Draft for Discussion Purposes
GPFI SME Finance SubGroup
Roundtable on Innovations in Agricultural Finance
Antalya, September 9, 2015

On behalf of

Innovations and Emerging Trends in Agricultural Insurance

Author: Ulrich Hess, Peter Hazell
Researcher: Saskia Kuhn

Innovations and Emerging Trends in Agricultural Insurance

1. The problem of risk in agriculture

Agriculture is a risky business and farmers face a host of market and production risks that make their incomes volatile from year to year. These risks include yield losses due to bad weather, pests and diseases; post-harvest losses during storage and transport; and unexpectedly low market prices. In many cases, farmers are also confronted by the risk of catastrophic losses, for example, when crops or livestock are destroyed by drought, fire or new pest outbreaks, or when lives and assets are lost due to extreme weather events like hurricanes and floods. These risks can pose challenging financial problems even for large commercial farms in developed countries, but the consequences for vast numbers of smallholders around the developing world are much more severe. Major shocks to household incomes, food consumption and assets worsen poverty and lead to episodic humanitarian crises that require large-scale relief interventions.

Given their long experience living with risk, farm households and rural communities have developed a number of well-honed strategies for managing it (Walker and Jodha, 1986). For example, to reduce exposure to potential losses, farmers often spread their bets by growing a mix of crops and crop varieties, stagger crop planting dates, and spread crops amongst fields that have different risk exposures in the landscape. These techniques can help reduce the chance of a major crop loss in any one season. Many farm households also engage in off-farm employment, or have a non-farm business of their own, and these help to reduce their dependence on farm income. To cope with the losses that do occur, farmers carry stocks of food, livestock, savings and other assets that can be consumed or sold in times of need. They may also borrow credit and engage in temporary off-farm employment.

Communities provide another layer of protection against risk (Sommerfeld et al., 2002; Keyzer et al., 2007; Bhattamishra and Barrett, 2010). Religious funds, credit groups, and kin-support networks provide reciprocal means through which individuals can help each other in times of need. Sharecropping contracts also emerged in many societies as a way of sharing risks between landlords and tenants (Otsuka and Hayami, 1993). In pastoral areas, reciprocal arrangements between spatially dispersed communities enable mobile or nomadic grazing practices that reduce the risk of livestock having insufficient forage in any one location (McCarthy et al., 1999).

Studies of traditional risk management practices show they are surprisingly effective, even in many drought prone areas (e.g. Walker and Jodha, 1986; Bhattamishra and Barrett, 2010). But they are not without their costs and limitations. Diversification strategies prevent farmers from specializing in their most profitable alternatives, essentially trading off higher income to reduce risk exposure. Studies of drought-prone areas in India and Burkina Faso suggest that farmers may sacrifice 12-15% of average income to reduce risk (Gautam, Hazell and Halderman, 1994; Sakauri and Reardon, 1997). Rosenzweig and Binswanger (1993) found that smaller and poorer farmers in a semi-arid region in India sacrificed 27% of their expected income to reduce risk. Farmers may also be less willing to invest in more profitable technologies and land improvements if these are more risky, leading to additional long-term sacrifices in average income.

Traditional risk management arrangements frequently fail to provide an adequate safety net for the poor. With few assets, poor people have limited options for coping with serious income losses. They are also more exposed to food price increases that may follow local production or market shortfalls, have less access to credit, and are more exposed to any contraction in local employment and wages. Repeated income shocks and asset losses can conspire to keep poor households trapped in poverty (Carter and Barrett, 2006).

Traditional risk management is also limited in its ability to manage catastrophic risks that impact on many farmers within a region at the same time (e.g. regional droughts or floods). The highly systemic or covariate nature of many of these catastrophic losses makes them especially difficult to manage. Community support networks cannot cope when everybody needs help at the same time. Local sources of credit also become scarce when everybody is seeking to borrow and few have money to lend. Local markets for crops, feed and livestock also work against farmers when they all are trying to trade the same way at the same time. For example, because many farmers try to sell livestock in drought years they force animal prices down, and then when they try to restock in post-drought years, prices rocket. Local food prices can also spike when regional shortages arise, and many farmers may lose important assets (e.g. livestock) that make subsequent recovery slow and difficult (Dercon and Christiaensen, 2007).

Covariate risks are also a problem for financial institutions and input suppliers, since they can be faced with widespread defaulting on loans and unpaid bills. Agricultural traders and processors lose too when they face a shortage of raw materials, and rural shopkeepers and small businesses suffer when local incomes and hence demand for their services fall. Some of the most dramatic evidence of the failure of traditional risk management comes from studies of severe drought, showing that in percentage terms, income losses can far exceed initial production losses because of a collapse in local agricultural employment and wages, non-farm income and asset prices (e.g. Webb and von Braun, 1994; Pandey, Bhandari and Hardy, 2007; Hazell and Ramasamy, 1991).

The business and humanitarian costs of agricultural risks are already high (Box 1) and seem destined to escalate in the future as population densities continue to grow in many vulnerable areas, e.g., drylands[1]. Global climate change will also increase the frequency and severity of many weather related disasters (WDR, 2010; IPCC WGII, 2014[2]).

[1] Drylands are defined by defined by the United Nations Convention to Combat Desertification (UNCCD) to include arid, semi-arid and dry sub-humid ecosystems characterized by low and irregular rainfall and high evapo-transpiration that are subject to cyclical droughts. So defined, drylands cover nearly 40% of the Earth's surface and are home to some 1.2 billion people, most of whom live in the developing world and are poor and food insecure.

[2] IPCC Report of WG II on Extreme Events states. Chapter 17, economics of adaptation, states on insurance: "Insurance-related instruments may promote adaptation directly and indirectly: (1) Instruments provide claim payments after an event, and thus reduce follow-on risk and consequences; and (2) they alleviate certain pre-event risks and allow for improved decisions."

Box 1: The extent of catastrophic losses due to natural disasters

Data from the EM-DAT Database show that almost 7,000 natural disasters occurred in the last 20 years worldwide, affecting a total of 4.2 billion people with damages estimated at US$ 2.2 trillion.

In **Africa**, 1,098 natural disasters including droughts, extreme temperatures, floods, storms, wildfire, earthquakes (including tsunamis), mass movements, volcanic activity and landslides occurred during 1995 and 2015 with 279 million people affected and damages of US$ 14.5 billion. The most frequent type of disaster was floods (65%) followed by storms (14%) and droughts (12%). However, droughts accounted for 79% of the affected people. The total damage was US$14.5 billion.

In **Asia**, there were 2,816 natural disasters in the last 20 years with floods (42%) and storms (28%) being the most common ones. Earthquakes accounted for 13% and droughts together with extreme temperatures for 7% of all disasters. 48% of the total damage (US$1.1 trillion) was due to earthquakes followed by floods (31%). Regarding the number of people affected by natural disasters (in total 3.8 billion), floods accounted for 58% of those damages, storms for 16% and droughts together with extreme temperatures accounted for 23%.

In the case of **Latin America and the Caribbean** 1,212 natural disasters occurred within the last 20 years. Again, floods and storms constituted for the major part with 40% and 29% respectively followed by earthquakes (7%) and droughts (6%). Regarding the total damage of US$154 billion, storms made up 44%, earthquakes 30% and floods 17%. In total, 110 million people were affected by natural disasters. Again, floods account for the majority (33%), yet, storms (25%), droughts (23%) and earthquakes (12%) follow closely.[i]

[i] Sourced from EM-DAT: The OFDA/CRED International Disaster Database. At least one of the following criteria must be fulfilled in order for an event to be classified as natural disaster: i) 10 or more people killed; ii) 100 or more people affected/injured/homeless; iii) declaration of a state of emergency and/or an appeal for international assistance.

What are the best ways to handle this pervasive and growing risk problem? So far, the private sector has played only a minor role in insuring farmers and rural communities against agricultural risks in the developing world, and the public (government) and nonprofit (NGOs, microfinance institutions, farmer associations, etc.) sectors have had to step in to help fill the void, either by organizing insurance themselves or engaging in relief efforts once disasters occur. In the next section, we review what the private, public, and nonprofit sectors have done to assist with risk management, and the lessons learnt from those experiences. A general finding is that while many interventions have achieved some important social and humanitarian goals, they have also proven inefficient and costly, diverting resources from more productive uses. However, case study evidence shows there have also been some promising developments, which, if scaled up, could greatly improve the performance of many risk management interventions. One of the most promising developments is index-based insurance (IBI). IBI can reduce the costs and difficulties of administering and delivering agricultural insurance and remove many of the negative incentive problems that have plagued agricultural insurance in the past. It is also a promising tool for underwriting the costs of relief agencies, providing a speedy and reliable source of funding once an insured catastrophe has occurred. Another promising development has been growing private sector involvement in agricultural insurance, attracted in part by the development of IBI but also by a shift towards more public-private and nonprofit-private partnerships in the delivery of insurance.

Despite these promising developments, improved forms of agricultural insurance and relief have not yet achieved much scale beyond a few countries like Brazil, China, India, and Mexico, and in section 4 we look at the constraints to scaling up and use case study material to highlight innovative new ways in which some of these constraints can be overcome. This leads to a discussion in section 5 of the kinds of policies needed to transform agricultural insurance and enable it to meet the risk management needs of agriculture and rural people.

2. The Experiences with Risk Management Interventions

In this section we review the experience with agricultural insurance and disaster relief programs. The two are interlinked. Relief is in part a response to insufficient levels of farm and household insurance, but at the same time relief, once institutionalized, can undermine incentives for individuals to purchase insurance. Relief programs can also be insured themselves, as a way of obtaining speedier and more reliable access to funds once an insured disaster has occurred.

2.1 Agricultural insurance

The extent of agricultural insurance around the world in 2007 was assessed by researchers at the World Bank. They estimated that 104 countries had some form of agricultural insurance that year, and sent out a questionnaire that was returned by 65 countries. Several salient facts stand out (Mahul and Stutley, 2010):

- The total agricultural insurance premium collected in 2007 in all 65 countries (including premium subsidies) was an impressive $15.1 billion, but 88% of this was collected in high income countries (mostly North America and Europe) while lower middle income and low income countries accounted for a meager 7.47%. Clearly, agricultural insurance is largely the preserve of better off countries.

- Market penetration remains small, even in rich countries. The total insurance premium collected (including subsidies) amounted to 0.9% of agricultural GDP, ranging from virtually zero in low-income countries to 2.3% in high-income countries (5% in North America).

- Private insurance was available in 54% of the countries, while the public sector operated in only 9%. However, there were public-private partnerships PPPs) in 37% of countries. Private insurers are most active in rich countries, and almost absent in low-income countries.

- 82% of countries offered both crop and livestock insurance, but crop insurance accounted for 90% of the premium.

- Multiple Peril Crop Insurance (MPCI) was available in 65% of the countries, but was most popular in the middle-income countries. Named peril insurance was even more widely available (69% of countries) and was even available in half of the low-income countries.

- Area-yield insurance was reported available in 15% of the countries, and weather index insurance was available in 22% of countries. Index-based insurance had also penetrated the low-income countries; 17% had area-yield insurance and 33% had weather index insurance. The only regions that seemed to be missing out on IBI were Oceana and Europe.

The World Bank study did not provide estimates of the numbers of farms insured, so in Appendix I we provide an updated list of all the currently known agricultural insurance programs in the developing world, together with estimates of the number of farmers insured. The total number of insured smallholders worldwide is 177 million divided into approximately 440,000 in Africa, 3.3 million in Latin America and the Caribbean, and about 173 million in Asia, of which 140 million are in China, and 33 million in India. Moreover, programs that insure public relief efforts can be found in 33 countries.

There are three types of agents that are active in providing agricultural insurance: the private for profit sector, governments (public), and other, mostly nonprofits (mutual groups, NGOs, microfinance institutions, etc.). Other agencies help finance and initiate insurance programs, including bilateral donors, UN organizations, multinational development banks, private foundations, and international reinsurers, but they do not deliver insurance on the ground.

Private agricultural insurance

Private agricultural insurance is focused on insuring farm business losses. Private insurers work on a ‘for profit’ basis, and unless working within a PPP or a nonprofit-private partnership that involves subsidies, they do not insure farmers who cannot afford to pay its full cost. Without subsidies, this usually leads to the exclusion of most smallholders and many types of agricultural risk. The private sector also avoids risks that are prone to moral hazard, focusing instead on insurance against named perils (e.g. hail or frost damage) that are easy to verify and whose damage tends to be concentrated in relatively small areas.

Private insurers have sought to expand their market in recent years by developing and underwriting index based products. Sometimes insurers use their own networks to sell insurance directly to farmers, but more often in developing counties they work through other players along value chains who sell directly to farmers. For example, they may link up with agroprocessors, input suppliers, or seed companies that offer farmers insurance along with credit, seeds, fertilizer, or contract farming arrangements (several examples are to be found in Appendix I). They may also link up with microfinance organizations and banks that offer farmers insurance along with loans. Insurers may also insure the aggregate risk portfolios of some of these same agencies, for example, underwrite the risk of a microfinance institution’s lending portfolio or a farmers’ mutual fund.

Index based products broaden the scope for insuring against named perils, opening the way for writing identical contracts for larger numbers of farmers who can be served by the same index contract (Box 2). While IBI can enhance the reach of the private sector and reduce its administration and transactions costs, private insurers have had only limited success by themselves in scaling up IBI. As we shall see, most IBI schemes of any size involve various kinds of public-private or nonprofit-private partnerships.

Box 2: Index based insurance (IBI)

Index-based insurance (IBI) grew out of the need to overcome the perverse incentive problems that have plagued traditional forms of crop insurance. Like private crop insurance, index insurance seeks to provide cover against specific perils, but in this case contracts are written against events defined and recorded at regional levels rather than at individual farm levels (e.g., a drought recorded at a local weather station, or a low official crop yield estimate for a district or county). 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 unit 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, the simplest being a zero/one contract (once the threshold is crossed, the payment rate is 100 percent), or a layered payment schedule that makes a series of payments as specified thresholds are crossed.

Using weather index insurance in this way has a number of attractive features for insuring farmers:

- Because buyers in a region pay the same premium and receive the same indemnity per unit of insurance, it avoids perverse incentive problems such as moral hazard and adverse selection. A farmer with regional index insurance possesses the same economic incentives for good husbandry as the uninsured farmer.
- It can be inexpensive to administer, since there are 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.
- The insurance does not need to be tied to specific crops and can in principle be sold to anyone. This opens up the possibility of insuring anybody in a region whose income is correlated with the insured event, including farmers, agricultural traders and processors, input suppliers, rural banks, shopkeepers, and agricultural laborers.

The private insurance sector has also become active in providing a reinsurance market to underwrite some of the tail end risks of the portfolio of agricultural insurers. Reinsurance is more accessible to insurers who sell IBI products because the insurance is based on a reliable and independently verifiable index. There is a large international reinsurance market that could easily absorb a lot more agricultural risk if suitable insurance programs could be established on a commercially viable basis (Swiss RE, 2012).

Public agricultural insurance

Public agricultural insurance has tried to fill the gap left by the private sector, especially for meeting the insurance needs of the many smallholders who cannot afford to pay the full costs of insurance. Until recently, most public agricultural insurance was provided through a public insurance agency, but in recent years there has been a marked shift towards involving the private sector in the actual delivery of the insurance to farmers through various kinds of PPPs.

Where governments have directly intervened, it has most often been in the form of MPCI provided by a government owned insurer. MPCI was first launched at scale in the US and Japan in the 1940s, and expanded rapidly to other countries during 1950-90. 63% of the countries with agricultural insurance surveyed by the World Bank in 2007 still had MPCI programs (Mahul and Stutley, 2010). MPCI is often linked to credit from a government owned agricultural development bank.

The performance of most government run MPCI programs has been disappointing. They have been plagued by the moral hazard problems associated with many sources of insured yield loss, by high administration costs, by political interference, and by the difficulties of maintaining the managerial and financial integrity of the insurer when government underwrites all losses. As a result, none have been financially sustainable without substantial government support. Hazell (1992) analyzed the experience with MPCI programs in several countries in the 1980s and found that governments were subsidizing 60-80% of their total costs. Many of these programs were phased out in the 1990s, but the ones that remain continue to depend heavily on government subsidies (Mahul and Stutley, 2010).

Although intended to help smallholders manage risks and access credit for agricultural development purposes, there is little evidence that this public spending had any significant impact on agricultural lending, agricultural production or farm incomes (Hazell, Pomareda and Valdes, 1986; Hazell, 1992; Wright and Hewitt, 1994; Glauber, 2004). What some MPCIs did achieve was to underwrite the losses of agricultural development banks, effectively enabling many smallholders to default on their loans in bad years. But there are less costly ways of achieving debt forgiveness without having to bear the costs of a public insurance agency and which are less destructive to a responsible credit culture.

Many of the government agricultural insurance programs that exist today have been redesigned and have moved away from MPCI. As with the private sector, there has been innovation in the development of new index based products that avoid the negative incentive problems of MPCI and which are much easier and less costly to administer (Box 2). To reduce costs and improve efficiency, many programs have also outsourced the provision of agricultural insurance to the private sector through various kinds of public-private partnerships. Done well, this approach can combine the efficiency of the private sector with targeted public sector financing.

India is a good example; its public MPCI insurance program was reformed into an area-yield index program, and again more recently with an option for states and farmers to choose a weather-based index program (Box 3). Mexico also had an MPCI program that became prohibitively expensive for the Government, and in 1990 converted it to a state owned insurance company Agro Aseguradore Mexicana (Agroasemex), which was charged with developing an agricultural insurance market that included the participation of the private sector and self insurance funds (Fondos). Fondos are farmer groups established for the explicit purpose of pooling risks and acquiring group insurance, which since 2001 has been provided by Agroasemex. In 2014, 452 Fondos were insured, covering 1.33 million hectares. Payments to the Fondos are based on weather indices. The insurance is 100% subsidized by the federal and state governments. The Philippines still has a national MPCI program, but has begun to test some new index based products in pilot programs. China has moved from farm to village (or group) insurance and payouts are made when a disaster declaration is determined for the village.

Box 3: India's agricultural insurance programs

India had a traditional public MPCI program since 1985 that was replaced by the National Agriculture Insurance Scheme (NAIS) in 1999. The NAIS is an area-yield index program that covers all the major crops, and yield indices for each crop are defined and tracked at sub-district levels. Payments are made whenever a yield index falls below a threshold level. The program is subsidized and is compulsory for all farmers who borrow seasonal credit from state banks, but voluntary for all others. Difficulties in the administration and financing of NAIS led to systematic delays in the settlement of claims, and fewer farmers than expected signed up. NAIS is offered by the state sponsored Agriculture Insurance Company (AIC) of India. In 2011/12 NAIS insured 16 million farmers, or 15% of the total, and 23.3 million hectares.

In response to these problems, the Government introduced a modified NAIS (mNAIS) in 2010 that among other things: reduced the insurance unit from sub-district to village cluster (panchayat) level to lower basis risk; raised the threshold yield levels; broadened the coverage to include failed planting, prevented sowing and postharvest losses; and introduced actuarially based premiums that are subsidized. mNAIS is now offered as an alternative to NAIS, and state governments choose the program they prefer to offer their farmers. In 2012/13, mNAIS insured about 3 million farmers and 3 million hectares. It is expected that NAIS will eventually be withdrawn in favor of mNAIS.

The Indian Government has also introduced a weather-based crop insurance scheme (WBCIS). Originally introduced as a pilot project in 2003 by a microfinance institution (BASIX) and a private insurer (ICICI-Lombard General Insurance Company) (Hess, 2003), the Government adopted it as an official alternative to NAIS in 2007. Around 40 crops are insured against a range of climate risks that are indexed at one of over 5000 reference weather stations. The program receives a premium subsidy of 60-75%, depending on the crop and state. Unlike the area-yield schemes, WBCIS is offered by private insurance companies in competition with AIC. WBCIS was purchased by 14.5 million farmers in 2012/13.

At the present time states can choose to offer their farmers any of the three insurance programs. For example, the government of Uttar Pradesh (UP), India's largest state (pop. of 200 million in 2011) offers farmers a choice between WBCIS and mNAIS.

Together, the UP state and central governments subsidize 50% of the insurance premium, which is usually set between 10-12% of the sum insured.
The UP government department of agriculture designs the insurance products with the state agriculture universities, and then uses a competitive bidding process to select eligible insurance companies who then market and service the insurance. Contracts are awarded on a district by district basis.

Source: Greatrex et al., 2015; GIZ, 2013; Government of India, Ministry of Agriculture, 2014; Sonu Agrawal, Weather Risk Management Services Ltd.(WRL)

Nonprofit agricultural insurance

Recent years have seen the growing involvement of many nonprofit organizations in providing insurance targeted at poor people. These include local and international NGOs, microfinance institutions, and farmer associations, all of which work at grass roots levels and have their own networks for distributing insurance to farmers. Since most of these organizations are not licensed to sell insurance, they inevitably partner with private insurers who provide and underwrite the insurance contracts. An advantage for private insurers is that these partnerships give them access to lots of small farmers whom they might not otherwise be able to reach, often in aggregated form (e.g. farmer groups or mutuals), and the nonprofit will typically do most of the work and market, service and subsidize the insurance.

There are many examples of nonprofit led insurance programs, many still at the pilot stage (see Appendix I). One example is the Agriculture and Climate Risk Enterprise (ACRE) in East Africa which, in 2014, insured 294,360 farmers. ACRE has recently transformed into a for-profit social enterprise. Another example is the R4 Risk Resilience initiative in Ethiopia and Senegal, which is run by Oxfam and the WFP. Most of these NGO led programs are funded by UN organizations (e.g., ILO, WFP), bilateral donors (e.g. Germany, Netherlands, Switzerland), private foundations (e.g. BMGF), international NGOs (e.g. Oxfam) and multinational development banks (e.g., WB/IFC). These grantees also help subsidize the cost of the insurance, something that is hard to avoid when targeting the poor.

2.2 Public relief

Many governments and nonprofits have found it necessary to provide direct disaster assistance to relieve the problems of rural areas stricken with catastrophic losses caused by natural hazards such as drought, flood, and hurricane. In addition to emergency assistance, recovery may be built around food and cash transfers, debt forgiveness, temporary employment schemes, and asset replacement. For many small, risk prone developing countries, such assistance can be extremely costly and may represent a significant percentage of national income when the disaster is large. This cost detracts from the resources available for development, and increases a country's dependence on donor assistance.

Relief programs are driven more by humanitarian than development agendas and their primary value is in saving lives and rebuilding assets and livelihoods. They are fully funded by donors, UN agencies and governments, and unlike insurance they do not try to recoup their costs from the beneficiaries. While most programs achieve their primary objectives, they vary widely in terms of their cost and efficiency. Two of the biggest challenges facing relief programs are a) the difficultly of targeting relief aid to the truly needy under emergency conditions while at the same time avoiding large leakages to others; and b) by the time an emergency has been declared and a relief effort funded and launched, the assistance may arrive too late to relieve the worst suffering and losses. Climate change can be expected to exacerbate these challenges (WDR, 2010).

In a promising development, some government relief programs have been able to purchase IBI products to insure part of their expected relief costs. This is helping them overcome delays and uncertainties in funding relief when most needed, and also helps smooth out their annual cost to government and/or donors in the form of a predictable and regular annual premium. A good example is the Agricultural Fund for Natural Disasters (CADENA) in Mexico, which aims to internationally reinsure part of the costs of Mexico's state managed relief programs (Box 4). Several groups of countries have also successfully worked together to pool their relief cost risks and to reinsure these risks in the international market. Schemes exist for the Caribbean, the Pacific Island countries, and Africa (Box 4). Pooling and insuring catastrophic risks in this way is less costly than if each country tries to reinsure independently, but even so it comes at a price. Clarke and Hill (2013) calculate that in a typical sovereign catastrophe risk pool, for every $1 of premium paid to a reinsurer the members might expect to receive on average between $0.20 and $0.70 in claim payments over the long term. The rest of the premium goes toward administrative costs, capital costs, and profit for the insurance provider.

Box 4: IBI for disaster relief purposes

The Mexican Agricultural Fund for Natural Disasters (CADENA) aims to internationally reinsure part of the costs of its state managed relief programs. CADENA was launched in 2003 by the Ministry of Agriculture and contains two main components: a) the Catastrophe Agricultural Insurance (SAC) program for farmers, livestock producers, aquaculture farmers and fishermen; and b) in States where SAC is not provided, direct compensation payments to farmers in the event of natural disasters. Under the program, State Governments purchase insurance to protect their budgetary allocations against natural disaster compensation for the most vulnerable farmers. The states are the insured, and the premiums are financed by the federal and state governments. Payments are made against a number of indices[3]. Small-scale, low-income farmers without access to commercial crop, livestock, or aquaculture insurance are the intended beneficiaries of the insurance coverage, and the program is designed to provide a minimum level of compensation to smallholder farmers to put them back into production following a major catastrophic event. In 2011, the CADENA program insured about 8 million hectares of crops and slightly over 4.2 million head of livestock. There were around 2.5 million beneficiaries and the total sum insured was approximately USD 1 billion. CADENA is part of a larger

[3] There are 4 Crop and Livestock Insurance Products under CADENA: 1) Parametric Crop Weather Index Insurance: weather indices measured at ground stations; insured perils: drought, excess rain, flood, hurricane wind storm 2) Crop Area-yield Index Insurance: Area-yields measured by in-field loss assessments; insured perils: comprehensive multiple-peril 3) Livestock-Pasture NDVI: satellite measured NDVI index; all perils which reduce pasture growth (mainly drought) are insured 4) traditional livestock: decreased forage and extraordinary weight loss in animals; insured peril: drought

national program – the Fund for Natural Disasters (FONDEN), which transfers part of its risk to the international market through reinsurance and the issuing of catastrophe bonds.

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) insures Caribbean countries against the cost of relief during natural disasters (earthquakes, tropical cyclones and excess rainfall). The first multiple country risk pooling program of its kind, CCRIF was developed to help mitigate the short-term cash flow problems small developing economies suffer after major natural disasters. CCRIF represents a cost-effective way to pre-finance short-term liquidity to begin recovery efforts for an individual government after a catastrophic event, thereby filling the gap between immediate response aid and long-term re-development. The excess rainfall product is based on available NASA-processed satellite rainfall data from the Tropical Rainfall Measurement Mission (TRMM). It is aimed primarily at extreme high rainfall events of short duration (a few hours to a few days). The excess rainfall product is triggered independently of the current tropical cyclone product, which is based on wind and storm surge, and if both policies are triggered by a tropical cyclone event, then two separate payouts would be due. Since the inception of CCRIF in 2007, the facility has made 9 payouts for hurricanes, earthquakes and excess rainfall totaling almost US$ 33 million to seven member governments. All payouts were transferred to the respective governments within 14 days (and in some cases within a week) after the event. In the 2013-2014 fiscal year, 29 policies were issued in 16 countries. Annual premium income totaled USD 19.5m for tropical cyclone and earthquake coverage. CCRIF's aggregate exposure for policies written was close to US$ 620m, with the tropical cyclone to earthquake aggregate split being close to 60:40.

In a similar scheme, the African Risk Capacity (ARC) is a WFP designed multiple country scheme for accessing international reinsurance against drought relief. Drought is measured through satellite based rainfall data, and the coverage is calculated using a computer model to predict estimated relief costs. The first policies were sold in 2014 to 4 countries (Kenya, Mauritania, Niger and Senegal), whereby Senegal, Niger and Mauritania paid a total premium of approximately $17 million and received a total payout of $26.3 million. Among others, food aid for 900,000 people in Senegal and school feeding rations in Niger were financed. Donors have contributed about $195 million to the cost of the program so far. The program aims to go Africa wide. In July 2015, an additional 5 countries joined: Zimbabwe, Malawi, Mali, Burkina Faso and the Gambia. Total coverage is set to rise from $129 million to $192 million.

The Pacific Catastrophe Risk Insurance Pilot is another multiple country program that enables Pacific Island Countries (PICs) to secure aggregate insurance coverage worth USD 43 million against tropical cyclones and earthquakes/tsunamis. This support is crucial given the exposure of the region to disasters – extreme natural events have affected more than 9.2 million people in the Pacific since 1950 and caused damage of about USD 3.2 billion. The World Bank acts as an intermediary between PICs and a group of reinsurance companies, which were selected through a competitive bidding process. Payouts are triggered by specific physical parameters for the disasters (e.g. wind speed and earthquake ground motion) taken from the Joint Typhoon Warning Centre and the US Geological Services (USGS). The PICs are responsible for paying the insurance premiums, though they received help from the Government of Japan and the World Bank in the first three years of the program.

Another promising development is the linking of disaster relief programs with existing safety net and cash transfer programs, as these already have an infrastructure in place for identifying the poor and delivering assistance (Grosh et al., 2008). In Ethiopia, for example, the government, WFP and the World Bank established the Livelihoods Early Assessment and Protection (LEAP) mechanism in 2008. LEAP is an integrated food security and early response system which combines early warning, capacity building, contingency planning and contingent finance. While LEAP is based on donor-provided contingent financing rather than commercial insurance, it uses an index-based approach. LEAP seeks to bridge an 'assistance gap' in the case of shocks in the government's Productive Safety Net Program (PNSP), and does this by allowing the immediate scale-up of the PSNP in anticipation of severe droughts. It is designed to trigger the timely disbursement of contingent funding to provide livelihood protection to the additional people at risk of food security, as well as to existing PSNP beneficiaries requiring additional months of assistance (Hess, Wiseman and Robertson, 2010; Government of Ethiopia, 2013[4]).

One way to view relief programs is as a substitute for insurance, since if farmers and rural people had adequate insurance they would be more self-reliant during disasters. Yet disaster relief, once people assume they can count on it, can also undermine incentives for buying insurance. Disaster assistance can also worsen future problems by encouraging people to behave in ways that increase their exposure to potential losses. For example, compensation for livestock losses in drought prone areas can encourage farmers to keep more livestock than before (Hazell et al., 2003; Rosenzweig, 2001). The primary reason for these perverse incentive problems is that beneficiaries do not have to contribute directly to the costs of relief they receive - unlike insurance where an annual or seasonal premium must be paid. An innovative way to reduce these problems while making relief more assured and effective for the poor is the use of Early Recovery Vouchers (ERVOs) (Box 5).

Box 5: Early Recovery Vouchers (ERVOs)

A concept, developed by Ulrich Hess and others at the World Food Program (WFP) and GIZ, ERVOs seek to make relief more assured and effective for the poor (Hess, Balzer and Calmanti, 2009). ERVOs are motivated by two concerns. First, in disaster prevention and mitigation there is need to recognize that it is not enough to respond to shocks and rebuild livelihoods; there is an underlying need to invest in disaster preparedness and mitigation measures. Communities that become more resilient and prepared to respond to disasters, when combined with government disaster preparedness efforts, significantly reduce disaster-related losses of life and livelihoods. In fact, studies show that every dollar invested in disaster risk reduction saves four or more dollars in future costs of recovery and rehabilitation.[5]

A second motivation is that the poor, who rely disproportionally on disaster relief when cat events occur, are probably the least well served. The relief they receive is often inadequate because of the type of aid they receive (e.g., food aid rather than

[4] https://www.agriskmanagementforum.org/content/ethiopia%E2%80%99s-livelihoods-early-assessment-and-protection-leap-system-improving-climate-risk-ma

[5] In a report to the United States Congress, the Federal Emergency Management Agency (FEMA) and the Multihazard Mitigation Council stated that "On average, a dollar spent by FEMA on hazard mitigation (actions to reduce disaster losses) provides the nation about $4 in future benefits." WFP estimates that US$1 spent on early livelihood protection in Ethiopia generates about US$4 in future cost savings and benefits.

cash), the amount they receive (especially when there are high leakages to the non-poor), and the timing is often too late to be truly effective.

ERVOs attempt to address both these problems by providing direct *ex ante* disaster protection for the poor by covering eligible households with an insurance policy that guarantees immediate disaster payments in cash following natural disasters. Moreover, instead of distributing the vouchers for free, recipient households might be asked to enact certain risk reduction measures, such as participation in training for good agricultural practices or disaster proofing homes, or by participating in community organized activities to improve disaster preparedness and mitigation.

ERVOs payments would be triggered by an index using weather station or satellite data about cat events, and which would meet the objectivity and transparency requirements for international reinsurance. The insurance cover is aimed at poor households identified *ex ante* based on national poverty lines or by a relevant safety net or cash transfer program. With the development of mobile banking systems like M-PESA in Kenya, households could be uniquely identified and registered by mobile phone and payments, when due, made directly into their accounts where they could be accessed by mobile phone. For example, the identified and registered households might receive a natural disaster insurance that paid out up to $500 on their private account in the event of an extreme drought, flood or storm. Governments and donors pay the premiums and the insured household covers a small processing fee in order for the households to realize that they are insured. Where mobile banking is not available, ERVOs might be distributed by existing organizations that have a grass roots presence, such as safety net and cash transfer programs, microfinance institutions, NGOs, farmer cooperatives, etc. Payments could be announced on public radio, and made available at local banks or post offices. Technological advances in delivery technology (mobile wallets) as well as index technology (satellite-based) and georeferencing of household locations (GPS) allow for the large-scale roll out of such ERVO schemes.

ERVOs have several attractive features:

- They offer benefits to the poor in terms of direct and timely assistance when a cat loss occurs. Moreover, since the amount of assistance is assured, poor households would be able to take on greater risk in their livelihood strategies, hopefully increasing their average incomes. As Binswanger- Mkhize (2012) reports, the risk avoidance strategies of poor farmers in the semi-arid tropics of India have an implicit cost of about 28% of expected income, a tradeoff that might be substantially reduced with the availability of an effective and low cost way of insuring against cat losses.

- Through their conditionality, they could contribute to building more resilient community infrastructure, livelihoods and farming systems.

- They are an indexed form of insurance that can be reinsured through an index product for the managing agency.

- They can also be interfaced with existing safety net and cash transfer programs, which offer a reliable way for the *ex ante* identification of the poor and vulnerable.

- To avoid the negative incentives that arise from assured but free disaster assistance, households might be asked to make a small financial contribution (e.g. pay a processing fee), or pay a graduated premium – a basic amount of coverage could be free but there would be an option to buy more coverage at an escalating price. For the poor, there might be an option to pay the premium through an insurance-for-work scheme working on community projects that help build resilience. A graduated premium would solve the problem of what to do with households who choose not to buy the insurance – disaster relief would be provided to all the needy during an emergency, but those who had not bought vouchers would only be given the basic amount of assistance that is free.

- Another nice feature of ERVOs is that by removing some of the worst cat risks facing farmers, this could open up more possibilities for insuring the more normal and less covariate risks that arise in agriculture. This might be especially relevant for many small to medium sized farms that want to pursue commercial farming opportunities.

A challenge for ERVOs is finding an index with a low basis risk for the households who receive the vouchers. This is a less daunting task than finding indices for crop insurance because a) the insurance is limited to the kinds of low frequency, high impact, highly covariate weather risks that affect most people in a region at the same time; and b) an index that correlates highly (on the downside) with losses in household incomes or assets may be more robust than indices that correlate with yield losses for specific crops. The type of index required for an ERVO scheme could also be meaningful to poor households in a region who are not engaged in farming, and who would benefit from receiving ERVOs.

ERVOs would have to be substantially funded by governments and donors, but if they could replace part of existing disaster assistance programs, and possibly some forms of publicly funded agricultural insurance that insure some of the same cat risks, then there might be sufficient savings from existing funding commitments to enable ERVOs to be implemented at some scale. ERVO like schemes are being piloted in China, Peru, Mexico’s CADENA system, and have been proposed in Paraguay for the most vulnerable rural families and their experience bears watching.

3. Challenges to scaling up IBI

IBI is a most promising development for overcoming many of the more serious problems that have plagued past agricultural insurance and relief programs, and it can help engage the private sector in a larger way in managing agricultural risks. But IBI programs have not yet approached anywhere near the scale needed to enable the majority of smallholder farmers and rural people to be protected from existing, let alone future levels of risk.

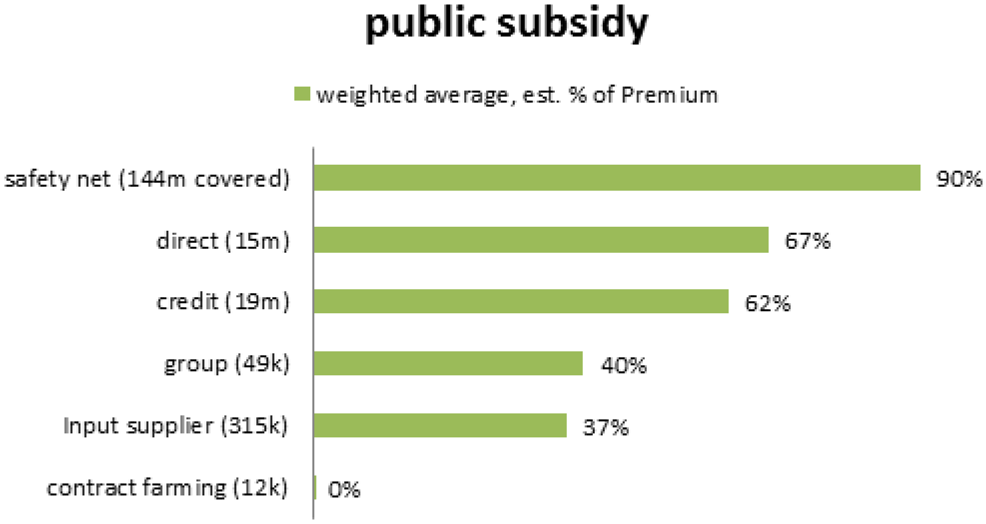
Appendix I provides details of many of the current IBI programs currently ongoing in the developing world and for which documentation is available. So far, the only form of index insurance to be adopted at scale have been area-yield insurance and weather-index insurance in India. Area-yield programs were pioneered in Sweden, the US, and India, and nine countries had programs by 2007 (Mahul and Stutley, 2010). There are currently two area-yield programs in India (NAIS and mNAIS - see Box 3) and together they insured about 19 million farmers in 2014 (though there may be some double counting of farmers who bought insurance in both the Kharif and Rabi seasons). Weather based index insurance is also sold in India (WBCIS - see Box 3), and this program provided insurance to about 14.5 million farmers in 2014. Other IBI programs listed in Appendix I insured about 525,000 farmers. The grand total from Appendix I of farmers insured by IBI policies was 37 million in 2014, of which 98.5% were in India (see Table 1). In addition, many farmers have received benefits from IBI products through the insurance of relief agencies (Box 4), but there is little data available on the number of people who benefited from these programs. China has a large agricultural insurance program that insures some 140 million farmers, and some components of this may now be structured on an index basis (e.g. potentially some of the losses determined at community levels). But there is little information available about the nature and extent of the index based components and it would be easy to exaggerate the number of farmers insured in this way. It is also clear from Appendix I that most IBI programs that have achieved any scale are heavily subsidized (Appendix II), and in the Indian case, are compulsory for farmers who take agricultural loans from state banks.

Table 1: Scale of index based agricultural insurance in 2014

	Scale (No. Of policyholders)	No. Of Schemes	Weighted Average subsidy (est.)
Africa	443,075	17	37%
India	33,222,000	4	64%
China	140,000,000		95%
Rest of Asia	963,460	11	64%
Latin America	3,315,626	8	91%
Developing countries	**177,944,161**	**40**	

Source: Appendix 1, Author's calculations

Figure 1: Public subsidies divided into scheme types



The rate of subsidization varies greatly between the different insurance scheme types. In the examined contract farming insurance schemes and input supplier schemes the rate of subsidization is very low with averages of 0% and 37% respectively. The group insurance schemes have average subsidy rates of 40%. Highest average subsidy rates are found in credit-linked (62%), direct (67%) and safety net (90%) insurance schemes.

Several international initiatives have been launched to promote and develop IBI to achieve greater scale (Box 6). If these efforts are to succeed, there needs to be a better understanding of the constraints on IBI, how these might be overcome, and at what cost relative to the potential benefits of IBI.

There have been several recent reviews of why scale is not being achieved, and these have identified some key challenges (Hazell et al., 2010; Greatrex, et al., 2015; Carter et al., 2014; Binswanger-Mkhize, 2012). Key challenges include problems of weak farmer demand, difficulties in developing appropriate indices and distribution networks, coping with climate change, insufficient public investments in necessary public goods, and first mover problems. We discuss each in turn, and this leads to discussion of whether, given all these challenges, governments and donors should subsidize IBI to enhance scaling up.

Box 6: New players and partnerships for promoting IBI

A number of important new players have recently taken influential steps in the index insurance space. The Global Index Insurance Facility (GIIF) of the World Bank/IFC signed knowledge partnership agreement with the **ILO's Impact Insurance Facility** in September 2014. The partnership focuses on raising awareness and developing knowledge about index insurance across the globe and included the launch of the **Community of Index Insurance Practitioners ("Index Insurance Forum")** in November 2014 during the GIZ-BMZ Conference on Agriculture Insurance in Berlin. The Community aims to address key challenges and gaps in index insurance and design related tools for more effective knowledge sharing and experience exchange. During this Community of Practice gathering in November, GIIF also launched the **Knowledge Platform <indexinsuranceforum.org>**, an online source intended to be a unique platform to gather information and material related to the index insurance industry. Through the partnership, the organizations will develop knowledge products such as project briefs and knowledge notes, strengthen index insurance markets through awareness-raising and provide targeted training of insurance stakeholders and distribution channels in support of market development.

The Global Action Network (GAN) on Agricultural Insurance was formed in November 2014 by the ILO's Impact Insurance Facility with support from the USAID and the BASIS Assets and Market Access Innovation Lab/I4 Index Insurance Innovation Initiative at the University of California Davis. The forum provides room for discussions on the key issues, constraints, lessons learned, best practices and quality standards in agricultural insurance projects. Moreover, it explores synergies and undertakes evaluation and research.

AXA Corporate Solutions, Swiss Re Corporate Solutions, and Grameen Credit Agricole also demonstrated their commitment to expanding the index insurance market in the developing world by joining GIIF in a knowledge partnership in January 2015 and launching an advocacy coalition in July 2015. The partners will collaborate to disseminate information on various index-insurance programs, share market intelligence through GIIF's grantee and partner network, share best practices on product design and relevant technical data, provide networking and communications support for increased access to industry events and technical forums and actively participate in the Community of Index Insurance Practitioners.

3.1 The demand problem

Few IBI schemes for farmers have achieved scale without being heavily subsidized and/or the insurance is made compulsory (e.g. for bank borrowers in India). Otherwise, relatively few farmers seem willing to purchase IBI products in what appears to be a significant demand problem (Binswanger-Mkhize, 2012). Several reasons have been suggested for this weak demand:

- Farmers have other ways of managing risk that may be less costly than insurance. However, better off farmers probably have more options than poor farmers, including in catastrophic years (Binswanger-Mkhize, 2012).
- Given that most farm households have developed diversified farming and livelihood strategies, an IBI targeted at weather outcomes correlated with yield losses for specific crops may correlate only weakly with losses in household income or consumption, and it is these correlations that really matter for rural households (Binswanger-Mkhize, 2012).
- Insuring against agricultural risks is expensive. Normal losses occur with high frequency, and many catastrophic events like droughts that involve large payouts occur with sufficient frequency that premium rates may need to exceed 10-15% just to cover the pure risk cost of the insurance (i.e. the average compensation expected).
- Farmers do not value insurance that does not compensate them when they have a loss for which they think they are insured. This is the basis risk problem (Box 7). As Clarke (2011) demonstrates, farmers who face high basis risk may be made worse off by buying index insurance, in part because they still have to pay the insurance premium in years they experience catastrophic losses but do not receive a payment.
- Farmers may not have the liquidity to pay the insurance premium at the beginning of the farming season, particularly poorer farmers.

Demand for weather based index insurance ought to be greatest in regions where weather related risks are the dominant risks confronting farm households, such as in arid and semi-arid areas, but even here the insurance has to be competitively priced compared to available alternatives for managing risk, and must be affordable to most farmers.

Estimates of demand elasticity for IBI based on experimental games played with farmers fall in the range -0.44 to -1.1, suggesting that cost is an important consideration for farmers (De Bock and Gelade, 2012). An inelastic demand also implies that the total revenue from the sale of insurance will fall if the insurer lowers the price. But knowing the elasticity of demand says little about the total volume of sales, and there may be insufficient demand at any reasonable price to make the insurance viable to an insurer.

Transactions costs for farmers also matter (De Bock and Gelade, 2012). If, for example, there are lengthy forms to be filled out or special journeys to make, then demand is weaker. This highlights the importance of marketing the insurance through existing distribution channels that farmers use and trust, such as microfinance or input suppliers.

Several quasi-experimental studies show that farmers' demand for insurance is negatively related to their degree of risk aversion (De Bock and Gelade, 2012). Some studies attribute this to behavioral ambiguity about the insurance (i.e., farmers do not understand or trust the insurance, especially when it is new), which adds to the perceived risk of buying it. This seems to be confirmed by evidence showing that the negative relationship decreases over time as farmers become more familiar with insurance. If trust is the problem then this again highlights the importance of working through existing distribution channels that farmers use and trust, such as microfinance or input suppliers. Experimental evidence also suggests that training and education do pay off in the case of agricultural IBI products, but results depend on the type of training provided (De Bock and Gelade, 2012).

Programs vary in how they tackle these problems. Many programs link the insurance to credit, access to modern inputs and better technologies, or to a better market outlet (e.g. contract farming), all of which can make the insurance part of a real value adding proposition for insured farmers that extends beyond the value of its direct risk reducing benefits (Hazell et al., 2010). There are several examples of these kinds of linkages in Appendix I, such as: the PepsiCo scheme in India which provides insurance against potato blight to farmers contracted to sell potatoes of crisping quality to an agroprocessor; the R4 Risk Resilience initiative in Ethiopia and Senegal which packages the insurance with credit and some other risk reducing interventions; and Fresh Co in Kenya and Pioneer in Zambia which sell insurance against failed plantings along with their improved seeds. In some cases the IBI products are packaged with other types of insurance that farmers find attractive, such as life or accident insurance. For example, the SFS program in the Philippines bundles fertilizer insurance with accidental death insurance, and NWK AgriServices in Zambia has built weather and life insurance into their cotton farming contracts in order to enhance farmer's loyalty and deliveries and secure them against debt and livelihood problems in case of weather failures. To help make the insurance more affordable to the poor, the R4 Risk Resilience initiative in Ethiopia enables them to pay part (or all) of their premium with labor, working on community-identified projects that help reduce vulnerability to drought (e.g. soil and water conservation projects).

In order to increase the correlation between IBI and household income, there have been attempts to write IBI contracts against total crop or farm revenues rather than yields of individual crops. This approach requires reliable data on cropping patterns, yields and prices to calculate an appropriate index. It has been adopted in the US agricultural insurance program, but does not seem to have been tried yet in a developing country. Another approach is to offer a range of index contracts against weather events that impact on the yields of many crops rather than just one or two dominant crops. By offering a smorgasbord of index contracts, farmers can then select a portfolio of insurance contracts that best correlates with their total production or revenue. This approach might also help reduce the basis risk problem (see Box 7).

Some programs also try to increase the types of risk insured by the index, so that farmers can get payouts in non-catastrophic years (e.g. against some idiosyncratic production risks). While this can be attractive to farmers, a problem is that the insurance quickly gets expensive, and unless the premium is jacked up, the insurance will not have the resources to pay much compensation in catastrophic years.

Another reason that may be limiting demand is that index insurance is typically only offered to farmers, and often only to farmers growing particular crops or livestock. IBI has the potential to insure many other types of rural people who are engaged in nonagricultural activities that are dependent directly or indirectly on local agriculture, e.g., agricultural traders and processors, landless workers, and village shopkeepers. One program that reaches out more broadly is the Livelihood Protection Policy (LPP) in the Caribbean, which insures non-salary income earners against adverse weather events (high wind speed and/or excessive rainfall). However, rather than offering the insurance on an unencumbered basis, it is tied to credit and distributed by financial institutions. The program started in 2014 and so far has sold only 80 policies in 4 countries. The program also gives customers early warnings about adverse weather events so they can take preventative actions.

3.2 The index problem

A fundamental requirement for IBI is the availability of an index that correlates highly with the agricultural risk to be insured, and for which there is a suitable and reliable database to perform actuarial calculations and objectively determine when an insured event has occurred. The index also needs sufficient spatial granulation to minimize basis risk (Box 7). These can be daunting requirements in countries and regions with limited weather stations, or where the data is unreliable or released too late to be useful for determining payouts.

Box 7: Basis Risk

Basis risk is the problem that arises if an individual farmer who experiences crop losses due to an insured weather event that is too localized to trigger a regionally-based insurance payout. Given a weak correlation between individual losses and insurance payouts, farmers soon lose interest in the insurance. In fact, as Clarke (2011) demonstrates, farmers who face high basis risk may actually be made worse off by buying index insurance. Basis risk can be surprisingly high even in some homogenous agricultural areas[6], and higher still in hilly and mountainous areas with many microclimates.

Basis risk is much less of a problem when an index is being used to insure a relief agency, (or indeed a microfinance institution or agricultural input supplier) since the insurance would be underwriting a regional or national portfolio that has already aggregated farm level variation.

There are several ways to reduce basis risk:

- Increase the number and dispersion of weather stations to better capture the spatial diversity of farming conditions in a region.
- Invest in agro-meteorological research to identify weather indices that minimize basis risk for as many households as possible in a region given the available weather data. Recent developments in crop-weather modelling, as well as participatory approaches to the design of insurance contracts, have demonstrated potential for matching seasonal weather events more precisely with yield failures for local crops (Hellmuth et al., 2009). Given panel household data, it is also possible to model the relationships between weather events and household incomes rather than yields, leading to even more relevant indices with low basis risk for insuring household welfare (Lybbert et al., 2010). However, the cost of this kind of "designer" research can be high and the indices that follow may prove too site specific to scale up to commercially viable levels.
- A related approach is to offer a variety of weather contracts in a region rather than a standard index contract geared for the average farmer, and then allow individual farmers the flexibility to form their own portfolios of weather contracts that best match their own crop mix and locational characteristics. However, an experimental trial of the approach in Ethiopia suggest that only modest gains are possible in areas where the average basis risk is initially high (Hill and Robles, 2011).
- Insure groups of farmers who can pool basis risk among themselves (Dercon et al., 2014). This idea follows from theoretical work showing that within-group risk sharing and index insurance should be complements, with index insurance crowding-in risk sharing and leading to greater demand for insurance among groups of individuals that can share risk. A pilot trial of group index insurance in Ethiopia provides support for this approach (Dercon et al., 2014).
- Limit the insurance to the kinds of low frequency, high impact weather risks

[6] A classic example is the low correlation of 0.61 recorded over 7 years between two weather gauges located at opposite ends of ICRISAT's 1,400 ha experimental station in Patancheru, India (Walker and Jodha, 1986).

that affect most people in a region at the same time. Individual losses are then much more likely to be highly correlated with the insured weather station event (Giné, Townsend, and Vickey, 2007). This approach can work for farm insurance as long as it is accepted that alternative types of arrangements may be needed to help households manage more frequent and less covariate risks.

Technological advances are rapidly reducing the cost of adding secure weather stations,[7] and in some countries private firms now offer weather station services for a fee (e.g. India). Greater problems are that additional weather stations add to the cost of developing and marketing insurance contracts, and new weather stations come without site-specific historical records. The absence of sufficient weather stations in many countries has led to interest in indices that do not require local weather data at all, but which correlate highly with production or asset losses for many farmers. Area-based yield insurance is sometimes a viable alternative, although as an index is suffers because official yield measurements are not reported until quite late after the harvest, leading to delays in payment (something that has plagued the India area-yield insurance program NAIS). Mongolia has pioneered a livestock insurance program in which the index is a county-level livestock mortality rate measured through an annual livestock census (Hellmuth et al., 2009).

There has been a lot of recent innovation in developing indices that can be assessed remotely with satellites, such as cloud cover, vegetative cover, or soil moisture content for a chosen region during critical agricultural periods. Such data is sometimes linked to a biophysical model that relates the remotely sensed data to the agricultural losses to be insured. For example, the Index Based Livestock Insurance (IBLI) project has developed a remotely sensed vegetation index to insure livestock mortality losses in pastoral areas of Northern Kenya. In 2007, 10% of lower middle - income countries had IBI schemes that used a satellite sensed vegetative index (Mahul and Stutley, 2010). The EU's new satellite system Sentinel-2A could also be a game changer for the types of indices that can be developed and monitored around the developing world.[8]

3.3 The distribution problem

There are serious difficulties and costs in marketing index insurance to large numbers of smallholders, and in collecting their premiums and making payments. Few private insurers have the required distribution networks in rural areas in developing countries, so they often work through an intermediary with an existing network of their own (e.g. a microfinance institution, bank, input dealer, agroprocessor, or NGO), or they work with groups of farmers that can be insured as single entities (e.g. farmer associations and mutual funds). For example, Fresh Co in Kenya, SFS in the Philippines, and Pioneer and NWK AgriServices in Zambia, all use private input dealers to market their insurance (Appendix I). Examples of the aggregator approach are the Zambian National Farmers' Union in Zambia (which arranges insurance for

---

[7] A good low-cost weather station with automatic capabilities costs about US$2,000. They cost even less in India.

[8] http://www.cnbc.com/2015/06/25/european-satellite-a-game-changer-for-farmers.html

groups of its members), and Agroasemex in Mexico which reinsures farmers' self-insurance funds (fondos).

To address the problem of collecting premiums and making payouts in a timely and cost effective manner, some insurers are taking advantage of mobile phone and mobile banking technologies. A good example is the ACRE program in East Africa, which enables farmers to pay their insurance premiums and receive payouts via the M-PESA mobile banking system (Box 8).

Box 8: The Agriculture and Climate Risk Enterprise (ACRE), East Africa

Covers primarily East African countries (mainly Kenya, Rwanda and Tanzania). It offers several types of insurance to farmers (credit insurance for farm inputs on selected crops, seed grower yield insurance, dairy livestock insurance, and a seed replanting guarantee). Each type of insurance has its own index and data source, including reliance on automated weather stations, satellite rainfall measurements, and area yield measurements. Distribution channels are specific to the type of insurance, and include a variety of partners along value chains, including financial institutions, seed firms, input suppliers, dairy cooperatives, and mobile banking companies. ACRE's use of mobile technology and mobile banking to collect premiums and make payments is very innovative (uses the M-PESA mobile banking system, a service that can be used to send money to virtually anyone or any firm in the country via text messages. Since 2014, ACRE operates as a for profit social enterprise (ACRE was previously known as Kilimo Salama, a project of the Syngenta Foundation. It has now turned into a registered company of its own). The program started with 200 farmers in 2009 and has achieved scale. In 2014 it sold 233,700 policies, insured $12.3 million of coverage, and made payouts of $379,405. The GIIF currently provides a premium subsidy of up to 40% of total premium volume.

There is some evidence that it is unlocking credit for farmers leading to greater investment and higher incomes.

3.4 The climate change problem

Climate change is expected to increase both the frequency and severity of extreme weather events, especially in many drought prone areas, and this will be compounded by greater uncertainty about the levels of risk involved. Adapting to these changes may in some cases require major changes in farming systems and livelihood strategies, or even relocation for some people. More widely, it will disrupt traditional risk avoidance and coping mechanisms at household and community levels, increasing the need for greater public and donor assistance in coping with catastrophic weather events. Under these circumstances, IBI ought to become an even more attractive risk management aid. However, its costs will also increase (IPCC 2014, WGII Chapter 17). This is because insurers will need to increase premium rates on a periodic basis to reflect higher payout levels, and they will need to add an additional premium charge to hedge against remaining uncertainties about the changing nature of insured risks. Index insurance can be adapted to climate change and this will require:

- Adjusting the types of insurance offered in different regions to reflect changes in growing conditions and risk. Priced correctly, older products may become more expensive for farmers, while new products will be needed as farmers adapt their land use patterns and choice of technologies.
- Adjusting premium rates on a regular basis to reflect changing risks.
- Adapting to more pronounced cyclical weather patterns by, for example, moving towards longer-term (multi-season) contract arrangements.
- Adapting to the emergence of more available and accurate seasonal weather forecast data. This may require establishing earlier sell by dates or adjusting premium rates to better match the purchase date with the availability of season specific forecasts.

However, increasing the cost of voluntary insurance will be difficult without the aid of subsidies. The additional cost of drought insurance with climate change compared to pre-change levels can be seen as a direct measure of the cost of climate change to the farmers concerned. Seen in this light, there may be a valid argument for subsidizing this additional cost using climate change adaptation funds set up by governments and donors, particularly in areas with high incidences of poverty.

3.5 Public goods and first mover problems

Although private insurers are actively engaged in most of the weather index insurance programs in Appendix I, they have rarely initiated programs. Instead, governments, multinational agencies such as the World Bank and World Food Program, and international NGOs like Oxfam have played the crucial initiating role. This suggests there may be important public roles that need to be met, without which the private insurers face high set-up costs and barriers to entry. There is also a first mover problem: the high initial investment costs in research and development of index insurance products might not be recouped given the ease with which competitors can replicate such products if they prove profitable to sell. Private insurers may be particularly wary of this issue; unlike public insurers, they are not subsidized and may miss the opportunities that public insurers have as early movers.

4. Solutions to challenges to scaling up IBI

There are a number of ways in which the public sector can help overcome these problems.

4.1 Building weather station infrastructure and data systems

As discussed earlier, weather index insurance requires a reliable weather station infrastructure, and these must be sufficiently dense to avoid excessive basis risk. Beyond the physical presence of weather stations, there is need to collect, maintain, and archive data and to make it available on a timely basis in relation to insured events. Ideally, these data would be placed in the public domain and, because they have multiple uses, made available to all, including those with commercial interests wishing to develop innovative weather insurance products, or seasonal weather forecasts. Much the same goes for making available reliable satellite data that can be used for IBI. It is not necessary that the governments themselves collect and provide these data, and private firms and research organizations can be contracted for this purpose. However, given the public goods nature of suitable weather and remote sensing data, at least part of their cost will need to be paid by governments or donors if there are to socially optimal levels of investment.

4.2 Supporting agro-meteorological research leading to product design.

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

4.3 Provide an enabling legal and regulatory environment

Establishing a legal and regulatory environment for enforcing contracts that both buyer and seller can trust is a fundamental prerequisite for index insurance. 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, 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.

4.4 Educate farmers about the value of insurance

To increase the likelihood that information is presented in a balanced way, and that sufficient investments are made in a broader educational effort for untested insurance products, public funds from governments and/or donors may be required. While private insurers will invest in marketing their products, they are unlikely to invest at socially optimum levels in educating farmers more generally about the appropriate role of insurance.

4.5 Facilitate initial international risk pooling or access to reinsurance

The highly covariate nature of the payouts for index insurance poses a challenge to a private insurer. The insurer can hedge part of this risk by diversifying its portfolio to include indices and sites that are not highly and positively correlated, an approach that works best in large countries. Most often it is also necessary to sell part of the risk in the international financial or reinsurance markets. Nearly all the programs in Appendix I are reinsured internationally. [9]The World Bank also created a market for a cat bond to enable the Caribbean countries to underwrite their Catastrophe Risk Insurance Facility (CCRIF), a multi-country risk pooling arrangement to help cover the relief costs associated with natural disasters (Box 4).

4.6 The question of public subsidies

Given all the challenges discussed above, it seems unlikely that IBI will ever scale up quickly without increased levels of public support by governments and donors. Pilot programs are still exploring the limits of unsubsidized insurance with IBI products, but there are no programs of scale that are not currently subsidized. This raises two key questions: Under what circumstances should the public sector provide a subsidy, and what are the best ways to do it?

Why subsidize? Sustained subsidies are inevitable when insuring disaster relief agencies given difficulties in recovering costs from beneficiaries. However, it needs to be recognized that assured relief can undermine incentives for people to purchase their own insurance, and it can lead to them taking on more risk than they otherwise would. One way to resolve this dilemma is to combine relief programs with compulsory insurance for some kinds of catastrophic losses, even if the premium has to be partially subsidized for poorer people. This is a common practice in many higher income countries for managing flood risks.

Arguments for subsidizing insurance for farmers are trickier (Box 9). If not used carefully, subsidies – like free relief, can inadvertently encourage farmers and herders to take on too much risk, increasing their dependence on future subsidized assistance (Siamwalla and Valdes, 1986). They can also distort incentives for insurers and banks. There may be good arguments for subsidizing insurance for poor farmers, especially if this helps them to graduate from more costly types of safety net programs, or to access game changing credit, technologies or markets. Subsidies might also be warranted to kick start insurance markets for non-poor farmers, for example, by offsetting some of the initial set-up, administration and reinsurance costs. Ant they need to be "smart". "Smart" subsidies are designed and implemented in ways that provide maximum social benefits while minimizing distortions in the market and mis-targeting of clients. Poorly designed subsidies can undermine

---

[9] Until a sufficient volume of business is established to attract global reinsurers, extreme losses for the insurance pool could even initially be underwritten by government and/or donors, perhaps through risk pooling or contingent loan arrangements. For example, the World Bank provided a contingent loan arrangement to the Mongolian Government as part of the reinsurance arrangements for the Index-Based Livestock Insurance Program (IBLIP) covering around 14,000 herders.

efficiencies and incentives within the insurance industry, and encourage over-utilisation of health care by beneficiaries, and overinvestment in risky, and sometimes environmentally damaging, agricultural activities. A subsidy should be designed with a clearly stated and well-documented purpose. It should address a market failure or equity concern, and should successfully target those in need with minimum inefficiency. Smart subsidies are designed with a clear exit strategy or with a long-term financing strategy in mind. Additionally, a good monitoring and evaluation system that tracks the performance of subsidies is paramount for the success of any subsidized insurance scheme." (Hill et al., 2014, p.v). Such subsidies will be less distorting if made directly to the insurer to offset administration and development costs rather than subsidizing the premium rates paid by farmers. If premium rates are to be subsidized, then it is better to do this on a proportional basis rather than establish premium caps. There should also be an explicit exit strategy.[10] Finally, subsidies might be warranted as part of a strategy to assist farmers adapt to climate change, where the subsidy is set to cover the part or all of the difference in the premium rate between pre- and post-climate change scenarios.

Recent literature provides guidelines on how to use subsidies in "smart" ways that avoid creating disincentive problems, or becoming a financial burden on the state (Box 9). A smart subsidy has a clearly stated and well-documented purpose, such as addressing a market failure, equity or climate change concern. Such subsidies will usually be less distorting if made directly to the insurer to offset administration and development costs rather than subsidizing the premium rates paid by farmers. If premium rates are to be subsidized, then it is better to do this on a proportional basis rather than establish premium caps. There should also be an explicit exit strategy or strategy for long-term financing[11]. Additionally, a good monitoring and evaluation system that tracks the performance of subsidies is paramount for the success of any subsidized insurance scheme (Hill et al., 2014, p.v).

Box 9: Guiding principles for subsidizing agricultural insurance

Dan Clarke (2011) has summarized the guiding principles as follows:

Any subsidies to agricultural insurance should be designed with a clearly stated and well-documented policy objective, and should be designed to address a market failure or equity concern. Subsidies on agricultural insurance premiums should be carefully considered and targeted. Policymakers should carefully identify their objectives, such as which beneficiaries, crop or livestock sectors, and regions to target, and whether the subsidies will be provided for a limited period or in perpetuity. This ensures that the subsidies are "smart" in that they minimizing distortions in the market and mis-targeting of clients, whilst crowding in the private insurance industry.

Premium subsidies are widely used by governments to support agricultural insurance markets, but are not always the best way to structure financial support to agricultural insurance. A review of agricultural insurance programs in 65 advanced and emerging

[10] See also USING SUBSIDIES FOR INCLUSIVE INSURANCE: LESSONS FROM AGRICULTURE AND HEALTH Ruth Vargas Hill*, Gissele Gajate-Garrido,Caroline Phily and Aparna Dalal,ILO MicroInsurance Papers No.29, BMZ/GIZ implemented

[11] See also USING SUBSIDIES FOR INCLUSIVE INSURANCE: LESSONS FROM AGRICULTURE AND HEALTH Ruth Vargas Hill*, Gissele Gajate-Garrido,Caroline Phily and Aparna Dalal,ILO MicroInsurance Papers No.29, BMZ/GIZ implemented

countries finds that almost two-thirds of the surveyed countries, including low, middle and high income countries, provide substantial agricultural insurance premium subsidies (Mahul and Stutley 2010). Premium subsidies can reduce the cost of insurance to the farmer, and thereby increase utilization of insurance particularly for more vulnerable farmers and herders, and can support insurance companies to develop a minimum sustainable market size. However, if not used carefully, subsidies can distort price signals and provide inappropriate incentives to farmers and herders (e.g. have an adverse effect of encouraging them to take more risks or continue engaging in risky activities).

Instead, during the early years of agricultural insurance programs, a combination of investing in data and providing public reinsurance to complement private sector reinsurance can be a cost effective alternative to premium subsidies. Like premium subsidies, such a combination can reduce the cost to the farmer, and support the development of a minimum market size, but can also address a market inefficiency typically faced by new programs: New agricultural insurance programs will typically require substantial investments in infrastructure for collecting, auditing and managing data to the standard demanded by international reinsurers. However, it will take some time before sufficient data is available to fully access international reinsurance on competitive terms. For example, building a reinsurable dataset for area yield index insurance will take about three to five years. In the interim period, whilst new data is being invested in, government can supplement international reinsurance to ensure that farmers are able to purchase reliable insurance at attractive prices. Over time, as international reinsurers become more comfortable with the new data collection procedure and reinsurance becomes affordable to insurers, government may revert to channeling financial support through premium subsidies.

Missing from the literature on subsidizing IBI is any empirical evidence on the size of the private and social benefits conferred by the insurance, which could help guide decisions about when some public financing might yield a positive net social return. A few studies have examined farmers' uptake of index insurance when linked to credit and technology packages, and of the socio-economic determinants of that demand (Giné et al., 2008), but none of the IBI programs in Appendix I has been subject to ex post impact studies to show their full impacts. We simply do not know how IBI has changed farmers' livelihood strategies and incomes or how protecting lives and assets has enabled people to avoid or escape poverty. Nor do we know how IBI has impacted on financial institutions, agrodealers and the like, and whether it has enabled them to expand their businesses by serving more small farmers. It will be important to build more long-term Monitor & Evaluation components into future index-based weather programs.

5. Conclusions and recommendations

Agricultural insurance has evolved considerably since the 1990s, away from costly and publicly provided MPCI programs towards insurance tied to named perils and index-based products. The private sector has also expanded its role, but in less-developed countries mostly through public-private partnerships that combine the efficiency of the private sector in delivering insurance with targeted financing by the state. There has also been growth in the role of various types of nonprofit agencies (e.g. NGOs, microfinance organizations and farmer groups) in delivering insurance to farmers, especially poor ones, and these have also formed partnerships with private insurers.

Despite these developments, agricultural insurance remains far too small to meet the risk management needs of most farmers and rural people in developing countries, or to protect them from distress when natural catastrophes occur. Relief programs have had to help fill the gap, but the reality for most smallholders is that they must manage risks on their own, and this can have high economic and humanitarian costs. These costs seem likely to increase as population pressures in many high-risk areas continue to grow, and as climate change increases the frequency and severity of many natural hazards.

Index based insurance is a promising innovation that might yet help scale up agricultural insurance to needed levels, as well as help underwrite many public relief programs. It also promises to be a useful bridge for increasing the engagement of private insurers in managing these risks, either directly or through various kinds of public-private or nonprofit-private partnerships. Yet despite many promising pilots, IBI has not yet taken off at scale. The largest IBI programs are in India, and although heavily subsidized by government and compulsory for borrowers from state banks, they still only insure about 30% of India's farmers. Most other IBI programs are reaching a few tens of thousands of farmers, particularly if not subsidized.

There are a number of challenges holding back IBI, including problems of weak farmer demand, difficulties in developing appropriate indices and distribution networks, coping with climate change, insufficient public investments in necessary public goods, and first mover problems. This paper has reviewed some recent innovations that seek to overcome these challenges, and some are indeed showing promise in ongoing pilot projects. But whether they will prove game changers that help scale up demand without large subsidies remains to be seen.

There are a number of ways in which governments and donors can support the development of IBI. These include: a) building weather station infrastructure and data systems; b) supporting agro-meteorological research leading to product design; c). providing an enabling legal and regulatory environment for insurance contracts; d) educating farmers about the value of insurance; and e) facilitating international risk pooling or access to reinsurance, especially for new programs. There may also be grounds for subsidizing insurance for poor farmers, especially if this helps them to graduate from more costly types of safety net programs, or to gain access to game changing credit, technologies or markets. Subsidies might also be warranted to overcome set up problems and first mover problems for private insurers, and as part of a strategy to assist farmers adapt to climate change. Where subsidies are warranted it is usually better if they are made directly to the insurer to offset administration and development costs rather than subsidizing the premium rates paid by farmers. If premium rates are to be subsidized, then it is better to do this on a proportional basis rather than establish premium caps.

One of the difficulties is assessing the promise of new innovations in IBI is a lack of ex post impact assessments of pilot projects. We simply do not know how IBI has changed farmers' livelihood strategies and incomes or how protecting lives and assets has enabled people to avoid or escape poverty. Nor do we know how IBI has impacted on financial institutions, agrodealers and the like, and whether it has enabled them to expand their businesses by serving more small farmers. Until such data becomes available, it is also hard to determine the net social value of subsidizing IBI products, which at this stage still seem crucial for making IBI succeed.

REFERENCES

Bhattamishra, R. and C. B. Barrett (2010): Community-Based Risk Management Arrangements: A Review. World Development, 38 (7): 923-32.

Binswanger-Mkhize, H. (2012): Is there too much hype about index-based agricultural insurance? Journal of Development Studies, 48 (2): 187-200.

Carter, M., A. de Janvry, E. Sadoulet, and A. Sarris (2014): Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling. Background document for the workshop: "Microfinance products for weather risk management in developing countries: State of the arts and perspectives", Paris, June 25, 2014.

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

Clarke, D. J. (2011): A Theory of Rational Demand for Index Insurance. Economics Series Working Papers 572, University of Oxford, Department of Economics.

Clarke, D. and R. V. Hill (2013): Insuring countries against natural disasters. IFPRI Policy Brief 22, July. http://www.ifpri.org/publication/insuring-countries-against-natural-disasters-pool-rules

De Bock, O. and W. Gelade (2012): The demand for microinsurance: A literature review. Research Paper No. 26, ILO, Geneva.

Dercon, S., R. V. Hill, D. Clarke, I. Outes-Leon, and A. S. Taffesse (2014): Offering rainfall insurance to informal insurance groups: Evidence from a field experiment in Ethiopia, Journal of Development Economics, 106 (January): 132-143.

Dercon, S. & Christiaensen, L. (2007): Consumption risk, technology adoption and poverty traps: evidence from Ethiopia. Policy Research Working Paper 4257, World Bank, Washington DC.

Gautam, M., Hazell, P. and Alderman, H. (1994): Rural demand for drought insurance. Policy Research Working Paper 1383, World Bank, Washington DC.

Giné, X., Townsend, R., & Vickey, J. (2008): Patterns of rainfall insurance participation in rural India. World Bank Economic Review, 22 (3): 539-566.

GIZ (2013): Weather Index Insurance in India – Situational Analysis and Case for Market Development.

Glauber, J. (2004): Crop insurance reconsidered. American Journal of Agricultural Economics, 86(5):1179-1195.

Government of Ethiopia (2013): Livelihoods, Early Assessment and Protection. Innovative Climate Risk Management for Food Security. World Food Programme.

Government of India, Ministry of Agriculture, Report of the Committee to Review the Implementation of Crop Insurance Schemes in India, May 2014.

Greatrex, H., J. Hansen, S. Garvin, R. Diro, S. Blakeley, M. Le Guen, K. Rao, and D. Osgood (2015): Scaling up index insurance for smallholder farmers: Recent evidence and insights. CCAFS Report No. 14, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available at: www.ccafs.cgiar.org

Grosh, M., del Ninno, C., Tesliuc, E., and Ouerghi, A. (2008): For Protection and Promotion: The Design and Implementation of Effective Safety Nets. Washington DC: The World Bank.

Hazell, P., J. Anderson, N. Balzer, A. Hastrup Clemmensen, U. Hess and F. Rispoli (2010): Potential for scale and sustainability in weather index insurance for agriculture and rural livelihoods. International Fund for Agricultural Development and World Food Programme, Rome.

Hazell, P., P. Oram and N. Chaherli (2003): Managing Livestock in Drought-Prone Areas of the Middle East and North Africa: Policy Issues. In: Food, Agriculture, and Economic Policy in the Middle Eas and North Africa, Volume 5. Hans Löfgren (ed.), pp. 70-104, New York: Elsevier Science, Ltd..

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 Ramasamy, C. (1991): The green revolution reconsidered: The impact of the high yielding rice varieties in South India. Baltimore: Johns Hopkins University Press.

Hazell, P., Pomareda, C., and Valdés, A. (Eds.) (1986): Crop insurance for agricultural development: Issues and experience. Baltimore, Johns Hopkins University Press.

Hellmuth, M. E., Osgood, D. E., Hess, U., Moorhead A. & Bhojwani, H. (Eds.). (2009): Index insurance and climate risk: Prospects for development and disaster management. Climate and Society No. 2. International Research Institute for Climate and Society (IRI), Columbia University, New York.

Hess, U. (2003): Innovative financial services for rural India: Monsoon-indexed lending and insurance for small holders. World Bank, Agricultural and Rural Development Department.

Hess, U., Syroka, J. (2005) Weather-based Insurance in Southern Africa, Agriculture and Rural Development Discussion Paper 13, World Bank 2005.

Hess, U., W. Wiseman and T. Robertson (2006): Ethiopia: integrated risk financing to protect livelihoods and foster development. World Food Programme.

Hess, Balzer and Calmanti, (2009), Community Early Recovery Vouchers, in: Weather Risk Management, Ed. by Kenny Tang.

Hess, U. and N. Balzer (2010): Climate change and weather risk management: evidence from index-based insurance schemes in China and Ethiopia. World Food Programme.

Hill, R.V. and M. Robles (2011): Flexible Insurance for Heterogeneous Farmers: Results from a Small-Scale Pilot in Ethiopia. Discussion Paper 01092, IFPRI.

Hill, R.V., G. Gajate-Garrido, C. Phily and A. Dalal (2014): Using subsidies for inclusive insurance: lessons from agriculture and health. Microinsurance Paper No. 29, International Labour Office. - Geneva: ILO.

IPCC (2014): Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge, United Kingdom and New York, NY, USA.

Keyzer M.A., Molini, V., and van den Boom, G.J.M. (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, Amsterdam, Netherlands.

Lybbert, T. J., Galarza F. B., McPeak, J., Barrett, C. B , Boucher, S. R., Carter, M. R., Chantarat, S., Fadlaoui, A. and Mude, A. (2010): Dynamic field experiments in development economics: risk valuation in Morocco, Kenya and Peru. Agric Resour Econ Rev 39(2):1–17.

Mahul, O. and Stutley, C. J. (2010): Government support to agricultural insurance: Challenges and options for developing countries. Washington DC: World Bank.

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

Mude, A., Chantarat, S., Barrett, C. B., Carter, M, Ikegami, M., & McPeak, J. (2010): Insuring against drought-related livestock mortality: Piloting index based livestock insurance in Northern Kenya. Working Paper. Ithaca, N.Y.: Cornell University. Available at: http://www.ilri.org/ibli/images/stories/files/Mude_et_al__2010.pdf

Otsuka, K., & Hayami, Y. (1993): The Economics of Contract Choice: An Agrarian Perspective. Oxford: Clarendon Press.

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

Rosenzweig, M. R. and Binswanger, H. P. (1993): Wealth, weather risk and the profitability of agricultural investment. Economic Journal, 103, pp. 56–78.

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

Siamwalla, A. and Valdés, V. (1986): Should crop insurance be subsidized? In Hazell, P., Pomareda, C., & Valdés, A. (Eds). Crop Insurance for Agricultural Development: Issues and Experience. Baltimore: Johns Hopkins University Press.

Skees, J. R. (2000): A Role for Capital markets in Natural Disasters: A Piece of the Food Security Puzzle. Food Policy. 25: 365-378.

Sommerfeld, J., Sanon, M., Kouyate, B. A., and Sauerborn, R. (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.

SwissRE. Sigma report.

Walker, T. S. and Jodha, N. S. (1986): How small households adapt to risk. In Hazell, P., Pomareda, C., & Valdés, A. (Eds). Crop Insurance for Agricultural Development: Issues and Experience. Baltimore: Johns Hopkins University Press.

Webb, P. and von Braun, J. (1994): Famine and food security in Ethiopia: Lessons for Africa. Chichester, New York: John Wiley.

Wright, B. D. and Hewitt, J. A. (1994): All risk crop insurance: lessons from theory and practice, In Hueth D. L., & Furtan, W. H. (Eds.). Economics of Agricultural Crop Insurance: Theory and Evidence, Boston, MA: Kluwer Publishers.

World Bank (2011): World Development Report 2010: Development and Climate Change. World Bank, Washington DC.

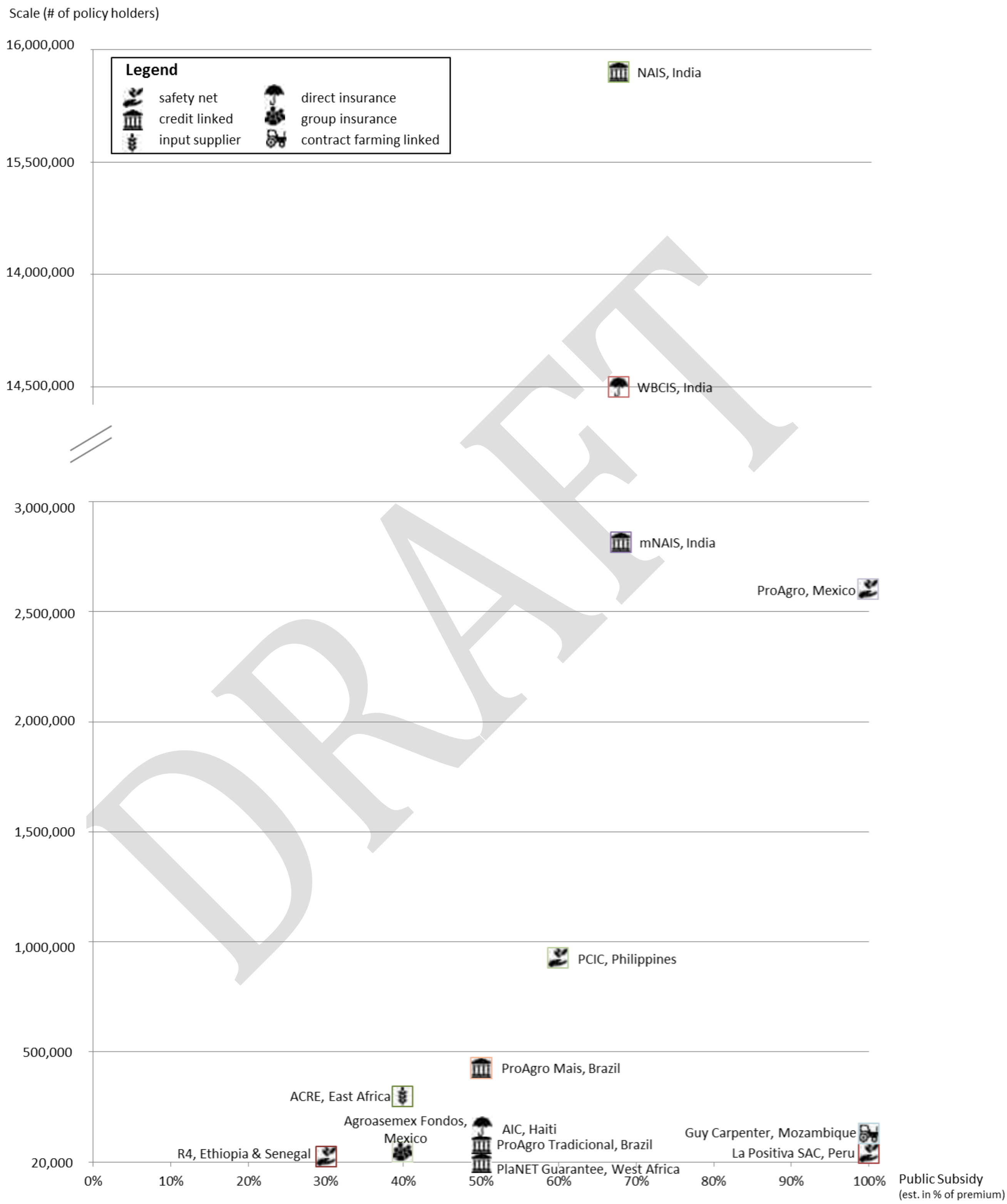
Appendix1: Table - Innovative Agricultural Insurance Programs

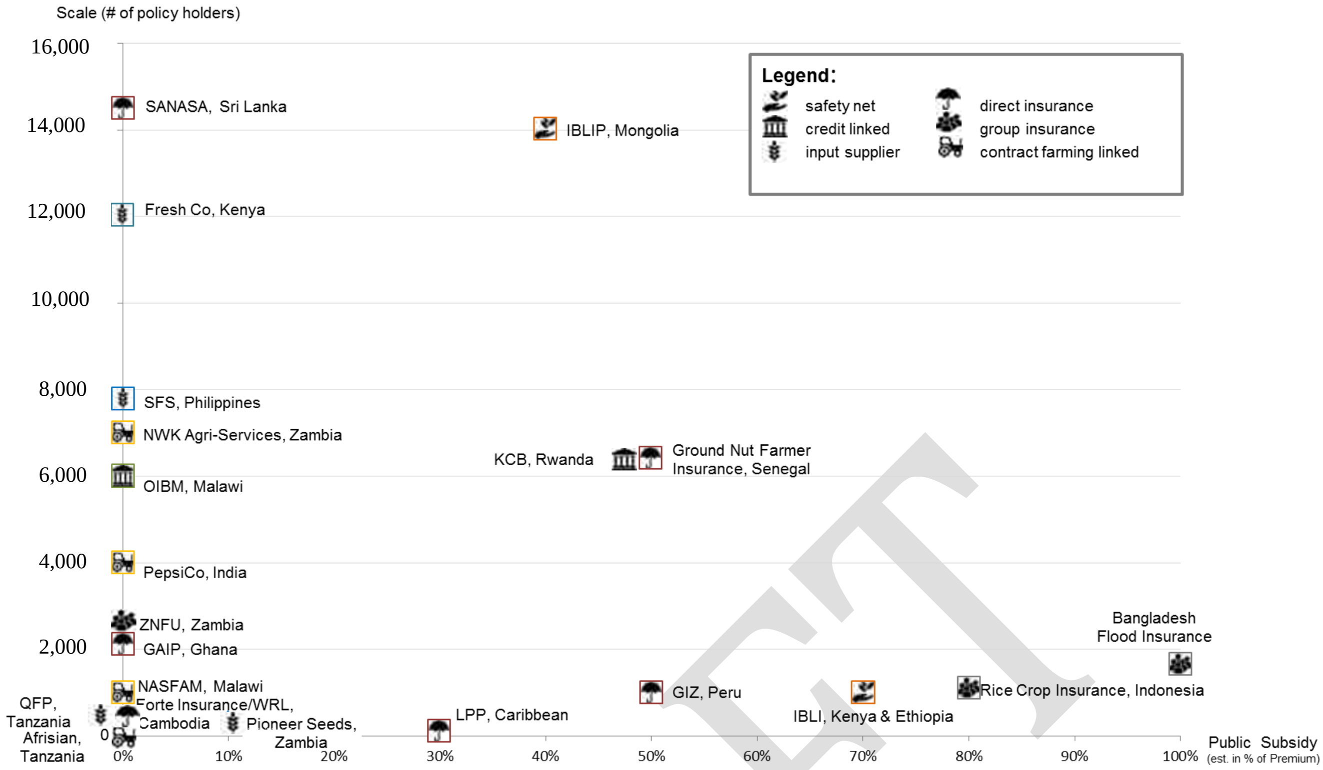
Country & program name	Scale (in or about 2014)	Main features	Start date
Programs that insure public relief efforts			
ARC, Africa	9 countries	Insures countries (Kenya, Mauritania, Niger, the Gambia, Mali, Burkina Faso, Malawi, Senegal, Zimbabwe) against cost of relief programs for droughts	2014
CCRIF, Caribbean	16 countries	Pools and insures risks of natural disasters for governments	2007
CADENA, Mexico		State managed relief program fully funded by national and state governments and insured by global reinsurers	2003
Pacific Climate Risk Insurance Pilot, Pacific Island Countries	5 countries	Catastrophe risk insurance against earthquakes, tsunamis and tropical cyclones for PICs (Cook Islands, Marshall Islands, Samoa, Tonga, Vanuatu); subsidized by Government of Japan and the World Bank	2013
Philippines Risk and Insurance Scheme for Municipalities (PRISM)		Parametric catastrophe insurance for municipalities; high-yield cat bond that the municipalities sell to private investors; claims are based on a pre-agreed threshold	2014
Total	**33 countries**		
Programs that insure farmers			
Africa			
ACRE, East Africa (Syngenta Foundation)	294,360	Several types of insurance offered for farmers; each has its own index and data source	2009
PlaNET Guarantee, West Africa	32,000	Credit insurance for purchased inputs against drought and excess rains	2011
R4, Ethiopia & Senegal	26,000	Drought insurance piggy-backed onto safety net programs	2009
Ghana Agricultural Insurance Pool (GAIP), Ghana	2,115	Experimental program; main product: drought insurance for maize based on rainfall index	2009
Fresh Co, Kenya	12,000	Insures purchased seed cost against risks of drought/excess rain (satellite-based)	2013
IBLI, Kenya & Ethiopia	*1,000*[a/]	Drought insurance for pastoralists; satellite vegetation index	2010
Opportunity International Bank Malawi (OIBM), Malawi	6,000	Satellite-based insurance linked to loans by OIBM against drought/excess rain for farmers belonging to outgrower schemes of tobacco companies	2013
NASFAM, Malawi	1,000	Insures bank loans for groundnut inputs; satellite-based group insurance organized by farmers' association	2013
Guy Carpenter, Mozambique	43,000	IBI for cotton farmers against drought, low temp and excess rain	2012
Kenya Commercial Bank (KCB), Rwanda	6,400	Satellite-based group insurance for farmer cooperatives; compulsory for farmers with agricultural loan from KCB	2012
Ground Nut Farmer Pilot, Senegal	8,500	Pilot drought insurance program for groundnuts using weather stations	2011
Afrisian, Tanzania	300	Insures cotton farmers against drought/excess rain losses; marketing through cotton gins; satellite-based	2014
Quality Food Products (QFP), Tanzania	500	Insurance integrated in agriculture finance program for small-scale to emergent farmers through QFP (agri-business)	2013
NWK Agri-Services, Zambia	7,000	Insures against losses due to drought/excess rain; marketed through an agrodealer (NWK AgriServices); satellite-rain index based	2013
ZNFU, Zambia	2,500	ZNFU buys insurance for farmer groups who use it as collateral to obtain loans from banks; satellite-based	2014
Pioneer Seeds, Zambia	400	Covers purchased seed costs; satellite-based	2014
Total Africa	**443,075**		

Asia			
Oxfam, Bangladesh	1,660	Flood index insurance; payout is triggered on the basis of water depth and duration of flooding; policy holder is a local NGO	2012
Forte Insurance/Weather Risk Limited, Cambodia	63	Weather index insurance for small rice farmers against floods and droughts	2015
China Insurance Regulatory Commission, China	140,000,000	Over 100m ha of crops insured against multiple risks accounting for 62% of the nation's total; corn, rice and wheat record highest insurance coverage rates; heavily subsidized by government	2004
Weather-Based Crop Insurance Scheme (WBCIS), India	14,500,000	Cover for a variety of crops and risks; compulsory with credit in states that have opted for WBCIS; lower premium rate for farmers who undertake soil & water conservation measures	2007
National Agriculture Insur-ance Scheme (NAIS), India	15,900,000[b/]	Area-yield insurance for range crops; compulsory with credit in states that have opted for NAIS	1999
Modified NAIS (mNAIS), India	2,818,000[c/]	Improved area-yield insurance for range crops; compulsory with credit in states that have opted for mNAIS	2010
PepsiCo, India (ICICI Lombard, WRL)	4,000	Weather Insurance and pest alerts plus growing advice for potato contract farmers	2006
Rice Crop Insurance Pilot, Indonesia	*1,102*[d/]	Insurance against flood, drought, pest/disease for rice farmers belonging to a Farmer's Group	2012
IBLIP, Mongolia	14,000	Livestock insurance for pastoralists that pays out against low mortality rates recorded at district level	2006
Security Farm Supply (SFS), Philippines	7,787	Bundles fertilizer insurance (typhoon) with accidental death insurance; uses satellite data	2013
Philippine Crop Insurance Corporation (PCIC), Philippines	924,343	Several agricultural insurance schemes: Multi-peril crop insur-ance, agricultural assets insurance, livestock insurance, fisheries insurance, loan repayment protection, agricultural producers protection and accident insurance; also weather-index pilots	
SANASA Insurance, Sri Lanka	14,508	Pilot program for paddy and tea farmers that is now going fully private; use of own distribution channels	2011
Total Asia	**174,185,463**		
Latin America and Caribbean			
ProAgro Tradicional, Brazil	50,078	Pays off farmers' credits in case of extreme weather events (drought, wind, frost, etc.) average sum insured $21k	
ProAgro Mais, Brazil	428,452	Pays off family farmers' credits in case of extreme weather events (drought, wind, frost, etc.) average sum insured $5.6K	
LPP, Caribbean (St. Lucia, Jamaica, Grenada)	80	Index insurance for any non-salary income earner banking with participating credit unions	2014
Alternative Insurance Company (AIC), Haiti	60,516	Natural catastrophe (hurricanes, earthquakes) and weather index insurance for women-owned micro-enterprises	2011
Agroasemex, Mexico	*45,000*[e/]	Fondos (self-insurance funds) aggregate and pool risk and then reinsure through the program	2001
ProAgro, Mexico	2,600,000	Government provides decoupled direct support payments to farmers; linked to specific actions to improve land productivity	
La Positiva SAC, Peru	130,500	Catastrophic Area yield index based; indemnity is paid directly into bank account	2010
Insurance for climate change adaptation project of GIZ, Peru	1,000	El Niño Index Insurance offered by La Positiva Seguros; average November-December sea surface temperature is used as index; payout before an extreme El Niño occurs	
Total Latin America	**3,315,626**		

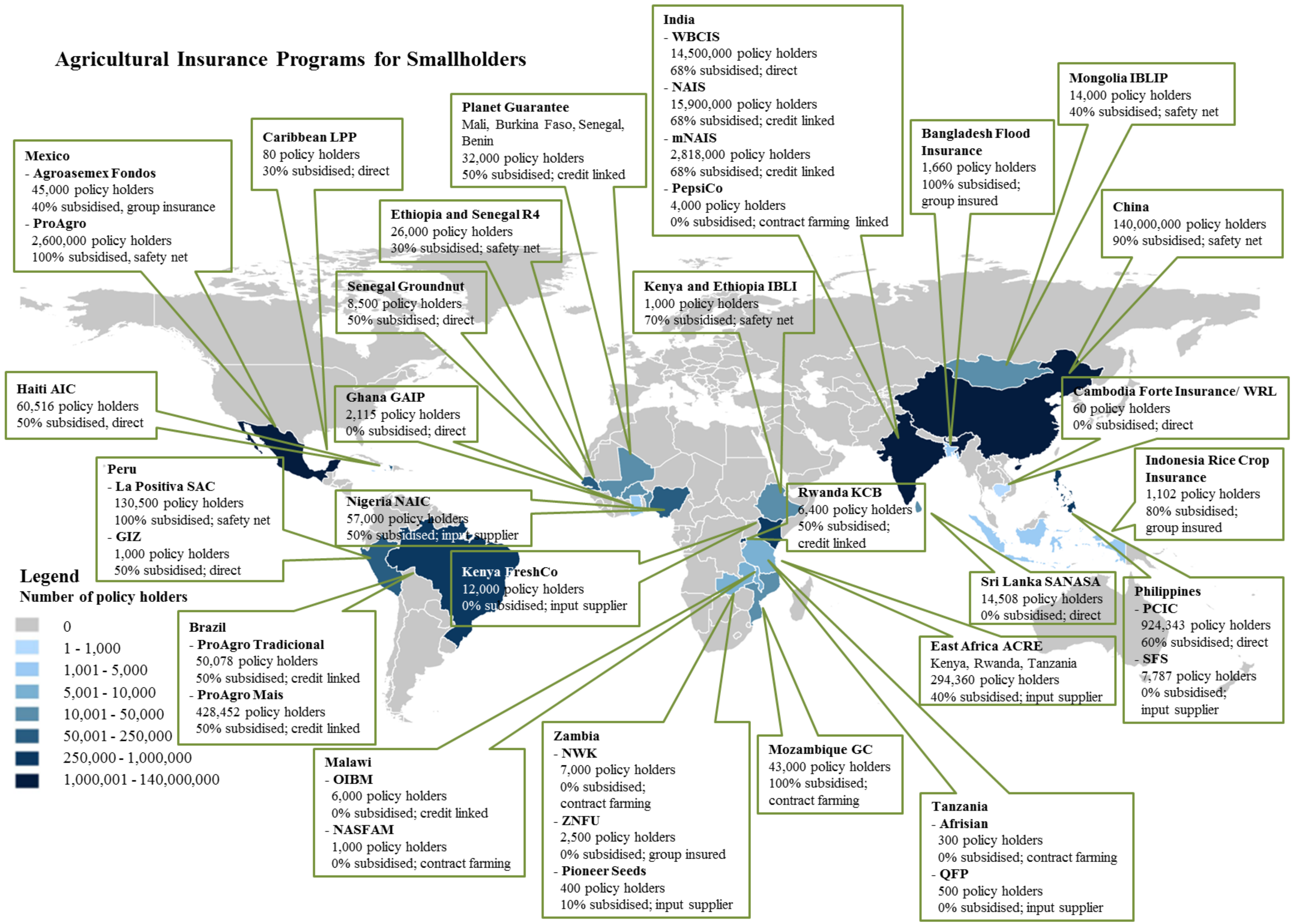
Notes: a/ Estimate: cumulative 10,000 since 2010; b/ 2012; c/ 2012, d/ 2,203 ha – assumption: ~ 2ha of land per farmer; e/ Rough estimate, based on 452 Fondos

Appendix 2: Insurance programs by number of policy holders and level of subsidies divided in programs > 20,000 and < 20,000





Note: "Subsidies" is the rate of subsidization (in%) is our estimate of the effective all-in rate of subsidy that the policy holder benefits from. That is, the rate of subsidization is the difference between the market rate the policy holder would pay for this exact level of risk protection and the actual rate paid. This estimate is only an estimate as of now, and will be verified and further refined with the relevant market makers and sponsors of insurance schemes.



Agricultural Insurance Programs for Smallholders
Mexico
- Agroasemex Fondos
45,000 policy holders
40% subsidised, group insurance
- ProAgro
2,600,000 policy holders
100% subsidised, safety net
Caribbean LPP
80 policy holders
30% subsidised; direct
Planet Guarantee
Mali, Burkina Faso, Senegal, Benin
32,000 policy holders
50% subsidised; credit linked
Ethiopia and Senegal R4
26,000 policy holders
30% subsidised; safety net
Senegal Groundnut
8,500 policy holders
50% subsidised; direct
India
- WBCIS
14,500,000 policy holders
68% subsidised; direct
- NAIS
15,900,000 policy holders
68% subsidised; credit linked
- mNAIS
2,818,000 policy holders
68% subsidised; credit linked
- PepsiCo
4,000 policy holders
0% subsidised; contract farming linked
Kenya and Ethiopia IBLI
1,000 policy holders
70% subsidised; safety net
Bangladesh Flood Insurance
1,660 policy holders
100% subsidised;
group insured
Mongolia IBLIP
14,000 policy holders
40% subsidised; safety net
China
140,000,000 policy holders
90% subsidised; safety net
Cambodia Forte Insurance/ WRL
60 policy holders
0% subsidised; direct
Indonesia Rice Crop Insurance
1,102 policy holders
80% subsidised;
group insured
Haiti AIC
60,516 policy holders
50% subsidised, direct
Ghana GAIP
2,115 policy holders
0% subsidised; direct
Peru
- La Positiva SAC
130,500 policy holders
100% subsidised; safety net
- GIZ
1,000 policy holders
50% subsidised; direct
Nigeria NAIC
57,000 policy holders
50% subsidised; input supplier
Rwanda KCB
6,400 policy holders
50% subsidised;
credit linked
Kenya FreshCo
12,000 policy holders
0% subsidised; input supplier
Sri Lanka SANASA
14,508 policy holders
0% subsidised; direct
Philippines
- PCIC
924,343 policy holders
60% subsidised; direct
- SFS
7,787 policy holders
0% subsidised;
input supplier
Legend
Number of policy holders
0
1 - 1,000
1,001 - 5,000
5,001 - 10,000
10,001 - 50,000
50,001 - 250,000
250,000 - 1,000,000
1,000,001 - 140,000,000
Brazil
- ProAgro Tradicional
50,078 policy holders
50% subsidised; credit linked
- ProAgro Mais
428,452 policy holders
50% subsidised; credit linked
East Africa ACRE
Kenya, Rwanda, Tanzania
294,360 policy holders
40% subsidised; input supplier
Malawi
- OIBM
6,000 policy holders
0% subsidised; credit linked
- NASFAM
1,000 policy holders
0% subsidised; contract farming
Zambia
- NWK
7,000 policy holders
0% subsidised;
contract farming
- ZNFU
2,500 policy holders
0% subsidised; group insured
- Pioneer Seeds
400 policy holders
10% subsidised; input supplier
Mozambique GC
43,000 policy holders
100% subsidised;
contract farming
Tanzania
- Afrisian
300 policy holders
0% subsidised; contract farming
- QFP
500 policy holders
0% subsidised; input supplier