* Dr. Vincent Smith is Professor of Economics at Montana State University

In low income countries, many families are desperately poor 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 ia wide rang1ult 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).

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)).

---

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 house 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 basis, here called risk management strategies, and what, in a reactive sense, happens , after a severe adverse event occurs, here described as risk coping mechanisms. The distinction is somewhat arbitrary because the potential for responses at the household, extended family and community level is taken into account by those households when they make 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

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 freq(o)bl 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.

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

Iner

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 wellETBT1 0 0 1 72.024 59g8297ou

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]

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.

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. B-3(BT(he)]BT(he)]BT(a t)-3(h)14(er-N)5(o)-5m)-2(t)7(to)3(w)-4(h)361mwum 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)

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)).

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

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.

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.

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 reason(c)3(r5)-3(BT1 0 0 1 72.0c11T1 0 0 1 72.0c11T1 0 0 1 72.-3(at)-4(so3(BTw54411

abethe In

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.

Alston, J.M., and B.H. Hurd. 1990. "Some Neglected Social Costs of Government Spending on Farm Programs." 72(1):149-156.

Bardsley, P., A. Abey, and S. Davenport. 1984. The Economics of Insuring Crops Against Drought. 28(1):1-14.

Barnett, Barry I., Christopher J. Barrett, and Jerry R. Skees (2008). "Poverty Traps and index-based transfer instruments." 36(10): 450-474.

Borch, Karl H. (1990) , North Holland, Amsterdam.

Buschena, D., V.H. Smith, and H. Di. (2005). "Policy Reform and Farmers' Wheat Allocation in Rural China." Australian Journal of Agricultural and Resource Economics 49(2): 143-158.

Binswanger, Hans P. (1981). "Attitudes Toward Risk: Theoretical Implications of an Experiment in Rural India."

Glauber, Joseph W. 2013. “The Growth of the Federal Crop Insurance Program, 2001-11.”

Mahul, O., and C. J. Stutley. 2010. Washington, D.C.: The World Bank.

McIntosh, Craig, Alexander Sarris, and Fotis Papadopoulos (2013). “Productivity, credit, risk and the demand for weather insurance in Ethiopia.” 44: 399-417.

Miranda, Mario J. (1991). “Area-Yield Crop Insurance Reconsidered.” , 73(2), pp 233-242.

Miranda, Mario J., and Katie Farrin. (2012). “Index Insurance for Developing Countries.” , 34(3) : 391-427.

Patrick, George. 1988. “Mallee Wheat Farmers’ Demand For Crop And Rainfall Insurance.” Australian Journal of Agricultural Economics 32(1) : 37-49

Skees, Jerry R., Peter Hazell, and Mario Miranda (1999). . International Food Policy Research Institute. EPTD Discussion Paper No. 55.

Smith, V.H., and A. Baquet (1996). “The Demand for Multiple Peril Crop Insurance: Evidence from Montana.” 78(1): 75-83

Wright, Brian D. (2014). "Multiple Peril Crop Insurance." , forthcoming.

Wright, Brian D., and Julie A. Hewitt (1994). "All-risk crop insurance: Lessons from theory and experience." In , ed. D.L Hueth and W.H. Furtan. Boston: Kluwer Academic Publishers: 73-114.

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.