First Draft

Producer Insurance and Risk Management Options for Smallholder Farmers

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Introduction

In low income countries, many families are desperately poor and exceptionally prone to substantial and potentially catastrophic decreases in their incomes and access to food. Within rural communities in those countries, families with smallholder farms typically face extraordinary production risk challenges in dealing with income volatility and food insecurity. Those challenges are even more severe for the very poorest families in those communities because of their particular circumstances, and not simply because as farmers they face periodically severe production risks. Often those smallholder households farm poor quality land on which crop yields are especially volatile because the household does not have either the financial (or quasi financial) assets or human capital to acquire, develop, and maintain the productivity of the land. Lack of human capital and, potentially, concerns about financial risks may also limit those families' abilities to adopt crop production practices with which they are relatively unfamiliar that have the potential to increase yields or to introduce new livestock management practices (see, for example, Binswanger-Mkhize (2010); Carter (2008); Dercon et al (2014); Miranda and Farrin (2012)).

Over the past decade, therefore, economists focused on rural poverty problems at the World Bank, at government agencies such as USAID, throughout IFPRI and the CGIAR, and, much more broadly, throughout the global development economics community, have become increasingly concerned with understanding how very poor farm households in very poor communities use risk management strategies to cope with short term food and income security crises because of crop failures and livestock losses. A natural extension of this focus has been

on the potential role of governments and international agencies in improving and expanding the array of risk management strategies available to those very poor farmers.

Those policy and infrastructure development related potential risk management and risk coping strategies include smoothing household incomes and/or food consumption through a wide range of agricultural insurance schemes, improving access to finance from formal institutions (most typically microfinance institutions), facilitating local coping mechanisms (for example, through informal credit systems at the village level in rural areas), providing improved technologies (including new crop varieties, improved access to irrigation, etc.), targeted emergency disaster aid, subsiding crop storage capacity at the household level, and emergency cash transfers. But they also include traditional programs that have long been recognized as central to economic development and increasing smallholder families' farm incomes, such as providing general education and health services, the development of roads, communication and water management and supply systems (including irrigation and water storage systems), agricultural research and development investments, and agricultural extension services. They also include programs that mitigate the adverse effects of domestic policies with respect to price and income volatility and agricultural productivity (including domestic taxation and other policies).

This paper examines the viability, scope and availability to poor farmers of alternative risk management strategies for addressing short term food security crises. We then consider the potential costs and benefits of alternative government and international aid policies intended to expand and enhance the array of risk management strategies that very poor farmers can use. A central issue in comparing alternative approaches is the opportunity cost of

government and foreign aid funds, some of which over the past decade have been allocated to various crop insurance projects (see, for example, Marenya, Smith and Nkonya (2014)) and, by straightforward extension, what constitutes efficient as opposed to inefficient policy (see, for example, Alston and Hurd).

Incentives for Smallholder Farm Household Risk Management and Coping Mechanisms

Binswanger has long argued that, as a group, smallholder farmers both understand the income and food security risks they face and, without any help from policy experts, address those risks in many important and often subtle ways. Thus, as Binswanger-Mkhize (2010) and Wright (2014) have pointed out, the costs and benefits of the often informal mechanisms for risk management and risk coping available to those farmers play a major role in determining the real opportunity costs they face with respect to many of the risk management tools that have recently been considered by policy analysts and policy makers, such as formal crop and livestock insurance policies. However, as Wright (2014) has recently suggested, many of the analyses that have presented arguments for the introduction of new risk management strategies have not adequately considered the portfolio of existing risk management tools available to farmers and their costs and benefits. The consequence has been an overemphasis on the argument that, because the production risks that smallholders face have potentially catastrophic consequences, they must be extremely risk averse and, therefore, willing to expend considerable resources to access specific risk management tools such as crop insurance.[1]

[1] Very recently, however, researchers have begun to question the utility of index and other insurance products as vehicles for risk management by small holders. See for example, Binswinger's assessment of the potential value of

Both Wright (2014) and Binswanger-Mkhize (2010) have emphasized that what matters for the smallholder household, as for any household, is their consumption of goods and services in any time period, not just the real income or food supply they obtain from any specific crop, and that the purpose of managing risk for most of those families is to smooth consumption. In particular, as some economists have also relatively recently begun to reemphasize in several contexts, in their risk management and risk coping strategies those households are likely to place particular emphasis on mitigating the consequences of potential shocks that could result in "extreme left tail" events (Goodwin, 2014).

These are the catastrophic events that have been given considerable emphasis by some researchers as disincentives for new technology adoption by very poor smallholder farmers (see Miranda and Farrin (2012) for a review of much of that literature and Barnet, Barrett and Skees (2008) for an example from the literature). Catastrophic events may also result in substantial reductions in asset holdings that undercut the household's future income stream. Selling livestock in order to obtain food is one example of what has been described as a poverty trap syndrome related to asset depletion (Carter et al (2008)). The problem is often compounded by the fact that the assets have to be sold in depressed markets (for example, livestock will bring a much lower price in an environment where feed is scarce because of drought). Various forms of crop insurance, therefore, have been proposed as a (partial) solution to mitigating such poverty trap problems (Skees et al (1999); Barnett et al (2008)).

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such products which he begin be asking whether their utility has been overhyped, Macours (2013) recent review of the evidence from randomized control experiments with respect to index insurance, and the survey by Miranda and Farrin (2012) of the academic literature and practitioner experiences with respect to index insurance.

In standard utility based models of an economic agent's insurance decision, the optimal strategy is for the agent to perfectly smooth consumption (Borch, 1990) which, in many of those models is equivalent to perfectly smoothing income (as the focus of the models is on the utility of income). In practice, whether the setting is a rich household in a rich country or a desperately poor family in a very poor country, almost no one does that for a variety of reasons. Not least in importance is the fact that such a goal is often infeasible (or at least impractical) because insurance companies are unwilling to offer contracts that perfectly smooth income (deductibles exist for a reason); but it is also typically sub-optimal from the perspective of households that face liquidity and other constraints on access to financial capital markets.[2] In addition, de Janvry, Dequiedt, and Sadolet (2014) have recently pointed out that investing in individual crop insurance protection can be welfare reducing for smallholder families who also rely informal risk sharing arrangements within a group of families in their locale.

Risk management and Risk Coping Strategies

Taking actions to mitigate and reduce the frequency and effects of extreme left tail events is often feasible and all but the most inveterate gamblers (extremely risk loving individuals) are likely to make non-trivial short term and, where feasible, longer term investments to mitigate or avoid extreme or moderately extreme adverse outcomes. The extent to which longer term investments in risk mitigating strategies will be made by

[2] As discussed below, one widely considered policy is to provide index insurance to financial intermediaries (see, for example, the discussion on this issue by Miranda and Farrin (2012)), especially microfinance companies, to enable them to enter rural markets and make operating loans to smallholder farms to obtain yield enhancing inputs (improved seed, herbicides, etc.).

smallholder farmers critically depends on the permanence of the property rights they believe they possess with respect to the land they farm.

In relation to strategies for mitigating risk, it may be useful to draw a taxonomic distinction between the strategies smallholder farm households use to address production, income and food security risks on an *ex ante* basis, here called risk management strategies, and what, in a reactive sense, happens *ex post*, after a severe adverse event occurs, here described as risk coping mechanisms. The distinction is somewhat arbitrary because the potential for *ex post* responses at the household, extended family and community level is taken into account by those households when they make *ex ante* plans for addressing risk.

For smallholder households, short term (within a crop season) risk management investments include the following: on farm enterprise diversification, diversification of household labor between on farm and off farm income generating activities (including off farm employment working for other entities and off farm self-employment/entrepreneurial activities), crop loss mitigation, spatial diversification of individual crop and livestock enterprises, and explicit self-insuring strategies such as food storage (Buschena, Smith, and Di (2004)) and holding livestock as potentially marketable assets (Barnett et al).

Crop loss mitigation strategies may include the use of chemical inputs (fertilizers, pesticides, herbicides) and the adoption of new (to the farm household) seed varieties that are more drought resistant but also more expensive. They may also include short term investments in irrigation (either through access to an existing village canal based irrigation system or well, or the use of family labor to carry water from available sources to where it is needed).

Investments in communication systems (for example, cell-phones) can also enable smallholder farmers to mitigate price risks associated with marketing their crops and livestock, enabling them to understand the range of price offers for their crops available in the markets in which they sell their crops and, as a result, substantially reducing price volatility and the frequency of low price offers for their crops.

Short term risk coping strategies (what smallholder farmers may be able to do after they experience an extreme or relatively extreme adverse event) include borrowing or receiving gifts from extended family members, borrowing from lenders in the local community who offer informal access to credit (for example, relatively wealthy farmers in the village), borrowing from semi-formal organizations such as iddirs (groups of households that, within a local community, jointly provide semi-formal insurance for burial expenses incurred by members of the group), and borrowing from formal financial credit institutions (for example, microfinance agencies or banks). They also include selling assets such as livestock and whatever farm equipment they may have to obtain food, often (as noted above) in depressed "fire sale" markets for those assets.

Longer term (multi-season) investments in risk management strategies by smallholder farmers may include improvements in land quality (through soil conservation practices such as agroforestry and terracing), development of a well or a site specific irrigation system (for example, through damming a local stream), participation in developing and maintaining a long term community irrigation system, investments in livestock herds as a longer run enterprise diversification strategy, and resource sharing arrangements among villagers to obtain risk reducing inputs like agricultural chemicals at a lower cost. They may also include longer term

social arrangements, for example through marriages that create incentives for expanded risk sharing among extended families by, for example, creating family ties with households in other locations (effectively, creating spatial diversification of crop yield and income risk within the horizontally extended family) and maintaining ties with extended family members who have established their own nuclear families in other locations.

Informal Insurance Programs

Many family and community based risk coping and risk sharing schemes exist that are, in effect, informal community or extended family based insurance programs. In those schemes, implicitly or explicitly, households agree to help one another in times of trouble, as among the iddirs in Ethiopia that provide informal burial insurance (Dercon et al (2013)). As a result, in those informal arrangements, indemnities in the form of "gifts" are likely to be provided when a potentially catastrophic decrease in an individual household's income occurs, but often payment of those indemnities is uncertain (because implicit obligations to help in times of trouble may not be fulfilled). So too are the analogs of premium payments and for the same reason: the "premium" is the reciprocal promise to provide resources to the other families in the group when they are in need of help. For example, within an extended family there may well be an expectation that, if one household experiences a catastrophic loss event, then other households in the extended family who are not affected, or much less severely affected, will "step up to the plate" and help out.

Importantly, these schemes tend have very low financial overhead costs (although non-cash expenditures of social relationship capital may not be so low). For example, the

household, which is likely to face severe liquidity constraints, does not have to make any cash outlays in the form of pre-loss premium payments to participate in the informal insurance scheme as the "premium" is the promise to help out after an adverse event has occurred if another family is in trouble. The schemes are also extremely flexible, and do not typically involve binding legal commitments (although the requirement to conform to well-understood customs established by the community may be just as binding in many circumstances).

However, these arrangements are perhaps most likely to fail when help is most needed because the catastrophic event that has severely curtailed the household-in-need's real income (for example, a disastrous region wide drought) also has had severe adverse impacts on all participants in the informal risk sharing arrangement. Some policy analysts have argued that such problems provide an obvious rationale for more formal insurance programs in which policies are guaranteed by reinsurance through commercial reinsurance companies and/or the domestic government, and/or aid agencies, while not using a formal market failure argument for their subsidization.

Essentially, the argument is that such policies are complements to the informal risk management strategies that already exist and will therefore be valuable and commercially viable. Others (for example, Dercon et al) have suggested that formal insurance is more likely to be taken up by individual farmers when leaders of informal insurance arrangements are well educated about the formal insurance products and , in that sense, commercial or subsidized index insurance products may be somewhat complementary to the informal schemes.

However, de Janvry, Dequiedt, and Sadolet (2014) show that insurance against a common shock (index insurance) purchased by a member of a common group can, and is perhaps likely to lead to free riding by other members of that group and therefore, for the individual, such insurance may have a negative value. They therefore suggest that group insurance policies which exclude the feasibility of free riding are likely to be preferred and, from a commercial perspective, such policies are likely to be offered at a lower cost because they spread fixed costs over a larger insured area.

Commercial and other Formal Insurance Programs

Formal crop and livestock insurance programs offered on a commercial basis have been proposed as a viable risk management tool for individual smallholder farmers by a wide range of policy makers and analysts (see, for example, Barnett et al, Vedenov and Barnett (2004), Skees et al (1999), and the extensive review by Miranda and Farrin of index insurance studies). However, as Hazell, Pomerada and Valdez pointed out in 1986, absent substantial government subsidies, formal farm-specific yield (or revenue) based insurance programs have never been successfully offered on a commercially basis because, given the premium rates the private insurance sector requires to offer them, smallholder farmers simple do not participate in them. Binswanger-Mkhize (2010) and Miranda and Farrin (2012) essentially draw similar conclusions for weather index based insurance programs.[3] And, as Smith and Glauber (2012) and, almost twenty years before them, Wright and Hewitt (1994) noted, citing Patrick's seminal study of

[3] While not the primary focus of their study, McIntosh, Sarris and Papadopoulos (2013) report that when smallholder farmers in Ethiopia were given a voucher to purchase a weather index insurance product for the most part the farmers used the voucher to fully subsidize insurance coverage for a part of the land they farmed, leaving the rest of the land uninsured. At the very least, their findings suggest that unsubsidized index insurance is not viewed as a viable risk management tool by those farmers.

Mallee River Valley wheat farmers in Australia (Patrick, 1986), such is also the case in developed countries for both index insurance and individual farm yield based insurance programs.[4]

Index Insurance

Over the past ten years, as discussed above, both insurance practitioners and some economists have argued that some form of crop or livestock insurance products can be offered successfully on a commercial basis to smallholder farmers because the required administration and operations loading factors are much lower than for all risk insurance. Further, they have argued that access to such insurance products will mitigate the adverse impacts of potential adverse events on the families' degree of food insecurity and willingness to adopt new technologies that on average increase their real incomes but may increase the volatility of their crop yields.

The infeasibility of implementing all risk or multiple peril crop insurance contracts that provide indemnities based on a farmer's actual yields and yield histories for major subsistence crops to smallholder farmers has been almost universally acknowledged (see, for example, Binswanger-Mkhize (2010); Miranda and Farrin (2012)), just as they are widely acknowledged to be infeasible in developed countries in the absence of substantial subsidies (Kramer (1983); Wright and Hewitt (1991); Goodwin and Smith (1995); Smith and Glauber (2012)). The loading factor – the amount in excess of the premium

[4] To the best of our knowledge, the only commercially sustainable form of "stand alone" agricultural insurance has been insurance against specific perils such as hail or fire (Kramer (1983); Goodwin and Smith (1995); Smith and Glauber (2012)) and markets for such insurance have tended to be small in scale. In addition, in some developed countries even specific peril hail insurance against crop loss has been subsidized by either national governments or regional governments in order to create a viable market (Goodwin and Smith, 1995). All other "successful" insurance programs have either encouraged extensive voluntary participation through large subsidies, as in the United States, Canada, India, and Brazil (Hazell, Pomerada and Valdez (1986); Mahul and Stutley (2008); Smith and Glauber (2012); and Wright (2014)), by mandating participation as a condition for participating in other government programs (Goodwin and Smith (1995), or, perhaps, by bundling the insurance with another commodity. Approaches like Syngenta's bundling an insurance policy with the purchase of seed by a smallholder is effectively a scheme that makes the insurance product a tied good. In effect, it is a way of extorting surplus associated with the purchase of seed to cover the cost of the insurance policy, which, given the evidence on willingness to pay for insurance, might well not be purchased if offered as a separate commercially priced commodity.

needed to cover expected indemnities - required by a private insurance company to cover their administrative and operations costs is widely viewed as simply far more than almost all farmers are willing to pay. Self-insurance and other risk mitigating strategies are less costly and more efficient.

One reason for the costliness of all-risk crop and livestock insurance contracts is that monitoring moral hazard behaviors (sometimes now called hidden action behaviors) is perceived to be expensive. Automobile insurance and property/casualty insurance, which on the supply side are typically competitive markets, have been described as comparable lines of insurance business with respect to moral hazard effects (for example, see Goodwin and Smith(2010)), and loading factors for such lines of business are typically in the range of 40 to 50 percent of expected indemnities. In the context of smallholder farmers, another factor is that the fixed costs associated with issuing and managing such policies are relatively high and have to be spread over an area of crops that is very small.

However, it should be noted that a similar overhead fixed cost problem exists for index insurance programs marketed to individual smallholders farming one or two hectares of land (Boucher, Barham, and Carter (2005)) and, as discussed above, is one reason why de Janvry et al (2013) argue that group based index insurance contracts are more viable. In addition, participation in all risk crop insurance programs is likely to be relatively low because of adverse selection (hidden information) effects as premium rates cannot be tailored to individual farms' actual loss experiences because of inadequate data on yields and ancillary farm specific information (Goodwin (1993); Smith and Baquet (1996); Just, Calvin, and Quiggin (1999)).

These are not new twenty first century insights. Halcrow (1948), in a developed country context, laid out the moral hazard and adverse selection issues associated with "all risk" crop insurance at the farm level 66 years ago, and the issues were readdressed by Miranda (1991) in his seminal analysis of area (county) yield based index insurance contracts 23 years ago. Both Halcrow and Miranda

argued that area yield index contracts that cover dozens of farmers in a specific region (say a county, or a sub-county grid that is 20 kilometers by 20 kilometers) rarely create incentives for moral hazard behaviors and are likely to substantially mitigate adverse selection problems. In a development context, however, reliable historically data on area yields adequate to estimate premium rates and develop actuarially viable contracts are typically not available. Hence it is natural to think of using an index based on a variable (or set of variables) that is closely related to area and farm crop yields in developing an insurance policy.

Weather is a major factor in determining crop yields and the availability of forage, and so weather indexes have become the focus of much of the work on potential agricultural insurance products. As rainfall can be measured relatively easily and inexpensively, it has received considerable attention in pilot projects and theoretical and simulation analyses as the basis for, or the sole component, of a weather index.[5] To some extent, satellite images of plant growth have also been proposed as the basis for a vegetation growth index (and are used in the United States as the basis for a heavily subsidized index contract to provide insurance against forage loss in areas with relatively low levels of annual rainfall), although they can only effectively be utilized in areas where thick cloud cover occurs relatively infrequently.

Basis Risk in Index Insurance

No matter how refined the weather index may be (or any other area-based index for that matter), as Miranda (1991) emphasized, crop insurance based on an area index is subject to what he called basis risk. Basis risk exists in two forms, both of which derive from the underlying problem that

[5] Weather indexes can be relatively simple or relatively complex. For example, lack of rainfall and excessive heat during the growing season are major causes of crop loss for commodities like maize and corn and a more optimal index for insuring those crops would therefore include measures of both rainfall and heat. However, reliable estimates of day time temperatures are much more difficult to acquire on a consistent basis and may be less meaningful for even a relatively small area when measured at a specific location. Hence, most of the attention with respect to index insurance has focused on rainfall insurance or satellite based measures of vegetation growth.

the index on which indemnity payments are based is less than perfectly positively correlated with an individual farm's actual loss experience. The first, which is not very important in the context of enabling a smallholder household to cope with a severe adverse change in their real income and food security from their crops and livestock, is that the farm may receive an indemnity when it has not suffered any substantial loss. The second is important; the farm may not receive an indemnity when it does experience a substantial loss.

Increasingly, over the past five years, the issue of basis risk has been given more serious attention than it received in some of relatively early analyses of index insurance.[6] For example, Smith and Watts (2009) examined the extent of basis risk in a rainfall index insurance instrument that reflected typically estimated correlations between plant growth and rainfall at the location of the weather station where rainfall is being measured (which they report as typically about 0.7) and the correlation between plant growth at that location and other locations in a typical area to be covered by the index (which they also report as typically about 0.7). Under somewhat restrictive independence assumptions, using a Monte Carlo approach and allowing correlations between the index and on-farm crop yields to vary, their results indicate that basis risk is likely to be substantial.

Smith and Watts' findings are presented in table 1 for farms experiencing fairly substantial actually crop losses of between 50 and 70 percent of expected yields who insure at an index strike trigger of 70 percent (an indemnity payment is made when the rainfall index's value falls below 70 percent of its expected value). They report that even if the correlation coefficient between the farm's yields and the index is as high as 0.9, there is 37.3 percent probability that the farm will not receive an indemnity. If the correlation coefficient is 0.6, perhaps a more realistic estimate, then the probability of

[6] For example, Vedenov and Barnett (2004) suggested that correlations between weather indexes and crop yields would be sufficiently large to ensure that basis risk would not be a major problem for farmers.

no indemnity payment increases to 59 percent and the likelihood of a substantial indemnity payment is only about 20 percent.

A more recent study by Jensen, Mude and Barrett (2014) examines basis risk in the context of the demand for a livestock mortality insurance product for Northern Kenya farmers which they report was specifically designed to minimize basis risk and cover losses of livestock. The product was offered to households for which the livestock enterprise provides about 70 percent of the smallholder household's income. The index on which the insurance product was based was derived from a Normalized Difference Vegetation Index (NDVI), the index first used by the USDA Risk Management Agency to provide forage index insurance to farmers in similarly dry arid and semi-arid regions of the United States.[7] The Northern Kenya product was priced to cover the costs of providing the insurance and, while initially 28 percent of farmers eligible to purchase the coverage participated in the first period the insurance was available, participation subsequently declined rapidly.[8]

Jensen et al estimate correlation coefficients between individual farm mortality rates and the index that applies to those farms in the insurance product. Consistently among the five districts covered by the product, for well over half of the farmers, the correlation coefficient is less than 70 percent. For between 9 percent and 29 percent of the farms in each of the five districts, they report a negative correlation between on farm losses and losses indicated by the forage based index. Not surprisingly, but importantly, they find that basis risk is a major adverse influence on the household's willingness to buy insurance coverage and that as a household's understanding of that basis risk improves the household becomes less likely to purchase the insurance coverage.

[7] Uptake for the US NDVI product has been substantial, not least because US farmers pay a premium that is on average less than 50 percent of the expected indemnity; that is, they expect to receive more than $2 for every $1 they pay in premiums (Glauber, 2012, Goodwin and Smith, 2012).

[8] This is a widely observe pattern for pilot index insurance schemes offered to smallholder farmers on a commercial or near full cost basis (Miranda and Farrin (2012)).

Elabed, Bellermare, Carter and Guirkinger (2013) have proposed the use of a double trigger contract to mitigate basis risk in which village cotton yields in Mali are used to make payments to individual farmers for losses only if district yields are sufficiently low to indicate that low village yields are not the result of moral hazard behaviors (in other words, the village is effectively viewed as a "collective" farm operated as a single entity). As such, even though described as an index product, the product has substantive elements of an all risk contract. The double trigger concept is not new; for example, Watts and Associates proposed a double trigger index product to the USDA Risk Management Agency in the mid-1990s when index insurance products were first being developed as part of the US crop insurance program. Certainly, as Elabed et al demonstrate, index insurance products based on a double trigger can be designed to mitigate basis risk. However, by increasing the frequency with which payments are made (even though a double trigger can also mitigate the frequency with which farmers receive indemnities when they do not experience losses), such contracts are often likely to increase premium rates.

Unambiguously, then, the literature seems to be clear about three aspects of basis risk in the context of index insurance. First, the theoretical literature indicates that an increase in basis risk will reduce a farmer's willingness to pay for an index insurance product (see, for example, Dercon et al; Miranda and Farrin; and de Janvry et al). Second, even though the potential exists for innovative product design to mitigate basis risk to some extent, basis risk is pervasive, extensive and substantial in almost all index insurance products. Third, the empirical evidence (as well as the theoretical models) consistently shows that basis risk has substantial adverse effects on smallholder farmers' participation in crop insurance products. As Jensen et al note, it seems likely that in many pilot index insurance schemes, as farmers come to realize the extent of that risk and, as a corollary, more accurately assess the expected net payoff from the insurance policy, they abandon the program.

Pricing of Index Insurance Products and Farmers' Willingness to Pay for Them

The price of a competitively offered commercially provided insurance policy has two components; the expected indemnity and the operating and administration costs associated with delivering the product. A risk neutral economic agent facing no liquidity constraints is therefore widely assumed to be willing to purchase an actuarially fair insurance policy for which the price is simply the expected indemnity. However, errors in rate setting associated with differences in the information sets available to the insured individual and the insurance company typically result in adverse selection problems, which are typically extensive in all risk crop insurance contracts, but widely viewed as less pervasive in index insurance contracts. Positive loading factors mean that only risk averse economic agents will purchase a commercially offered insurance policy, although if those risk averse agents face liquidity constraints, the requirement that premiums be prepaid before the occurrence of adverse events may further diminish the likelihood of purchasing the insurance.

Consistently, studies of willingness to pay for either multiple peril insurance products based on the farm's actual yields or index insurance products have reported that farmers are not willing to pay very much, if anything at all, for crop insurance coverage (Wright (2014)). And that finding holds whether the farmers being investigated are located in rich countries like the United States and Australia or poor countries like Morocco and Tanzania (Smith and Watts (2010)). Basis risk simply makes matters worse for index based insurance products as compared to all-risk insurance products that always pay indemnities when a farmer incurs an insured loss.

In effect, as Smith and Watts (2010) suggested in their review of the then extant willingness to pay studies, once the loading factor for a product exceeds about 9 percent, only extremely risk averse farmers are willing to buy the product. Numerous studies of risk preferences among smallholder farmers have done little more than replicate Binswanger's (1981) finding that most of them are

moderately risk averse and, in fact, on average extreme risk aversion attitudes occur about as frequently as risk loving attitudes occur (in other words, relatively infrequently). This finding is consistent with the results of most studies of farmers' willingness to pay for agricultural insurance and one that goes a long way to explaining why so few smallholder farmers have participated in most of the pilot index insurance programs that have been offered over the past decade.

If a nine percent loading factor is effectively the demand side choke price for multiple peril insurance, then the choke price for index insurance is likely to be lower. An important question, therefore, concerns what sort of loading factor is required by private insurers to deliver index insurance to farmers. Very early estimates by some academics that index insurance could be provided with loads of 2 to 5 percent now appear to be very optimistic. For example, BASIX in India was initially willing to offer an index product to smallholder farmers with about a 15 percent loading factor, but then estimated that a minimum load of 25 percent would be required to cover the company's operations and administration costs.

Even in developed countries, where a single policy is likely to cover hundreds or thousands of hectares over which fixed costs can be spread, insurance companies appear to require a loading factor well in excess of 15 percent to offer an index insurance product (either via subsidies or underwriting gains). For example, two types of cost that are always incurred by primary insurance companies are often overlooked in discussions about agricultural insurance. These are the primary companies' reinsurance costs and the costs of the financial capital they have to hold in order to offer the insurance in the first place. Those costs, by themselves, are likely be close to or exceed nine percent of the expected indemnity associated with the policy.[9]

[9] Industry sources suggest that reinsurance and cost of capital costs each are likely to be three to five percent of the expected indemnity, and reinsurance costs will be substantially higher than that for books of business that are small (where an insurance policy generating a hundred million dollars of premium would be viewed as small).

Using Government and Aid Agency Resources to Support Risk Management and Risk Coping Strategies

There are clearly important limits to the value of commercially provided and priced index insurance as a risk management strategy that would alleviate the food and real income insecurity effects on smallholder households of catastrophic and moderate adverse crop and livestock production shocks. The question is then whether domestic government or foreign aid resources should be used to subsidize access to those products. Too little attention has perhaps been given to this question. However, the theoretical and empirical evidence that does exist suggests that subsidizing access to such products may be sub-optimal. For example, as discussed above, de Janvry et al show that where informal risk sharing occurs, purchasing individual insurance is likely to have a negative impact on the farm's welfare because of free riding effects. A better way to go is therefore to offer such coverage to the group, in effect the village. However, if the product is to be subsidized, why not just provide disaster aid when an area wide adverse event occurs and avoid many of the costs associated with private delivery of the insurance product? As Smith and Glauber (2012) note, these costs are often substantial relative to the amount of aid to be provided.

One argument for private delivery of foreign aid dollars though crop insurance schemes, instead of allocating the aid through the government, is that governments are more likely to divert aid from the communities that need the help than private insurance companies.[10] However, one potential use for weather and plant growth indexes is to more accurately target foreign emergency and other aid dollars to the communities who most need them. If all farmers in a community come to expect aid when widespread adverse outcomes for the community occur, then informal risk sharing programs are less likely to fail in those circumstances because on a community wide basis resources are enhanced. To some extent, some of the anti-poverty trap benefits claimed for individually purchased index insurance

[10] It is by no means clear that private insurance companies can be relied on to deliver aid dollars where they are most needed. Issues about the integrity of insurance companies abound, even in countries where the regulatory and legal systems are well developed.

products might then accrue in terms of technology adoption and reductions in fire sales of livestock assets because smallholder families become more certain that those informal risk sharing networks will be work when they need help.

A recent study by Marenya et al (2014) suggests that index insurance may also not be an optimal policy for encouraging a longer term for of investment in risk management practices. They carry out stated choice experiments with respect to alternative incentive for the adoption of agroforestry yield enhancing conservation practices by Malawi small holder farmers in the Shire River Valley. Their results indicate that farmers will chose cash payment incentives that are substantially smaller than the subsidies associated with an ideal index insurance product (essentially an index product that has no basis risk) as their preferred incentive for adopting the same conservation practices that would increase yields and reduce the frequency of extreme adverse shocks.

If index insurance targeted to individual smallholder farmers is much less than a silver bullet solution for improving their ability to manage and cope with the income and food security risks, then what would be a more effective and efficient use of domestic government and foreign aid funds? The answer is both discouraging and encouraging because many of the public policy and aid driven initiatives that are most likely to benefit smallholder farmers are programs that have been supported for a long time. For example, public investments have high returns when they are made in agricultural research targeted towards both enhancing yields and reducing their volatility (for example, improving drought resistance) and in extension programs that enable smallholder farmers to minimize production risks associated with adopting new varieties. Programs that allow smallholder farmers to cope with climate change driven reductions in growing season rainfall and/or changes in the timing of that rainfall are likely to substantial mitigate the volatility of their yields and incomes. These clearly include investments in water storage and irrigation systems.

Finally two alternative uses of agriculture related index insurance products have been extensively discussed. One approach is to offer index insurance to private credit institutions that would otherwise not offer loans to smallholder farmers. To the extent that such an approach is a least cost way of ensuring those farmers have some access to financing for purchasing inputs that are likely to improve and stabilize their crop yields and livestock operations, there may be a genuine economic justification for such an approach. However, an alternative that accomplishes the same objective is to establish a farm credit system underwritten by the government and/or aid agencies. Whether the former or latter approaches would be more effective is not clear as, in the former case the financial intermediaries' actions may be subject to moral hazard effects and in the latter case there may be several reasons for a "government failure" problem.

The other use of index insurance products is for the lending institution to bundle loans to farmers with an insurance policy. The effect, absent subsidies, is to increase the cost of the loan to the farmer which reduces their return from the inputs they purchase with the loan. In addition, as Miranda and Farrin (2012, p 413) and, earlier, Smith and Goodwin (1995) note, assuming that the lending institution receives the indemnity payment when a farmer defaults on the loan, the incentives for the lending institution to monitor and invest in strong loan recovery actions may be mitigated. If the insurance product is subsidized, one result could be that a substantial number of low quality loans are made with potentially serious adverse consequences for the financial systems and government expenditures.

Summary

Smallholder households in many developing countries have many ways of managing the income and agricultural production risks they face. These include production practices such as enterprise diversification, the use of risk reducing resources, storage, and household investments in marketable assets such as livestock, as well as participation in extended family and community based risk sharing arrangements. Nevertheless, those households are still subject to relatively frequent crop and household income losses that have potentially catastrophic consequences for the welfare of their members.

In response, especially over the past decade, economists and policy makers have searched for innovative ways of improving those households' resiliency with respect to such adverse events. A particular focus has been the potential for smallholder households to use commercially viable weather based index insurance products to improve their welfare. However, increasingly, the empirical evidence indicates that, as is the case for very rich farmers in developed countries, almost all smallholder farmers in developing countries will not purchase such products absent substantial subsidies, which their governments probably cannot afford.

There are several reasons why those farmers are not willing to pay for such insurance. Fundamentally, and perhaps most importantly, many smallholder farmers appear to have less expensive ways of managing risk through practices that are already available to them. In addition, the overwhelming majority of those farmers do not appear to have sufficiently risk averse attitudes have risk premiums that exceed the loading costs that would be incurred by the insurance companies who would supply the insurance. Further, the extensive degree of

basis risk associated with most index based agricultural insurance products severely exacerbates the problem.

Index insurance, however, might be helpful in other contexts. For example, if communities purchase such insurance, perhaps on a subsidized basis, the indemnities provided when the community experiences broad based crop losses may facilitate the performance of informal or semiformal risk sharing agreements within the community. Alternatively, providing index insurance products to smallholder households by tying them to operating loans used to purchase improved inputs may reduce the impacts of adverse events on the household, although such bundling raises the cost of the loan to the household and may provide a moral hazard disincentive for the bank (that receives the indemnity in cases of loan default) to be diligent in its loan management practices.

Finally, using government and/or international aid agency resources to subsidize access to index insurance may seem like a potentially useful use of such funds, especially if the consequence is the adoption of more productive but perhaps higher risk technologies by very poor smallholder households. However, those funds have many other potential uses and the empirical evidence that very poor farmers who purchase such insurance are likely to adopt new technologies is weak. Perhaps more evidence is needed about the relative returns from subsidizing crop insurance as opposed to the returns from those other uses (such as subsiding the adoption of conservation practices, providing education, and increasing location specific agricultural research and extension programs). However, much of the evidence currently available indicates that many of those other programs are likely to provide substantially higher returns.

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Table 1. Indemnity Payment Outcomes for Farmers Experiencing Significant Yield Losses (yields between 50 and 70 percent of average)

Rainfall Index-Area Yield Correlation	Probability of Indemnity Event		
	No Indemnity	Small Indemnity [A]	Large Indemnity [B]
0.00	0.784	0.114	0.103
0.20	0.723	0.145	0.132
0.40	0.661	0.179	0.159
0.60	0.590	0.219	0.192
0.80	0.479	0.316	0.205
0.90	0.377	0.429	0.194
0.95	0.278	0.559	0.163
1.00	0.000	1.000	0.000

A. A small indemnity is an indemnity paid when the rainfall index has a value of between 50 and 70 percent.

B. A large indemnity is an indemnity paid when the rainfall index has a value of less than 50 percent.