (e.g. area yield loss, drought, or flood) which are defined and recorded at regional levels (e.g. at a local weather station). To serve as agricultural insurance, the index should be defined against events that are highly correlated (on the downside) with regional agricultural production or income. For example, an insured event might be that rainfall during a critical period of the growing season falls 70% or more below normal.

All buyers in the same region are offered the same contract terms per dollar of insurance coverage. That is, they pay the same premium rate and, once an event has triggered a payment, receive the same rate of payment, and their total payments and indemnities would be that rate multiplied by the value of the insurance coverage purchased. Payouts for index insurance can be structured in a variety of ways, ranging from a simple zero/one contract (once the threshold is crossed, the payment rate is 100 percent), through a layered payment schedule (e.g., a one third payment rate as different thresholds are crossed, to a proportional payment schedule.

Area-yield insurance was the first type of index insurance product to be developed for agriculture. The insurance is written against the average yield for a region (e.g., a county or district) as measured through official crop cuts, and a payment is made whenever the officially reported yield for the region falls below some predefined yield (say, 90 percent of normal). Area-based yield insurance requires long and reliable time series of area-yield data, and this kind of data is not widely available in developing countries. The need to wait for official yield reports after the harvest also leads to delays in compensating farmers (in India the delays have become a serious problem (Hazell and Skees, 2006). Hence alternative indices based on weather data have become more attractive, such as area rainfall or temperature. Weather data are much more widely available and are collected on a regular basis at large numbers of local weather stations. Index-insurance contracts can also be written against other natural disasters, including flood, wind speed from hurricanes, and earthquake events using the Richter scale.

Area-based index insurance has a number of attractive features:

- Because buyers in a region pay the same premium and receive the same indemnity per unit of insurance, it avoids all adverse selection problems. Moreover, moral hazard is avoided because the insured's management decisions after planting a crop will not be influenced by the index contract. A farmer with rainfall insurance possesses the same economic incentives to produce a profitable a crop as the uninsured farmer.

- It can be very inexpensive to administer, since there are no individual contracts to write, no on-farm inspections, and no individual loss assessments. It uses only data on a single regional index, and this can be based on data that is available and generally reliable. It is also relatively easy to market. At the extreme, contracts could even be sold rather like travelers' checks or lottery tickets to any willing buyer. Unfortunately, existing insurance law in many countries does not allow this option.

- The insurance could in principle be sold to anyone. Purchasers need not be farmers, and the insurance could be attractive to anybody in the region whose income is correlated with the insured event, including agricultural traders and processors, input suppliers, banks, shopkeepers, and laborers. Unfortunately, existing insurance law in many countries does not allow this flexibility.

- It is easy for the private sector to run, and might even provide an entry point for private insurers to develop other kinds of insurance products for rural people. For example, once an area-based index removes much of the covariate risk, an insurer can

wrap individual coverage around such a policy to handle independent risk (i.e., certain situations where the individual has a loss and does not receive a payment from the area-based index).

- As long as the insurance is voluntary and unsubsidized, it will only be purchased when it is a less expensive or more effective alternative to existing risk management strategies. If the insurance is offered in small denominations it could also appeal to poor people.

- Recent developments in micro-finance make area-based index insurance an increasingly viable proposition for helping poor people better manage risk. The same borrowing groups established for microfinance could be used as a conduit for selling index insurance, either to the group as a whole, or to individuals who might wish to insure their loans

A key question is under what conditions index insurance would prove attractive to buyers. An index product should be more affordable than individual insurance, particularly if government does not subsidize either. Moreover, by offering an index contract that removes most of the systemic, correlated risk that an individual faces, he/she only faces independent risks that may more easily be insured through conventional insurance or credit markets.

However, index insurance is subject to basis risk and this can dampen demand. This is the problem that arises if an individual suffers a loss but is not paid because the major event trigging a payment for the region has not occurred. For example, an individual farmer with rainfall insurance could lose his/her crop to drought, but not receive an indemnity if the drought is not widespread and recorded at the region's weather station. With index contracts it is also possible for an individual to be paid when they suffer no losses. Index contracts essentially tradeoff basis risk for transaction costs, and the insurance will not be attractive if the basis risk becomes too high.

Basis risk can be reduced by limiting the insurance to severe or catastrophic weather events affect all people in a region. Individual losses are then much more likely to be highly correlated with the insured weather station event. Another way to reduce basis risk is to increase the number and dispersion of weather stations so as to better capture spatial variation in climatic conditions in writing contracts. However, adding weather stations is expensive and they come without site specific historical records. This has led to interest in new types if indices that can be assessed remotely with satellites, such as cloud cover or soil moisture content for a chosen region during critical agricultural periods. This kind of data is becoming increasingly available and may prove the wave of the future. But its current use in writing contracts for individual households (or borrowers) is constrained by a credibility problem; people may not trust financial decisions made by others on the basis of "unseen" data that may, because of basis risk problems, fail to correlate highly with their own on-the-ground observations. It may be more relevant for now in writing index contracts for lending institutions to cover their own portfolio risks.

While a high covariance risk increases the attractiveness of the insurance to buyers, it presents a serious problem for the insurer. This is because all those who have purchased insurance against the regional index must be paid at the same time. Moreover, if the insured risks in different regions are highly correlated, then the insurer faces the possibility of having to make huge payments in some years. The insurer can hedge part of this risk by diversifying its portfolio to include indices and sites that are not highly and positively correlated, but it may also be necessary to sell part of the risk to the international and financial markets through reinsurance contracts or the emerging markets for sharing catastrophic risk.

International reinsurance is already available for some kinds of natural disaster risk. The simplest form of reinsurance is a stop loss contract where the primary insurer pays a premium to get protection if their losses exceed certain levels. Other forms of reinsurance are also common. Quota-share arrangements involve simply sharing both premiums and indemnities. Despite significant growth in the international reinsurance markets in recent years, reinsurance markets are still thin with few large international firms and limited capacity.

As an alternative to formal reinsurance, recent developments in global financial markets are making it increasingly feasible to use new financial instruments to spread covariate risks more widely, such as catastrophe bonds. However, the high transaction costs associated with these arrangements have been a major impediment to their use for developing countries and for agricultural risk. These costs could be reduced by having

government play a role in aggregating risk within a country and insuring part of the aggregate risk itself before going to the global markets. The need to go to the global market could also be reduced if international development banks, such as the World Bank or others in the capital markets, provide governments with contingency loan arrangements so that the government would have sufficient capital to pay all losses if the bad year. This kind of arrangement could be especially valuable during the early years of an insurance program before an adequate reserve had been built up.

In addition to farmers, banks and micro-finance organizations might also value index insurance as a useful aid for insuring loans to a wide range of borrowers that have exposure to agriculturally related risks. Despite the success of microfinance, it is not widely used for agricultural lending. An important reason is the common exposure of borrowing group members to covariate weather risks that undermine their collective capacity to repay loans in bad years. Weather based index insurance might be a feasible way to underwrite some of the covariate risks of borrowing groups. Lending institutions may also value index insurance as a way of hedging some of their own portfolio risk.

India has had a government backed area-yield insurance scheme since the early 1980s (Hazell and Skees, 2006). Although the program is generally well designed and managed by a public insurance agency (the Agricultural Insurance Company of India, AICI), government interventions in premium setting has led to a situation in which the insurance is not financially sustainable without heavy government subsidies (the average loss ratio between 1985 and 2002 was 5.0, implying that the government had to subsidize 80% of the total cost). Not only are the premium rates that farmers pay not based on actuarial

principles, but there is little price discrimination among rates to reflect the large differences in relative risk that occurs among different Indian states. These differences and the poor rate-making procedures have led to the preponderance of payments from the Indian crop insurance program being made to only one state — Gujarat. Not surprisingly, the private sector does not sell area yield insurance in India.

Weather index insurance has been piloted in a number of developing countries. We consider three recent examples. In India, two insurance companies (ICICI Lombard General Insurance Company and Iffco Tokio General) offer market weather insurance. Although total sales have grown rapidly in the past few years, market penetration remains well below 1% of both the number of farms and the area under cultivation.

ICICI Lombard partners with a microfinance organization (BASIX) as an intermediary to promote and sell the insurance and this creates opportunities for the insurance to be linked to credit. The financial performance of the insurance sold through BASIX has been favorable to date (Table 1), with an accumulated loss ratio of 0.65 since 2003/04. But BASIX has only sold 34,000 policies so far, and seems to be having trouble scaling the product up. Emergent problems from this experience include: the need to establish additional private weather stations to reduce basis risk; low numbers of contract sales (and hence high costs per sale) against each weather station; and high cost of international reinsurance. Scaling up weather insurance in India is also challenged by competition from the heavily subsidized crop yield insurance program, which is compulsory for all farmers borrowing from the state banks.

Table 1: Financial Performance–BASIX weather insurance portfolio

	2003-04	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**Cumulative**
No of customers	230	402	6,689	11,716	4,545	10,604	34,186
Claims settled	154	319	864	2379	537	793(due)	5046
% of farmers who received claims	67%	79%	13%	2%	12%	7.5%	15%
Premium Collected (Rs)	88,685	824,681	1,703,098	1,430,171	1,539,175	2,098,638	6,145,273
Claim amount Paid (Rs)	41,860	471,485	950,000	2,063,160	298,922	470,671	3,997,176
Loss Ratio	47%	57%	56%	144%	20%	22%	65%
Weather Stations	1	5	36	50	45	40	

Source: Presentation by Vijay Mahajan (BASIX) at a WFP/IFAD/BASIX workshop on The Current State of Practice in Index Insurance, Hyderabad, India, November 18, 2008.

In Malawi, the Insurance Association of Malawi offers weather index insurance to small farmers to insure loans from local banks for buying improved groundnut seed (Skees and Collier, 2008). A crop-yield simulation model is used to structure the rainfall insurance payouts to ensure a high correlation with yields. The product has been piloted in four areas, and in the 2005–2006 growing season, 892 farmers purchased weather insurance for a total sum insured of $35,000. In the 2006–2007 growing season farmer uptake increased to 1,710 groundnut farmers and a rainfall-based insurance contract was also purchased by some 826 farmers for maize production. No claims have been paid so far.

Mongolia has recently launched a pilot index insurance program to protect herders against high livestock losses due to severe winters. The insurance is sold by private insurance companies, and was bought by 2,400 herders (10% of the eligible herders) in 2006, the first pilot year. The index is based upon county-level livestock mortality rates that are collected by the national statistics office. Though the index is based on livestock

mortality and not on a specific weather event, the major underlying cause of large livestock losses is severe winter weather.

Some more general lessons emerging from these and other pilots are as follows:

- The insurance is often tied to farmers, individual crops or farm credit. This greatly narrows the type of households that can purchase the insurance, and when tied to the yields of specific crops may even make the insurance unattractive to many farmers. Many small farmers are diversified, producing a mix of crop and livestock products and often having significant off-farm sources of income. In this context, losses in household income that affect debt repayment capacity may not highly correlate with the yields of individual crops and hence would not be improved much by insurance tied to specific crop yield outcomes. Unfortunately, the insurance regulations prevailing in many countries require a proven business exposure in any insurance contract and therefore make it difficult to market insurance for more general purposes.

- Insurers can cut transactions costs by using an intermediary organization with an existing delivery infrastructure, such as a microfinance organization (e.g. BASIX in India). Linking to a finance organization can also enable the insurance to be linked directly to credit, and for credit to be provided to finance the insurance premium. There may be other types of useful intermediaries in the market chain, such as fertilizer distributors and seed companies that could sell insurance to cover the costs of their products. These kinds of options may be even greater in high value market chains where processors or retailers are willing to contract with farmers and provide

credit and other inputs. However, existing insurance regulations may hinder these kinds of partnerships. In India, for example, insurance can only be issued by a registered insurer, requiring that every insurance contract drawn up by an intermediary is vetted and approved by the insurer. This adds to costs and delays contract approval.

- Farm households sometimes have access to season specific information that enables them to forecast insured weather events with greater than normal probability. For example, in India the date of onset of a monsoon has been shown to be a reasonable predictor of the season's rainfall pattern, and seasonal climate forecasts are available from meteorology services that are increasing in accuracy. In Mongolia, the condition of the summer pastures gives some indication of the vulnerability of livestock in the coming winter (Skees, 2007). It is therefore critical to either establish closing dates for selling insurance that are far enough in advance to preempt the value of such forecast information, or to adjust the premium rate on a dynamic basis. More difficult problems can arise in areas that are impacted by cyclical weather patterns. For example, in Peru a rise in sea temperatures can be used to predict the onset of the El Nino Southern Oscillation some seven to eight months before it occurs. In extreme cases, insurance might have to be sold on a multiyear contract basis.

Although the private sector is playing a key role in many of the new index insurance programs, still the schemes have been initiated by the public sector or international players such as the World Bank. It appears there are serious set up problems that need to

be overcome, and private insurance companies are not able to do this on their own. If index insurance is to scale up, governments will need to intervene more actively by playing important facilitating roles. According to Skees and Collier (2008) these roles include:

- Collecting, maintaining, and archiving the data needed. These data should be made available for public use and for use by those with commercial interests wishing to develop innovative weather insurance products. Increasing the number of weather stations at which such data are collected is also an important need in many developing countries. Private firms can be contracted for this purpose but the data should be made publicly available on a timely basis.

- Establishing a legal and regulatory environment for enforceable contracts that both buyer and seller can trust. Additionally, laws and regulations need to be consistent with international standards to improve the chances of insurers gaining access to global markets for risk transfer. Unfortunately, in many countries, laws and regulations are simply not in place to accommodate the development and use of weather insurance products. Human capacity building and technical assistance are essential for preparing the legal and regulatory environment to govern index insurance programs.

- Educating farmers about the advantages and disadvantages of index insurance products. To increase the likelihood that information is presented in a balanced way

and that sufficient investments are made in a broader educational effort for an untested product, public funds from governments and/or donors may be required.

- Supporting product innovation. One of the challenges associated with private-sector development of new financial products is the ease with which they can be copied and replicated by others. This "free-rider" problem discourages many companies from making initial investments in new product development, especially in underdeveloped markets. Thus, some level of government and/or donor support for product development can be justified. These investments should be targeted at feasibility studies and developing pilot tests of new products with the involvement of local private-sector partners.

- Underwriting part of the insurer's exposure in the early years. Until a sufficient volume of business has been established to attract global reinsurers, extreme losses for the insurance pool may need to be underwritten by government and/or donors, perhaps through contingent loan arrangements. For example, the World Bank has a provided a contingent loan arrangement for the Mongolian livestock insurance scheme.

Futures and Options Markets

The removal of many public price stabilization schemes as part of market liberalization programs has led to increased exposure to price risk for many developing country farmers.

Although producer prices typically have high coefficients of variation (often 20-30% or more), producers are typically more concerned about downside risks than variability per se. Forward pricing arrangements are primarily a way of hedging against downside risk. Indeed, their repeated use can only reduce the variance of price farmers receive if the variance of the futures price is smaller than the variance of the spot price (Tomek and Peterson, 2001).

There are two market mechanisms for hedging price risks. One is contract farming where the buyer provides the farmer with a forward price contract early in the growing season. Essentially the buyer assumes the price risk for the grower. Forward contracting is most likely to be found in high value market chains where buyers have clear reasons for wanting to source their supplies. For example, high value export crops like flowers and vegetables where the buyer needs assured quality and reliable supplies. These kinds of market chains have grown rapidly in recent years but there are not many studies of their effectiveness in sharing risk or of the number of farms that have benefited. One exception is a study by Ramaswami, Birthal and Joshi (2006) who find that contract farming for poultry meat in India does lead to significant reductions in the coefficient of variation of income for contract farmers.

Futures and options markets are a less individualized way of enabling farmers to lock into forward prices. Since there are not many operating futures markets around the world, their use is constrained by basis risk. Hedging price risks for an export crop may be attractive because the basis risk can be low. This is because the farmer is selling the same

product in parallel and highly linked world spot and futures markets and, since both transactions are undertaken in the same currency, there is no foreign exchange rate risk (Morgan et al., 1999). On the other hand, incentives for hedging the price of non-export crops in a world futures market are much less favorable. In this case there may only be a low correlation between the domestic price of the commodity and the foreign futures price, and the two transactions are carried out in different currencies leading to an exchange rate risk. These problems can only be adequately resolved by having a local futures market. Morgan, Rayner and Vaillant (1999) discuss what is needed to set up local commodity and futures markets.

Few farmers use futures and options markets, even in industrial countries. In the US, only about 10% of farmers use futures and options markets (Tomek and Peterson, 2001), and the level of participation is even lower in Australia (Simmons, 2002). Basis risk is an important problem, especially for developing country farmers without national futures markets. Although the cost of futures trades are not particularly high (about 2%), access to those markets is a problem, especially if the trading is to be done overseas. Individual farmers need marketing intermediaries who can trade on their behalf. In Costa Rica, coffee exporters serve as intermediaries. They offer farmers forward contracts and then hedge the risk in the NY coffee futures market (Myers, 1993). This way the farmer may not even know that his/her price risk has been transferred to the NY market; all he or she sees is a forward contract price with the mill/exporter. Similar arrangements are possible for other high value export crops. It seems unlikely that marketing intermediaries can be

found for commodities like food staples sold in domestic markets until such time as national or regional futures/options markets for those commodities have been developed.

Conclusions

Since the withdrawal of many public risk management schemes, there has been much hope that market mediated solutions to risk management would emerge to handle the kinds of covariate yield and price risks that farmers and rural communities cannot manage on their own. This has led to considerable innovation and the piloting of new approaches, particularly with index insurance and forward pricing arrangements.

These are still early days, but it is becoming clear that market mediated approaches to risk management are not achieving anything like the scale needed. There has also been little spontaneous development by the private sector, and governments or international agencies like the World Bank have had to initiate activities. This reluctance by the private sector seems related to the high basis risks associated with too few weather stations or futures exchanges; set up problems that private firms cannot easily overcome on their own; the need for marketing intermediaries to link farmers with insurers and futures traders; and the fact that many risk management products are simply too expensive for many small farmers to afford.

There is need for further product and institutional innovation and also for a stronger public sector role in helping to launch new programs. In particular, governments need to

create more enabling regulatory environments, set up more weather stations and futures market exchanges, and in the case of index insurance, provide a first line of reinsurance. If market mediated solutions cannot be made to work better, many governments and donors are likely to become even more entrapped in providing expensive safety net programs for rural people.

References

Anderson, J.R. and J.L. Dillon. 1992. *Risk analysis in dryland farming systems.* Farming Systems Management Series. Rome: FAO.

Carter, Michael R., and Christopher B. Barrett. 2006. The economics of poverty traps and persistent poverty: An asset-based approach. *Journal of Development Studies*, 42(2): 178-199.

Cummings, Ralph Jr., Shahidur Rashid and Ashok Gulati. 2006. Grain price stabilization experiences in Asia: What have we learned? *Food Policy,* 31 (2006): 302-312.

Gautam, Madhur, Peter Hazell and Harold Alderman. 1994. Rural demand for drought insurance. Policy Research Working Paper 1383, World Bank, Washington DC.

Goodwin, Barry K. and Vincent H. Smith. 1995. *The Economics of Crop Insurance and Disaster Aid.* Washington D.C.: The AEI Press.

Hazell, Peter, Luz Maria Bassoco and Gustavo Arcia. 1986. A model for evaluating farmers' demand for insurance: Applications in Mexico and Panama. In P.B.R. Hazell, C. Pomareda and A. Valdés (eds.), *Crop Insurance for Agricultural Developments: Issues and Experience*. Johns Hopkins University Press, Baltimore.

Hazell, Peter, Peter Oram, and Nabil Chaherli. 2001. "Managing Livestock in Drought-Prone Areas of the Middle East and North Africa: Policy Issues". In (ed) Hans Löfgren. *Food and Agriculture in the Middle East*. Research in Middle East Economics, Vol. 5. New York: Elsevier Science.

Hazell, Peter and Jerry Skees. 2006. Insuring against bad weather: recent thinking. In *India in a Globalizing World, Essays in Honour of C. H. Hanumantha Rao.* R. Radhakrishna, S. K. Rao, S. Mahendra Dev and K. Subbarao (eds.). New Delhi: Academic Foundation.

Hazell, P.B.R. 1992. The Appropriate Role of Agricultural Insurance in Developing Countries. *Journal of International Development*, 4(6):567-581.

Hazell, P.B.R. and R.D. Norton. 1986. *Mathematical Programming for Economic Analysis in Agriculture*, MacMillan Publishing Co., N.Y.

Hazell, P.B.R., C. Pomareda and A. Valdés (eds.). 1986. Crop Insurance for Agricultural Development" Issues and Experience. Johns Hopkins University Press, Baltimore.

Keyzer M.A.., V. Molini and G.J.M. van den Boom (2007) “Risk minimizing index functions for price-weather insurance, with application to rural Ghana”. Center for World Food Studies SOW-VU Working Paper 07-02.

McCarthy, Nancy. 2003. Demand for Rainfall-Index Based Insurance: A Case Study from Morocco. Environment and Production Technology Division Discussion Paper No. 106, IFPRI, Washington DC.

Morgan, C. W., A. J. Rayner and C. Vaillant. 1999. Agricultural futures markets in LDCs: A policy response to price volatility? *Journal of International Development*, 11: 893-910.

McCarthy, N., B. Swallow, M. Kirk and P. Hazell (eds.). 1999. *Property Rights, Risk, and Livestock Development in Africa.* Washington DC: International Food Policy Research Institute.

Meyers, Robert J. 1993. Strategies for managing coffee price risks in Costa Rica. Chapter 6 in *Managing Commodity Price Risks in Developing Countries,* S. Claessens and R. Duncan (eds.). Baltimore: Johns Hopkins University Press for the World Bank.

Newbery, David M. 1989. Agricultural institutions for insurance and stabilization. Chapter 14 in *The Economic Theory of Agrarian Institutions,* P. Bardhan (ed.), Oxford: Clarendon Press.

Newbery, D. M. G. and J. E. Stiglitz. 1979. Sharecropping, risk-sharing, and the importance of imperfect information. Chapter 17 in *Risk, Uncertainty and Agricultural Development,* J.A. Roumasset, J.M. Boussard and I. Singh (eds.), Agricultural Development Council, N.Y.

Newbery, D. M. G. and J. E. Stiglitz. 1981. *The theory of commodity price stabilization.* Oxford: University Press.

Otsuka, K., and Y. Hayami. 1993. *The Economics of Contract Choice: An Agrarian Perspective*. Oxford: Clarendon Press.

Pandey, S., H. Bhandari and B. Hardy (Eds.). 2007. Economic costs of drought and rice farmers' coping mechanisms. Los Banos (Philippines): International Rice Research Institute.

Ramaswami, B., P. S. Birthal and P. K. Joshi. 2006. Efficiency and distribution in contract farming: The case of Indian poultry growers. MTID Discussion Paper No. 91. Washington DC: International Food Policy Research Institute.

Sakurai, Takeshi and Thomas Reardon. 1997. Potential Demand for Drought Insurance in Burkina Faso and its Determinants. *American Journal of Agricultural Economics*, 79(4):1193-1207, November.

Skees, Jerry. 2000. A role for capital markets in natural disasters: A piece of the food security puzzle. *Food Policy*, 25(2000):365-378.

Skees, Jerry and Benjamin Collier. 2008. The Potential of Weather Index Insurance for Spurring a Green Revolution in Africa. Paper presented at the AGRA policy convening, June 23-25, Nairobi.

Simmons, Phil. 2002. Why do farmers have so little interest in futures markets? *Agricultural Economics*, 27 (2002):1-6.

Sommerfeld, Jojannes, Mamadou Sanon, Bocar A. Kouyate and Rainer Sauerborn. 2002. Informal risk-sharing arrangements (IRSAs) in rural Burkina Faso: Lessons for the development of community-based insurance (CBI). *International Journal of Health Planning and Management*, 17: 147-163.

Tomek, William G. and Hikaru Hanawa Peterson. 2001. Risk management in agricultural futures markets: A review. *The Journal of Futures Markets*, 21 (10): 953-985.

Walker, T. S., and N. S. Jodha. 1986. How small households adapt to risk. Chapter 2 in Hazell, P.B.R., C. Pomareda and A. Valdés (eds.). *Crop Insurance for Agricultural Development" Issues and Experience.* Johns Hopkins University Press, Baltimore.

Webb, Patrick and Joachim von Braun, 1994. *Famine and food security in Ethiopia: Lessons for Africa*. Chichester New York: Published on behalf of the International Food Policy Research Institute (IFPRI) by John Wiley.

Wright, B.D. 1988. Storage, Stability, and Farm Programs. In; D.A. Sumner (ed.). *Agricultural Stability and Farm Programs: Concepts. Evidence, and Implications.* Boulder: Westview, 27-49.