Agricultural Insurance Revisited: New Developments and Perspectives in Latin America and the Caribbean

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EXECUTIVE SUMMARY

Agriculture is an inherently risky business. It is subject to a number of random price, climatic, biological, and geological shocks that require coping strategies and financial management instruments to deal with the implications. Traditional risk management strategies and ex post government provided emergency relief have often not proven to be sufficiently effective and robust in preventing serious economic loss or permitting a speedy recovery. This paper focuses on production risk management, explaining key concepts, understanding why crop insurance markets have been slow to develop, and making recommendations about how to build sustainable markets in developing country contexts.

For the most part, producers in developing countries are quite exposed to weather vagaries and have little access to formal agricultural insurance products that would allow them to transfer production risk to other parties. Agricultural insurance was more widespread in Latin America and other developing regions of the world during the 1960s and 1970s. However, most of the comprehensive, multiple peril programs common then, encountered financial difficulties and were either scaled back or completely closed. At present in Latin America, the volume of agricultural insurance premiums is a miniscule share of total insurance premiums.

Nonetheless, agricultural insurance is reemerging as a topic of interest, especially in light of the need to improve agricultural competitiveness in increasingly integrated commodity markets. The challenge is how to overcome obstacles and deliver efficient and sustainable agricultural insurance products. The principal obstacles—lack of high quality information, inadequate regulatory frameworks, weak supervision, lack of actuarial expertise, lack of professional expertise in designing and monitoring agricultural insurance products, a mass of low-income, dispersed clients, who may not be willing or able to pay actuarially sound premiums for multiple peril products, and the tendency of governments to undermine market development through inappropriate use of subsidies and disaster relief funds--are highlighted and discussed. Case studies on Uruguay, the Dominican Republic, and Peru reveal how crop insurance products are evolving and/or what government-supported initiatives are under the way to expand coverage. Recommendations of how to build markets step-by-step and the importance of applying new technology to lower costs are made.

Agricultural insurance is presented as important financial risk management tool but not as a panacea for unprofitable farms, management failures, underinvestment in public infrastructure, or compensation for other poorly functioning factor markets. Different types of agricultural insurance products—single peril, multiple peril, parametric, and revenue—each have a niche but should adhere to basic principles of actuarial fairness, seek to minimize problems with adverse selection, moral hazard, and administrative costs. Governments have a vital role to play in providing the necessary information needed to measure, evaluate, and monitor risk, in maintaining an auspicious but sound regulatory and supervisory framework, in helping with reinsurance and catastrophic disaster relief, and supporting private insurance providers with technical assistance and training. Often time, the argument is made that "public subsidies for premiums" are necessary in order to make premiums more affordable for

the majority of farmers. The argument presented here is that scarce pubic monies may be better spent on creating favorable market conditions for the development of the industry (i.e. the maintenance of databases, training, and pilots) than on making transfers to private individuals. In the context of developing countries, with large rural populations (often exceeding 20%), sizeable agrarian sectors (agricultural share of GDP >10 %, agricultural exports as a share of total exports > 30%), and severe fiscal constraints, agricultural insurance systems should be cost effective and operate as part of a larger, layered risk management framework. Installing comprehensive and universal systems, as is the case for several industrialized countries, may be an inefficient use of scarce public monies for developing countries. In a layered framework, farmers should be trained how to reduce and cope effectively with some of the production risks on-farm through better management practices and diversification strategies; how to transfer some of the production risks to financial markets through efficient and sustainable instruments (insurance, savings, and credit); and how to rely on the government assistance for catastrophic events. In the latter case, rules for accessing disaster relief should be clear ex ante and not remove or undercut incentives for the adoption of better on-farm management techniques (moral hazard), the purchase of private agricultural insurance, or the accumulation of personal savings.

I. INTRODUCTION

Purpose

Agricultural insurance is reemerging as a topic of interest to farmers, policy makers, insurance companies, and development finance institutions in Latin American and the Caribbean after a long hiatus. In recent survey conducted by the Inter-American Development Bank and the Interamerican Federation of Insurance Companies (FIDES) in 16 Latin American countries, 35.3% of the insurance companies polled stated that development of crop insurance is important and 43.5% believed that the growth potential for this product is high (Tovar, 2005). The renewed interest stems from a confluence of factors: a number of economically costly natural disasters in recent years; the need to improve agricultural competitiveness in the region in light of ongoing agricultural trade liberalization and integration movements that will expose regional producers to farmers in industrialized countries that avail themselves to a greater extent to an array of modern agricultural risk management instruments, among them crop insurance; and the promise that new information technology and advanced probabilistic risk modeling techniques holds to lower the cost of developing and supervising crop insurance products.

The purpose of this paper is to provide Bank staff interested in agricultural yield insurance market development, public officials responsible for financial market policy formulation and supervision, and insurance industry practitioners in Latin America and the Caribbean with a basic primer on the topic, an overview of previous experiences, and a set of guidelines and recommendations on how to develop viable and sustainable agricultural yield insurance markets. The paper relies heavily on the data and analysis stemming from a regional technical cooperation project financed by the Spanish Trust Fund, which conducted reviews and pre-feasibility studies in three countries—the Dominican Republic, Peru, and Uruguay—between 2003-2004. That work has been supplemented by an extensive economic literature review, fieldwork in Honduras, and numerous interviews and exchanges of opinions with leading authorities on the topic and key regional stakeholders.

Organization

The paper is organized as follows. Section II provides a basic review of concepts and definitions and highlights the theoretical and practical reasons why agricultural insurance is an extremely difficult product to deliver in an efficient and sustainable manner. Section III gives an overview of where the agricultural insurance market is going in Latin America and the Caribbean with some comparative information from selected developed countries. It extracts lessons learned from experiences of selected countries with more developed agricultural insurance markets. Section IV focuses on three country case studies where pre-feasibility studies were conducted. Section V makes a series of recommendations on how to promote and develop insurance markets and includes a discussion on how to best use public subsides to this end.

II. AGRICULTURAL YIELD INSURANCE: A PRIMER

Importance of Production Risk in Agriculture

Agriculture is a risky business. Producers face a host of different risks among them production or yield risk[1]. While production risk cannot be totally eliminated, it can be reduced and managed. In order to address the financial implications of this type of risk, producers have historically relied on a variety of strategies and coping mechanisms that can be categorized into three general classes: risk mitigation, risk transfer, and risk retention. This paper focuses on how to effectively transfer risk. Producers often report that production and price risks as their two major concerns.[2] Each year, unmanaged production risk contributes significantly to high economic losses throughout the developing world and helps to perpetuate poverty and income inequality.

Among the numerous sources of production or yield variability, weather is universally recognized as the dominant one. Figure 1 lists the principal sources of yield variability—quality of soil, planting date, genetic potential of the plant or animal, application of fertilizer, husbandry practices. Recent research from the Baltic states show that weather differences alone explained 35% of the variation in yield for a representative sample of farmers (See Figure 1). Of course, the relative importance of the factors may vary from place to place and with the level of technology employed. But what distinguishes climate risk from the other listed factors, however, is the degree of human control possible. The non-weather factors can be significantly reduced or mitigated with on-farm strategies, with the principal constraints being farmer knowledge and financial resources. In contrast, weather cannot be controlled and

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[1]Discussion of risk in this paper will be limited only to production or yield risk. Agricultural enterprises face other types of risks that can affect the profitability and viability, namely:

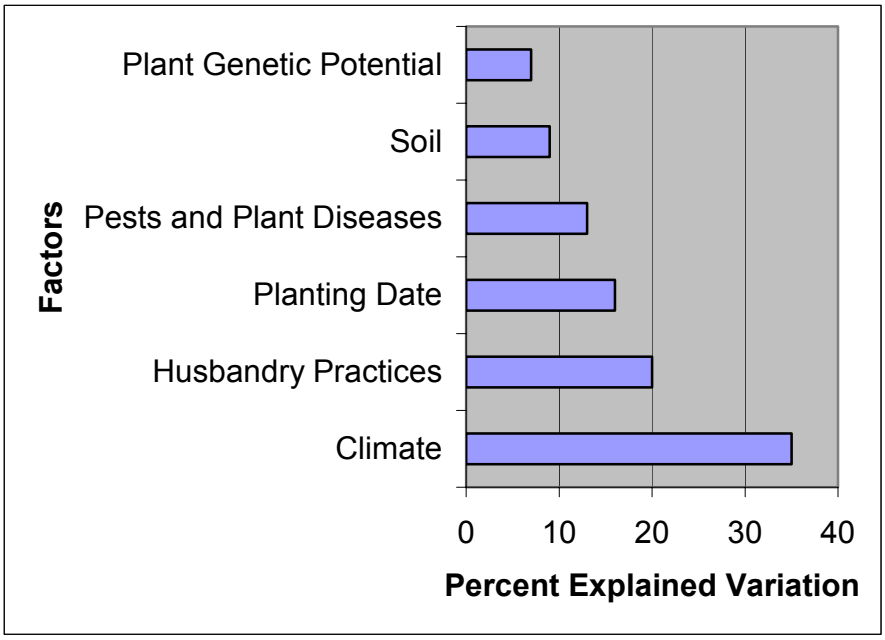
price or market risk referring to uncertainties about prices producers will receive for commodities or prices they must pay for inputs;
asset risk referring to the potential loss or damage to physical buildings, equipment, vehicles, and implements due to fire, theft, water damage, or accidents;
institutional risk referring to unexpected changes in government regulations governing taxes; environmental protection, employment rules, workplace conditions, price or income supports, repatriation of profits, support payments, other subsidies, property confiscation, and the like;
operational risk, referring to uncertainties in scheduling or using equipment at critical times, making or receiving shipments of critical inputs/outputs, and handling of labor disputes;
financial risk, referring to rising costs of capital, exchange rate movements, insufficient liquidity to meet liabilities, loss of equity, and the prospect of loans being called by lenders;
personal risk, refers to uncertainties and risks connected to health and personal relations such as accidents, illness, death, and divorce.

These types of risk are managed by different instruments and strategies, not crop insurance.

[2]A 1994 World Bank survey of rural Mexican households found that 63% of the farm households had experienced an "economic crisis" in the period 1989-1994 that resulted in either loss of income or higher than normal expenditures. Of the 63% farm households reporting an "income shortfall crisis", 48% said it was due to low yields as opposed to 11% due to low prices. In comparison, 34% of non-farm households reported low sales or low effective demands as the principal reason for "income crises". Source: World Bank 1995, Financial Markets in Mexico. op. cit Skees, Varangis, Larson, and Paul Siegel, 2002. When internationally traded agricultural commodities are involved price volatility tends to dominate quantity variability, especially in cross country analyses. See Larson, Varangis, and Yabuki, 1998.

constitutes a residual risk that should be transferred, and it cannot be retained with serious financial indications.[3] For example, the farmer can select the best seeds for planting, match plant agronomic requirements with soil characteristics, take preventive actions to minimize the risks of insect infestations or disease, and fertilize according to a schedule based on best available extension service knowledge and nutrient analysis of the soil. In practice, however, the degree of effective control is far from ideal, more so in the case of developing countries where extension services are weak, farmers have less access to information, and have less years of education, and limited access to credit. Thus, the combination of management shortcomings and weather vagaries makes agriculture more risky than most other economic enterprises in developing countries. This high degree of riskiness, especially in a sector dominated by producers with low-incomes and scant assets, has serious implications for economic growth, social equity, and poverty alleviation. Market and government-based solutions are needed.

Figure 1: Schematic of Sources of Yield Variability in Rainfed Agriculture (Percent)



Source: Jacob Lomas work on Baltic agriculture op. cit. Eduardo Zegarra, 2003

Three major types of natural phenomena contribute to yield risks in agriculture: hydro-meteorological, geological, and biological. Hydro-meteorological risks include excessive rain, floods, droughts, high winds, tornados, hurricanes, hail, frost, abrupt temperature changes, heat waves, blizzards, prolonged cold spells, avalanches, landsides, high waves, storm surges. Geological risks include earthquakes, volcanic eruptions, and tsunamis. Biological risks include diseases and insect infestations. Each of these risks can then be

[3] Irrigation can be a means to limit exposure to irregular and scant rainfall but irrigated agriculture can still be affected by adverse climatic risks, namely, meteorological and hydrological droughts reducing the volume of water available for irrigation from reservoirs, rivers, lakes, and aquifers. Livestock ranching can be affected by rainfall shortfalls that reduces the productivity of pastures or the supply of feed as well as by severe temperature changes or excessive precipitation.

categorized as either **catastrophic** or **non-catastrophic**, depending on frequency, scale, intensity, and duration. Catastrophic risk refers to natural disasters (earthquakes, hurricanes, volcanic eruptions, tsunamis, tidal waves, storm surges, etc.) that inflict large-scale damage over an extended area but are infrequent, low probability events. Non-catastrophic climatic risks (droughts, floods, landslides, mudslides, hail storms, freezes, heat waves, etc) affect localized areas (one or two provinces) or sometimes only a few farms. They tend to be more frequent, last longer, but cause less total economic damage. Biological risks such as insect infestations and disease epidemics tend to be localized but in some instances, if the disease is highly communicable, livestock may have to be slaughtered over a very wide swath surrounding the original outbreak point as a containment measure. Thus, an outbreak of brucellosis, a bacterial infection that affects ruminants, on one farm is a non-catastrophic risk whereas an outbreak of mad cow disease (BSP) would be a catastrophe for the entire cattle industry in a particular country.

Frequency of Natural Disasters and Estimated Economic Losses

Over the last decade the occurrence of natural disasters has been trending upward[4] (See Figure 2). The set of countries experiencing the least growth in disasters are the Central European States and the former Soviet Republics.[5] By the year 2050, the United Nations estimates that natural disasters will cost 300,000 lives and approximately $250 billion in economic losses per year worldwide, if more measures are not taken to mitigate risks and reduce global warming (UNISDR, 2002). For the period 1994-2003, the countries that are most vulnerable to natural disasters are developing countries, particularly those in Sub-Saharan Africa and East Asia. Latin America and the Caribbean are most exposed to windstorms, floods, and droughts, and windstorms (See Table 1). Within the region, however, there are marked differences. For example, while windstorms are the most frequent threat for the Caribbean, whereas floods are virtually six times more frequent than windstorms for South America. The seven Central American states, in turn, differ markedly from the other two subregions. They are disproportionately exposed to a larger array of threats—windstorms, floods, droughts, earthquake, volcanic eruptions, and epidemics-- and thus accounted for 35% of all the region's disasters. South America, with a larger number of states and with each state being larger in landmass than any of the Central American states, accounts for 47% of the natural disasters.

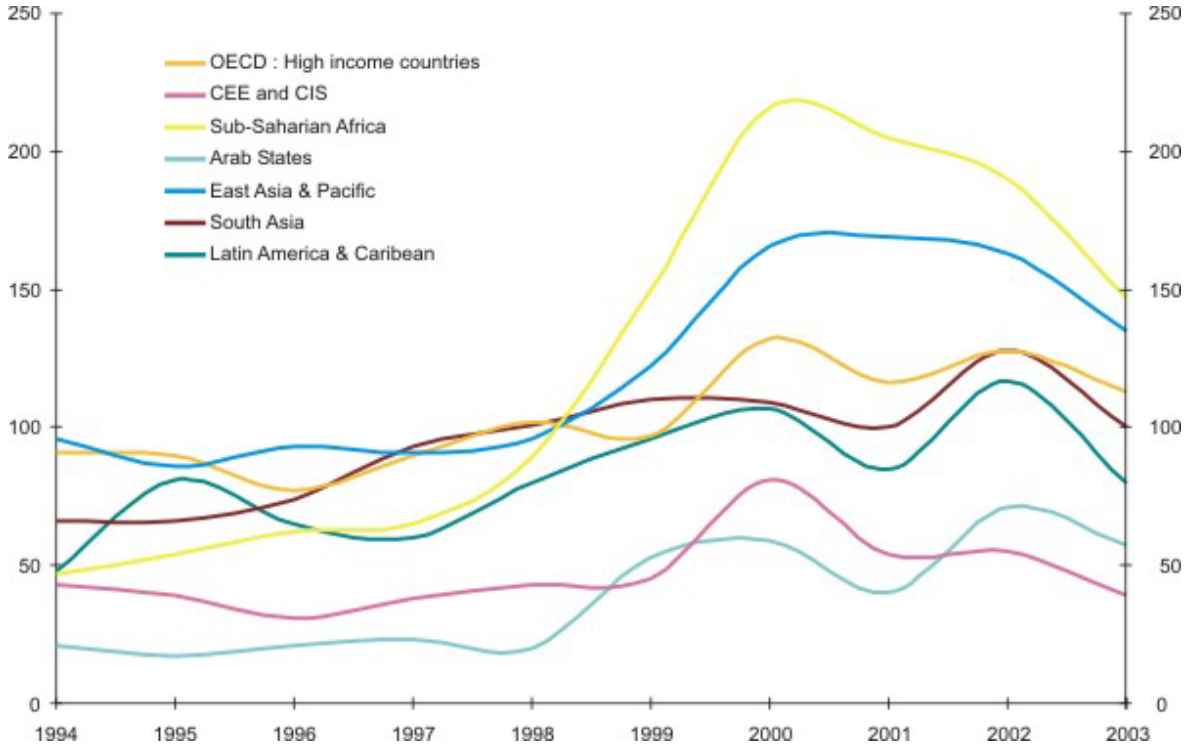
[4] Centre for Research on the Epidemiology of Disasters (CRED) defines a disaster as a "situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering". For a disaster to be entered into the database at least one of the following criteria must be fulfilled:

- 10 or more people reported killed
- 100 people reported affected
- Declaration of a state of emergency
- Call for international assistance

The number of people killed includes "persons confirmed as dead and persons missing and presumed dead"; people affected are those "requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance."

[5] Note: Data collection is problematical and the estimates provided are considered conservative. Certain regions of the world underreport occurrences and estimates of damages are subject to frequent and sharp revisions.

Figure 2
Total number of disasters by year 1994-2003 according to income aggregates



Source: http://www.unisdr.org/disaster-statistics/occurrence-trends-period.htm

Table 1: Number of Natural Disasters by Triggering Hazards: 1994-2003

	Hydrometeorological disasters							Geological Disasters			Biological disasters			
	Floods	Storms	Droughts & rel. disasters	Landslides	Avalanches	Waves & surges	Total	Earthquakes & Tsunamis	Volcanic Eruptions	Total	Epidemics	Insect infestations	Total	Grand Total
Africa														
Eastern	101	36	65	6	0	0	208	5	0	5	122	2	124	337
Middle	35	3	6	3	0	0	47	0	3	3	68	1	69	119
Northern	46	6	13	0	0	0	65	6	0	6	13	0	13	84
Southern	19	14	17	1	0	0	51	0	0	0	9	0	9	60
Western	68	11	15	2	0	0	96	0	1	1	117	0	117	214
Total	269	70	116	12	0	0	467	11	4	15	329	3	332	814
America														
Caribbean	25	57	6	1	0	0	89	2	4	6	4	0	4	99
Central	55	51	33	7	0	0	146	19	15	34	21	0	21	201
Northern	52	145	58	1	0	0	256	5	1	6	4	0	4	266
Southern	124	24	46	32	1	1	228	23	5	28	13	2	15	271
Total	256	277	143	41	1	1	719	49	25	74	42	2	44	837
Asia														
Eastern	82	122	36	26	1	2	269	53	2	55	8	1	9	333
South-Central	162	95	65	30	13	2	367	55	0	55	84	1	85	507
South-East	139	80	27	33	0	3	282	32	10	42	33	1	34	358
Western	38	14	24	2	1	0	79	24	0	24	8	0	8	111
Total	421	311	152	91	15	7	997	164	12	176	133	3	136	1309
Europe														
Eastern	66	28	58	3	3	0	158	6	0	6	17	1	18	182
Northern	17	15	6	0	2	0	40	2	1	3	3	0	3	46
Southern	54	13	36	4	0	0	107	18	1	19	8	0	8	134
Western	46	27	10	1	5	0	89	0	0	0	2	0	2	91
Total	183	83	110	8	10	0	394	26	2	28	30	1	31	453
Oceania														
Australia-New Zealand	24	35	17	2	0	0	78	1	1	2	0	1	1	81
Melanesia	3	14	6	4	0	0	27	9	5	14	5	0	5	46
Micronesia	0	6	2	0	0	0	8	0	0	0	2	0	2	10
Polynesia	2	6	0	2	0	0	10	0	0	0	1	0	1	11
Total	29	61	25	8	0	0	123	10	6	16	8	1	9	148
Grand Total	1158	802	546	160	26	8	2700	260	49	309	542	10	552	3561

Source:http://www.unisdr.org/disaster-statistics/occurrence-type-disas.htm

According to the World Bank (2001), between 1988 and 1997 natural disasters in the developing countries claimed an estimated 50,000 lives and caused direct damage valued at more than US$60 billion a year. In the Latin American and Caribbean region, as can be seen in the figures that follow (Figures 3a, 3b, and 3c), the economic losses for the Latin American and Caribbean region was US$31.9 billion for the period 1990-99 (CRED International Disaster Database, 2005). In the period 2000-05, the losses sum to US$17.5 billion (CRED International Database, 2005), the Caribbean having experienced double the losses than the entire previous decade as a result of hurricane damage in Haiti, Dominican Republic, and Grenada in 2004. These costs create dislocations at many levels— farm household, local regional economies, and national economies.

Figure 3a:
Estimated Economic Losses Due to Natural Hazards in Central America (1990-99) (US$ thousands)

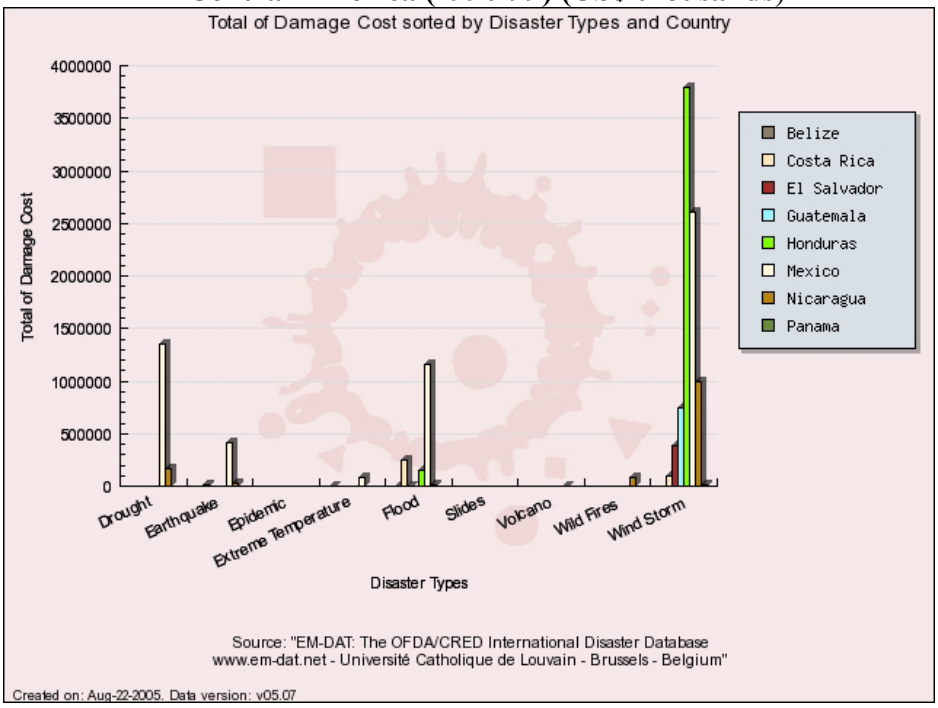


Figure 3b:
Estimated Economic Losses Due to Natural Hazards in the Caribbean (1990-99) (US$ thousands)

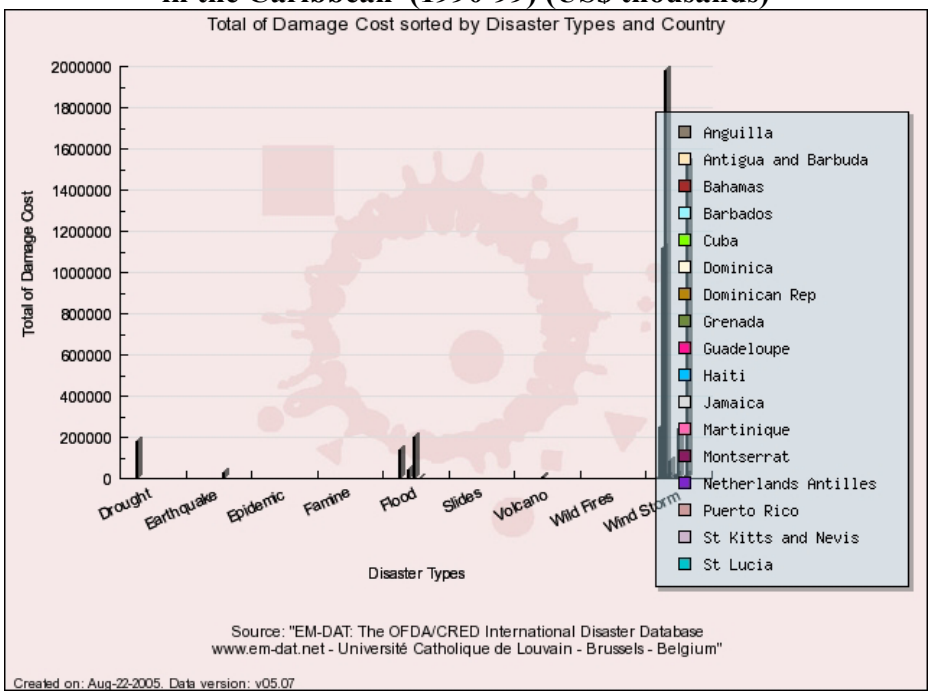
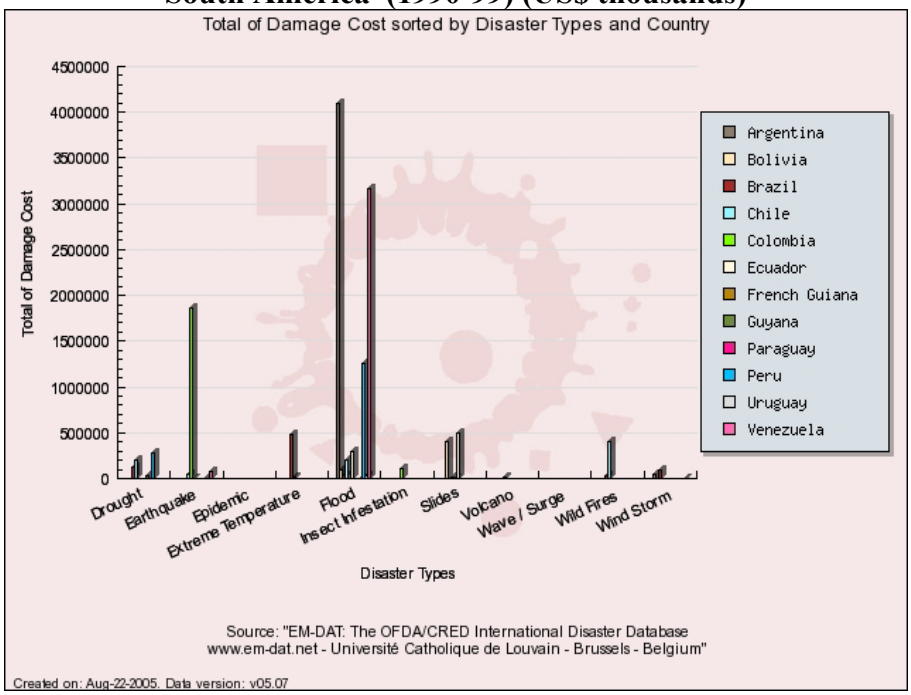


Figure 3c:
Estimated Economic Losses Due to Natural Hazards in South America (1990-99) (US$ thousands)



Effects of Shocks and Common Traditional Production Risk Management and Coping Mechanisms

The typical effects of a hydro-meteorological, geological, or biological disaster are one or more of the following. The number of effects detectable is a function of the scale, severity, and duration of the initial shock. The more spatially correlated the shock, the more effects will be noted.

- A decrease in farm income.
- A decrease in employment for hired farm workers.
- A generalized fall in demand throughout the local or regional economy as a result of the reduced agricultural income of affected farm families and agroindustries.
- An increase in loan defaults in affected region, affecting both financial intermediaries and agricultural input suppliers who sold on credit.
- A decrease in government tax revenue and foreign earnings due to a fall in agricultural exports.
- An increase in the price of basic food items, if the affected commodities where normally marketed domestically.

Ex post, the affected rural population in response to the shock may engage in more than one of the following behaviors depending on the severity of the shock and initial economic conditions. Note that some of the behaviors have primarily micro or local effects, that is they affect mostly the household and immediate neighbors while other behaviors have macro or farther reaching external effects in that they affect not only the household in question but other parties such as municipal, state, and national governments, financial intermediaries, and urban residents.

MICRO EFFECTS:

- Drawdown accumulated savings
- Seek loans
- Reduce consumption, including food intake and withdrawing children from school nutritional threshold that would impair health.
- Liquidate assets
- Seek off-farm wage employment
- Depend on remittances.
- Depend on informal reciprocal sharing arrangements with neighbors and kin (mutual insurance)

MACRO EFFECTS:

- Seek to refinance existing loans
- Seek debt forgiveness for existing formal loans
- Petition the regional and national government authorities for emergency relief
- Exit farming permanently and migrate to an urban area
- If persistent over time, competitiveness of agricultural production unit(s) reduced.

Ex ante, farm households, in the absence of affordable, formal risk transfer instruments such as insurance, tend to rely on a series of informal risk reducing and risk retention coping strategies. The only informal risk transfer strategies are share tenancy and mutual aid.

- Use lower yielding but drought resistant varieties
- Stagger planting times to assure that a fair percentage of the crop receives sufficient rain in first stage of development
- Fragment plots to take advantage of different soils, elevations, slopes, and microclimates, going as far as to rent land that has distinct agroecologic characteristics from own land
- Intercrop two or more crops and/or tree species on a parcel
- Diversify income streams
- Conserve soil moisture by applying litter and mulch to the roots of plants or using raised beds.
- Use of integrated pest management
- Allocate relatively more labor resources of the household to other non-farm businesses or off-farm employment opportunities if crop yields are threaten by bad weather or pests during the growing season
- Adopt irrigation technology
- Sharecrop
- Engage in reciprocal lending where in a household provides a no interest loan to another distressed household in good times and in turn expects to be able to borrow in bad times.
- Engage in gift giving to build social capital in the community and to create "chits" that can be called in time of economic distress.
- Participate in informal group mutual aid , savings, and insurance schemes such as ROSCAs and ASCAs.[6]
- Accumulate buffer stocks or liquid assets
- Maintain a credit reserve with a bank or agricultural supplier
- Reduce amount of purchased agricultural inputs and thereby minimize debt load or reduce the amount of target income needed to assure survival of the household

Public Policy Implications of Inadequate Traditional Risk Management and Coping Strategies

While some of the on-farm, risk mitigation practices are time tested and highly recommendable such as crop diversification, intercropping, soil humidity management, integrated pest management, irrigation, and accumulating savings. Many of the other practices such as such as plot fragmentation, economizing on purchased inputs, and the use of low-yielding but drought resistant varieties, represent production efficiency losses (Rosenweig and Binswanger, 1993; Morduch, 1995; and Kurosaki and Fafchamps, 2002). By foregoing specialization, farmers tradeoff income variability for lost profitability and reduced future earning ability. Others such as reciprocal lending, gift giving, and participation in ROSCAs and ASCAs work for idiosyncratic risk but maybe overwhelmed and useless if the risk is covariant, that is affecting with more or less equal severity all the households in a particular community or region. Consequently, these

[6] Rotating savings and Credit Associations and Accumulating Savings and Credit Associations

costly risk mitigating techniques and can contribute to chronic poverty and increased vulnerability**.** In a setting of increasing trade liberalization and integration, the absence of absence of agricultural insurance instruments places developing country producers at a serious disadvantage vis-à-vis farmers in industrialized countries that have greater access to such instruments. The result is less trade competitiveness ceteris paribus.

In short, the farm household produces inside its production possibility curve and increases its chances of remaining below or close to the poverty line. At the level of the regional economy, a large number of households engaging in risk avoidance behaviors and producing at a suboptimal level, reduce tax revenue, limit the ability to finance social services, makes for a stagnant regional economy due to less effective demand. At the national government level, a slow growing or stagnant agricultural sector contributes to less marketed food output, less export earnings, high rural-urban migration rates, incomplete financial markets, and increases the demand for extraordinary fiscal assistance to cope with major emergencies.

The cumulative micro effects create the setting for the existence of a poverty trap and the cumulative macro effects create the setting where government intervenes inappropriately and instead of solving a market failure aggravates the situation by creating a government failure.

Lack of Modern Risk Management Instruments Increases the Vulnerability of the Rural Poor and May Contribute to the Persistence of a Poverty Trap: One of the distinguishing characteristics of the poor is their vulnerability to risk. Poor people in developing countries depend heavily on agricultural production and selling their labor to survive. Since consumption takes a greater share of income among low-income families, shocks that create a marked drop in income can easily force the household below minimal nutritional thresholds. Some can recover quickly, especially if they have enough tangible assets. [7] Others do not fare as well and are unable to break the cycle of poverty and stagnation and remain in a poverty trap. The lack of formal, risk transfer instruments makes the poor and near poor more vulnerable and adverse to making risky and uncertain investment decisions that would put at make their income levels more variable than it is and risk their meager stock of physical assets. Thus, a low-productivity, poverty equilibrium could arise.

Recent research has shown that not only is the magnitude of poverty different between industrialized countries and developing countries (rates of poverty in developing countries surpass 30% on average while it is less than 20% for higher income countries) but also the dynamics of poverty (Naifeh, 1998). Whereas the monthly poverty exit rate hovers around 7% for the U.S., exit rates in developing countries such as Cote d'Ivorie and KwaZulu Natal state in South Africa range between .7%-1.3%, meaning that the median duration of poverty for many in developing countries can last a lifetime while the median time in poverty is 4.5 months for the U.S. (Barrett and McPeak, 2005). In developing countries, some individuals have accumulated sufficient assets that qualifies them as non poor but a transitory shock reduces their income and expenditures levels and forces them below the poverty line (stochastic poverty). Others lack a sufficient endowment of assets and can never seem to improve returns to their assets or

[7]Barrett, McPeak, Luseno, Little et. al. 2003, reports that on average it takes 3 years for farmers in Ethiopia to recover financially from the effect of a drought and to return to consumption levels per drought.

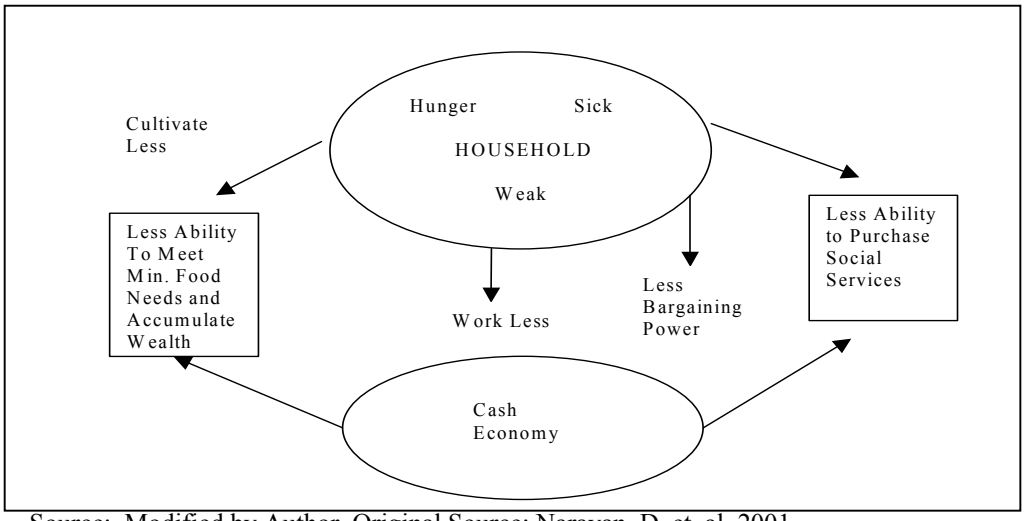
accumulate more, so they languish below the poverty line (structural poverty). This phenomenon is illustrated in the two figures below.

Taking a static view in figure 4, a household is pictured as mired in a vicious cycle. Insufficient income and assets contribute to hunger, lethargy, and poor health, which in turn reduce income-earning ability and prevents investments in activities that would enhance upward mobility such as education.

Taking the dynamic perspective in figure 5, a poor household (II) is much more vulnerable to falling deeper into income poverty and staying poor, than say household (I), when both households experience the same adverse shock at Time period 4 resulting in an income decline, systemic economic growth processes would be sufficient for household (I) to reemerge from poverty but it would be insufficient to break the cycle of poverty for household (II). In the case of household (II), the causes of structural poverty and income inequality will have to be attacked through asset based poverty reduction strategies—asset redistribution, social safety nets, targeting, better protection of property rights, more investments in human capital. The introduction of a more modern risk management instrument such as crop insurance as one element in a larger package of interventions could theoretically help household (II) protect what few productive assets it has during a downturn and then to leverage those assets to a higher extent to grow out of poverty over time. The use of crop insurance could help to place household (II) on the dashed orange upward growth trajectory II^1 preventing the liquidation of assets.[8]

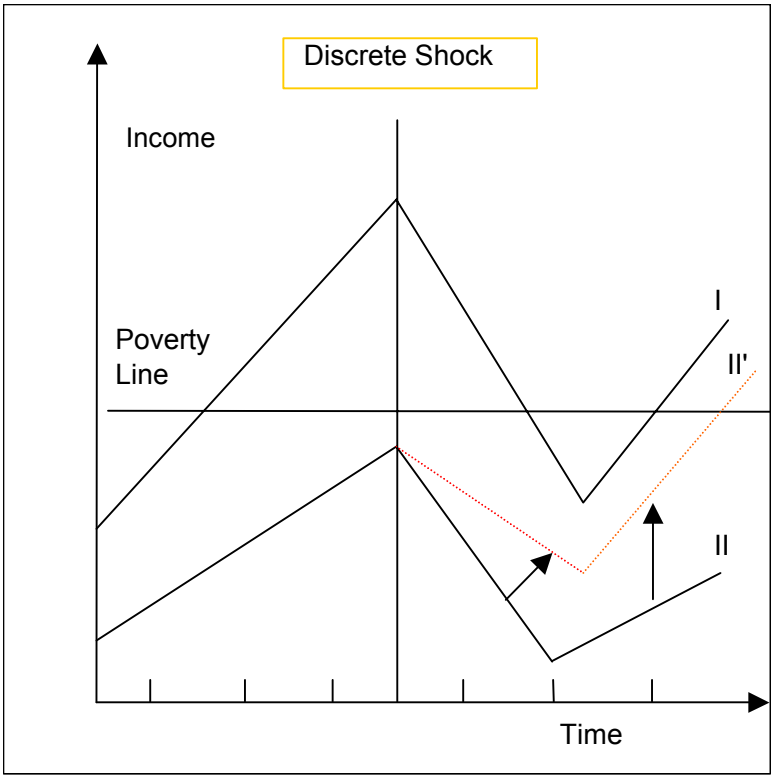
[8]The risk management economic literature has long appreciated and understood how asset risk influences consumption and accumulation patterns because future income is endogenous to current asset shocks and subsequent consumption choices. When income shocks and asset shocks occur contemporaneously, then forward-looking agents may lower consumption to a subsistence threshold in order to defend productive asset stocks and thereby maximize the probability of future survival. This willingness to accept consumption instability can contribute to ill health, lower labor earnings, and lower investments in the education and health of offspring. Thus the cause of poverty becomes the symptom of poverty and poverty gets transmitted from generation to generation. This is the "trap".

Figure 4:
Illustration of Static Poverty Trap



Source: Modified by Author. Original Source: Narayan, D. et. al. 2001.

Figure 5:
Illustration of a Dynamic Poverty Trap and the Impact of an Effective Risk Management Intervention over Time



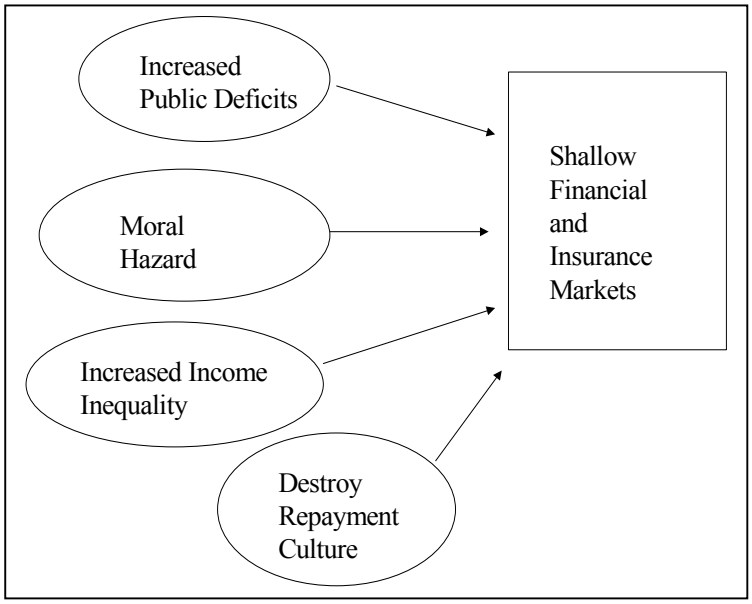
The Lack of Ex Ante Crop Insurance Can Retard Rural Lending, Create Fiscal Stresses for Central Governments, and Promote Rent Seeking Behavior: When crop insurance does not exist or is not used to an appreciable extent in an agrarian economy, the central government and international donors are relied upon to provide relief in the case of very severe disasters. While it can not be denied that central governments and international organizations must respond and play a role in the case of massive catastrophes, the use of ad hoc, ex post interventions sets dangerous precedents and tends to have four negative consequences if the role of government is not clear and actions are not well designed.

First, ad hoc emergency programs disrupt budget planning and administration. Funds often time have to be diverted from other ongoing and approved government programs to attend to the agricultural emergency. In the absence of a well-established emergency disaster fund with transparent rules and adequate funding, governments can easily fall into the trap of "robbing Paul to pay Peter." If the country in question is under budget stress, it may have to engage in deficit financing and as a consequence contribute to upward pressure on interest rates in the banking system. Higher lending rates reduces the demand for loans and makes agricultural financing ever more problematic, since as a whole agriculture is a sector noted for smaller profit margins than others.

Second, the knowledge that the government is likely to "bail out" affected parties creates moral hazard conditions and depresses the market for private crop insurance. Farmers do not do all that they can do to reduce individual vulnerability to adverse climatic conditions and other biological threats. Similarly, insurance companies have little incentive to enter rural markets and offer costly insurance products since they fear that demand for their products will be weak since farmers would prefer free ex post assistance from the government as opposed to paying a premium ex ante. The negative results are represented in Figure 6. Central governments should provide disaster assistance but should set rules of eligibility so as to encourage the purchase of private insurance and/or precautionary actions to reduce vulnerability to losses.

Third, well-organized groups of farmers have a strong incentive to lobby the government for relief from a wide and varied number of adverse climatic and price effects. Thus, government can be called upon to provide relief for non-catastrophic events, which normally should be in the domain of private insurers. Many times, the farmers that are more organized and most influential tend not to be the poorest. They, tend to produce a crop that is "strategic" i.e. a domestic staple like rice or an export commodity like beef cattle, wine, cotton, or sugar. Thus, the government provides transfers to relatively non-poor farmers. To counteract and limit rent seeking opportunities, the government should be clear as to how risk management will "layered" in that private individuals will be responsible for certain types of risk and up to a certain limit, private insurance markets for another segment, and as last resort, central government will be responsible for risk losses that surpasses the limits of both private insurance and reinsurance companies.

Figure 6:
Unintended Consequences of
Ex Post Emergency Disaster Programs



Fourth, the ready willingness of central governments to use debt forgiveness of formal agricultural loans undermines the solvency of banks, destroys repayment culture and dampens the willingness of financial intermediaries to expand and innovate in rural areas. Financial intermediaries tend to retreat from the agricultural sector after such an event, and if they stay, they only lend to collateral rich and well-known clients. Thus, financial markets remain shallow, noncompetitive, and incomplete. Debt forgiveness, while timely and easy to implement from the perspective of politicians, also tends to be regressive in nature. It benefits larger farmers much more so than smaller one because they tend to have more access to formal credit and take out on average larger loans. Smaller farmers tend to experience greater difficult accessing formal credit, and if successful, borrow smaller amounts. Over time, the combination of intermediary weakening and regressive transfers, contributes to increased income inequality. Those with access to finance can invest in more productive technology, diversify faster, expand their scale of operations, and thus experience faster income growth, all else equal. The use of debt forgiveness should be avoided and used sparingly.

Formal Agricultural Yield Insurance: Definition, Basic Requirements, and Benefits

In previous sections, we have argued that traditional risk management and coping mechanisms are often time neither sufficiently robust nor cost effective. The amount of residual risk that remains with the household in question may induce asset liquidation and poverty. Ex post government relief actions also create incentive problems and are costly to the treasury. But what is agricultural yield insurance and how does it function?

Agricultural yield insurance is a financial contingency contract that transfers production risk from a producer to another party via the payment of a premium that reflects the true long-term cost of the insurer who is assuming the risks. The insurer pools the risks faced by a large number of individuals and covers losses incurred by any one individual in the pool. It serves to essentially protect assets, stabilize income, and smooth consumption. However, for insurance to be viable and sustainable, there are certain "ideal" conditions for the risk to be considered insurable and for a self-sustaining market to appear.

1. **Symmetric Information**: The insurer and the insured should have the same approximate knowledge of the distribution of probable losses so that proper risk classification can occur. Insurers typically do not develop premium rates on an individual basis since it would be extraordinarily expensive. Instead, insurers classify applicants into homogeneous risk pools and calculate a premium for everyone in that group. In order to estimate probable losses for different groups of risks, extensive amount of reliable and accurate information is needed on weather patterns, yields, market trends, farm conditions, farm management ability, risk attitudes, and capacity to pay for the insurance.

2. **Large Number of Similar Exposed Units:** The statistical Law of Large Numbers upon which the actuarial models use to calculate coverage, indemnity, and premium levels , states that the more uncorrelated risks that are added to a portfolio the lower the variance of outcomes for the entire portfolio. Thus, for the actuarial models to be accurate the size of the pool or portfolio should be large and the risks faced in a particular class or group should be similar.

3. **Statistical Independence of Risks:** Risk should be nearly or perfectly independent across insured individuals and spatially uncorrelated. Insurance is based on the principles of diversification so that a major consideration is the degree of correlation in financial losses caused by the risk to be insured. The more spatial correlation there is the less efficient insurance will be as a risk transfer mechanism. When losses are catastrophic, the risk–pooling advantage of insurance breaks down because the contributions of the unaffected are insufficient to cover the damages of the affected.

4. **Calculable Expectancy Frequency and Magnitude of Loss:** The insurance company should be able to estimate both average frequency of the random event to be insured and the average severity of loss. For low-probability risks with potentially catastrophic outcomes it is often difficult to estimate the average expected loss, because there are so few data points.

5. **Actual Losses must be Determinable and Measurable:** The actual loss should be clearly and causally linked to the random event insured and it should be a tangible and measurable loss. If this is not the case, claims settlements will tend to be highly contentious. Purchasers will lose faith in the process and insurer's administrative costs will skyrocket.

6. **Potential Losses Must be Significant and an Insurable Interest Must Exist:** Potential buyers must perceive the probable loss as significant and beyond their own means to cover; otherwise there will be no incentive to purchase insurance. Furthermore, insurance cannot be provided to policyholders who have a vested interest in a loss occurring. For example, a property insurance policy cannot be sold to anyone other than the owners of the home and/or the owners of the furniture in the case of a renter with an unfurnished lease. If someone else could purchase such a policy, they would experience no loss if the house or furnishings were damaged or destroyed but would receive a pay-out from the insurance company. Owners and renters with "insurable interests" would have incentives to take precautions because of deductibles.

7. **Limited Policyholder Control over the Insured Event:** Insurance protection should not be offered if policyholders can control whether an insured event will occur. If a policyholder has sufficient control over whether a risk can occur, they can take advantage of the insurance and generate "moral hazard or suspect claims". For example, a farmer can fail to properly care for livestock, which could induce disease causing the death of the animal, and then file a claim for loss.

8. **Premiums should be Economically Affordable:** In general, for an insurance policy to be attractive to potential policyholders, the annual premium cost must be substantially less than the potential benefit offered by the policy, should the insured event occur. A market for insurance may fail to appear, if the majority of clients are very poor, very isolated, and/or the chances of losses are high. A fully loaded premium could exceed the estimated cost of a one-time loss and make the product uneconomical and useless. When insurance premiums are very high, credit and savings instruments become preferable risk management instruments.

If the above conditions are met, agricultural insurance can be offered on a sustainable basis and has five main benefits.

First, agricultural insurance is often time a more efficient and potent financial instrument than either using liquid savings or credit in managing yield risk. If a household or farm enterprises is subject to a series of shocks in a short span of time, it may deplete its entire savings and not have enough to invest to improve future earnings. In many countries rural formal credit markets are very undeveloped and access is problematic. Thus, in the event of a sudden income loss, a credit-constrained household may have to rely on informal sources, friends, family, and moneylenders that may not extend sufficient volume of credit necessary to meet the crisis or at a very high interest rate. Recent empirical research from rural China, that analyzed portfolio behavior in represent to income and health risks shows that households in the lowest and highest quintiles did not appreciably reduce wealth held in liquid forms while those in the middle quintiles did to a higher extent (Jalan and Ravallion, 1998). The authors reason that the rich do not need to hold unproductive precautionary liquid wealth to deal with income losses because they had access to credit and the poor could not afford to hold precautionary savings. Thus, in the context of undeveloped savings and credit markets, making formal insurance accessible to the very poor households would permit them to transfer unmitigated residual risk to an external party and thus avoiding sinking deeper into poverty.

Second, the use of agricultural insurance can facilitate the adoption of higher yielding technologies and intensification of production by risk adverse farmers. The presence of insurance gives added comfort to innovators.

Third, agricultural insurance reduces credit default risk for financial intermediaries financing agricultural production. Crop insurance policies can serve as a substitute for physical collateral and give financial intermediaries more comfort and incentive to lend to the sector. Insurance policies can be made endorsable to a credit lender.

Fourth, agricultural insurance would help both rural households and governments manage natural hazards better and reduce the vulnerability of the rural poor. Insurance could help a rural house avoid falling into poverty traps. It would help forestall political demands for ad hoc disaster relief. Governments normally provide monetary compensation to affected households in ex post disaster relief efforts but often distribution of the aid is not timely.

Fifth, agricultural insurance in a world marked by increasing agricultural trade liberalization and integration is a means to enhance agricultural competitiveness. In a global marketplace, producers that enjoy the benefits of crop insurance are better able to assume new investment risks without mortal fear of losing a significant share of their asset base or being forced to exit agriculture if the undertaking fails due to adverse weather. Many producers in OECD countries enjoy the benefits of crop and livestock insurance and the spread of agricultural insurance to developing regions with help to level the playing field.

Impediments to the Development of Agricultural Insurance Markets

Despite the inadequacies of informal risk management systems and problems with ex post government actions, agricultural insurance is grossly underdeveloped in middle and low-income countries. One may ask why this is so given the clear benefits. The fundamental reason is that the ideal conditions laid out in the previous section are not often met in reality and the adjustments and compromises made often prove to be inadequate so one veers between markets with a few insurers offering sustainable but limited appeal single peril products to markets heavily intervened by governments either directly or indirectly offering multiple peril products with broader appeal but which are unsustainable. Many of the crop insurance programs that appeared in the 1970s and 1980s failed miserably because the "golden rules" were not adhered too. Below is a complete list of impediments to a more stable and complete insurance market.

- Lack of Statistical Independence
- Asymmetric Information
- High Administrative Costs
- Mismatch between Farmers Preferences and Capacity to Pay
- Inadequate Legal and Regulatory Frameworks
- Distorted Government Incentives
- Reluctance of Reinsurers to Enter the Market

Lack of Statistical Independence: Formal insurance work best when the risks to be insured are perfectly independent and spatially uncorrelated, but agricultural production risks are in between.

Agricultural production losses, deviate from the ideal and tend to fall between the two extremes of being 100% uncorrelated and 100% correlated. Agricultural yield losses tend to be characterized by some degree of positive spatial correlation. The degree of spatial correlation is often inversely related to the size of the region or country where activities will be insured. Thus, relatively small countries are likely to be characterized by more positively correlated agricultural losses than a large country. Moreover, positive spatial correlation in losses reduces the benefits that can be obtained by pooling risks from different geographical areas. When, risks are perfectly correlated, insurance fails as an instrument of risk transfer, and capital market instruments such are derivatives are more appropriate.

A good agricultural insurance risk would be an idiosyncratic or largely uncorrelated one, a risk that is unique to a household and unrelated to neighbors and possibly due to management differences. Examples would be hail or fire. Hail and fire tend to be very localized events. In the case of fire, people can take preventive measures against fire. Thus, with inspections and a large and geographically diverse pool, theses risks are insurable. On the other hand, private insurers do not like to insure against drought or hurricanes (systemic or correlated risks), which affect large areas, unless reinsurance is available.

Asymmetric Information[9]**:** Problems arise when prospective farm insurance clients have more knowledge about their own distribution of probable losses than the insurer who, as a result, cannot correctly classify potential clients by risk type and subsequently calculate premium rates that accurately reflect the true likelihood of losses for individual farmers, or monitor them effectively once a contract has been purchased. As a result, two attendant problems emerge—adverse selection and moral hazard. In the case of adverse selection, persons with very risky profiles will purchase the insurance in greater proportion than persons with less risky profiles, generating an imbalance between indemnity payments and premium revenue. If the insurer raises the premium higher in subsequent periods, less risky clients will withdraw and the profits of the company will fall further[10]. In order to overcome adverse selection problem, the company will have to invest more heavily in obtaining better information, especially farm level yield data for long periods, so as to permit better risk classification. The other related information problem is one of moral hazard, wherein the insured changes behavior and may become less diligent in minimizing production risks knowing that potential losses are covered. Since monitoring the behavior of the insured is costly and imperfect, this could lead to potential losses for the insurer.[11] To overcome this problem, the insurer has to design better contract designs and rely on less costly systems of monitoring.

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[9]Note all financial markets suffer from asymmetric information problems. The remedies are incentive compatible contract designs, better disclosure laws, better auditing, and better information. Rothschild and Stiglitiz in 1976 established the conditions for market equilibria under asymmetric information. The model entails a separating equilibrium with low-risk and high-risk agents buying different insurance products, both of which breakeven individually. The challenge is to design and price a contract so that it is in the own best interest of the two different risk types to "reveal" themselves.

[10]Numerous researchers have found evidence of adverse selection in U.S. insurance markets. Goodwin (1993) provided one of the most rigorous and sophisticated empirical analysis. He examined county-level data for Iowa corn producers and found the elasticity of demand for crop insurance was considerably smaller for riskier counties, confirming that risky farmers are willing to pay more to insure themselves.

[11] Smith and Goodwin (1996) and Smith (2001) found that insured Kansas wheat farms in 1991 spent an average of $4.23 per acre less on fertilizer and chemicals than did non-insured farms, controlling for difference in land quality by using regional location dummy variables. Just et al., (1999), show with a national database for the U.S. that

High Administrative Costs: Information is vital to risk measurement and evaluation yet it is tends to be costly to obtain, process, and analyze. Agricultural insurance companies have to gather significant amounts of data on climate, production conditions, yield distributions, prices; capacity to pay; develop models to determine probable losses; design appropriate contracts and set premiums and indemnity levels; establish, inspection, monitoring and claim adjustment processes; and seek reinsurance. The more disperse the client base, the more heterogeneous the farm production systems, and the smaller the insured value, the higher the administrative costs are as a percentage of premiums. Compared to other lines of insurance, agricultural underwriting and claims adjustments are generally much more costly.[12] In the context of developing countries, where data tend to be unreliable and difficult to obtain in a timely manner, the costs escalate. In rural areas with poor roads and telecommunications systems, the cost of client monitoring and making quick claim adjustments escalates.

Mismatch between Farmers Preferences and Willingness to Pay: Many farmers seem to have a limited willingness to pay a premium that covers the cost of the service provided. As a result a sustainable market does not appear. Farmers seem to prefer insurance that protects a sizeable proportion of income from multiple threats as opposed to ones that partially cover income loss from a specific threat.[13] These types of insurance products, revenue and multiple peril, are the most costly and difficult products for private insurance companies to provide in a profitable and sustainable manner (Goodwin, 2001). The financial performance of multiple peril insurance programs has been universally disappointing (Just et al, 1999). The fact that insurance these insurances are designed to protect against losses from a multitude of perils makes the calculation of probable losses and the determination of actuarially fair premiums very difficult if not impossible. In the countries were these types of policies are offered, they normally require substantial government subsidization.[14] The products that can be delivered profitably and at affordable premiums are specific or single peril policies—hail and fire – and parametric or indexed based products. But they have less broad based appeal. In the case of parametric products, ones that pay an indemnity when an easily observable and independently verifiable "trigger", usually a particular temperature or rainfall level is struck, suffer from basis risk. Basis

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adverse selection is present and more interestingly that farmers participated to a high degree to obtain subsidy benefits.

[12]Pomareda in Hazell et. al. eds. (1986) concludes that the administrative costs of crop insurance schemes in the U.S., Israel, Panama, Brazil, and Costa Rica where so high that in addition to a premium of 15% adequate to cover the losses, an additional 5 percent would be needed to cover field operation expenses. A premium of 20% would dissuade many low risk types from participating without a susbsidy.

[13]A recent study by Midir Bhatt for the All India Disaster Mitigation Commission that covered three districts in India shows that farmers only want to pay up to 2% of insured valued for a multiple peril policy and would prefer that it be delivered by rural agent that comes to the doorstep, which was incidently the most expensive delivery mechanism of all the choices presented.

See http://www.itf-commrisk.org/documents/meetings/AgInsurance%202005/bhatt.pdf. Furthermore, Skees, Barnett, and Hartell report that in the U.S. in 2004, 73% of premium revenue is for crop revenue insurance products and 25% for multiple risk yield insurance products. Area yield index premiums were miniscule.

[14]In the U.S. there is evidence to suggest that farmers are risk neutral or risk preferring (Smith and Goodwin,(1993). Only 11% of the sample reported themselves to be risk adverse. Strongly risk adverse farmers would demand even higher cost insurance. Subsidization could be better justified if a large proportion were risk averse and the negative effects of inadequate private risk management were overwhelming. Just et. al (1999) finds in nation wide data set evidence adverse selection and a desire to obtain government subsidies as reasons why farmers participate in multiple peril programs, not risk aversion.

risk is when insurance is brought and an economic loss is realized but the indemnity payment is not made. Due to differences in microclimates and quality of information, an individual farmer's crop yield distribution may not closely correspond to the distribution used for the index. In the case of developing countries, much more empirical research is needed to measure farmer's risk attitudes and capacity to pay for crop insurance.

Cognitive Failure: Some farmers may perceive the risks they face as being smaller than they actually are. This phenomenon is called "cognitive failure" and can stem from either insufficient information or an inability to properly process and assess information. In common language, it is the feeling of invincibility: "That can't happen to me". Also it refers to the common feeling among farmers that "premiums paid are lost money if nothing happens". Many farmers tend to dismiss low probability but high cost events in their decision-making processes and to just focus on developing risk management strategies for high frequency, low cost events, the "commonplace threats" (Skees, Barnett, and Hartell, 2005).

***Inadequate Legal and Regulatory Frameworks*:** Legal and regulatory frameworks can either help promote or hinder the development of agricultural markets. The most common areas of complaint from insurers and observers concern the following. Inappropriate Reserve Requirements: Often time capital reserve requirements are adequate for life, auto, property, and casualty lines of insurance but not for agricultural insurance due to higher rates of rotation in the portfolio. Many agricultural production cycles are a few months long and if capital has to be reserved for period longer than the actual length of risk exposure, it increases the reserve load in the premium and makes the product unattractive to client. Possible solutions could entail treating agricultural insurance reserves like marine insurance reserves and use of more sophisticated calculations. Agent Licensing Requirements: How to deliver agricultural insurance to smallholders is a big obstacle and one obvious way around this obstacle would be for rural microfinance institutions and rural development NGOs, and cooperatives to serve as agents for insurance companies selling agricultural insurance products. Often the agent licensing provisions are either too strict or too lax. Some country's insurance laws may require a long number of years, formal training, and other high qualifications, which make it difficult for young microfinance institutions to qualify. Other time, the laws may require that the agent be a natural person, thereby eliminating the possibility for a cooperative or NGO. Traditional individual agents have little incentive to sell agricultural insurance compared to auto and life. The latter two are high margin and imply less administrative costs and time. Possible solutions to help protect consumers against misselling of insurance policies but at the same time facilitate the development of agricultural insurance would be specialized training for financial intermediaries, NGOs, cooperatives etc. in the selling of agricultural insurance and the adoption of market conduct standards subject to compliance checks. Reporting requirements: Lastly, the reporting requirements can place a high burden on an insurance company that wants to specialize in a low-income, high-risk segment of the market. The impetus to the insurance company would be to specialize in more lucrative lines such as auto and life, where the high cost can be more easily borne. Regulators do need information but the practical issue of maintaining computerized databases for a dispersed, low-come clientele is a serious one for crop insurers wanting expand in developing countries. Possible solutions may involve more streamlined and effective reporting for agricultural insurers and encouragement and support for agricultural insurers to invest more heavily in wireless technology, if the infrastructure of the country permits. Product

Classification: Many times when an insurance company wants to introduce an weather based index there is a legal debate as to whether it is a derivative and therefore subject to the rules governing capital market securities or whether is covers an "insurable loss" and should be subject to the rules governing insurance products. If the crop insurance market is to develop, parametric or index based instruments need to be classified as insurance products and not as derivatives so that easier and more flexible delivery systems can be used to get the product to small holders. The most promising retail delivery channels for parametric products and other insurance products targeting the low-income are indirect ones. Urban-based broker and insurance office outlets will not suffice. Moreover, capital market instruments are aimed at sophisticated and knowledgeable market participants and may be subject to very little regulation or a very direct regulatory regime than insurance products. The capital market regulatory regime may not include sufficiently strict financial reserve requirements nor be subject to market conduct rules equivalent to those that international standards require should apply to the sale of insurance. Thus, small farmers with in regime where parametric products are classified as derivatives will not have the benefit of the regulatory protection that he needs. In short, the farmer client is at serious risk of abuse. If index based risk management products are not recognized as insurance products with an "insurable interest" and the requirement that an insurance policy indemnifies a loss, there is a risk that the framework will not recognize payment against an index.

Distorted Incentives: When governments intervene and make ex post unconditional emergency relief payments, forgive loan contracts, and/or offer subsidized emergency loans, it removes the incentives for farmers to purchase insurance ex ante and for insurance companies to innovate and offer appropriate crop insurance products. The government intervention is often justified on the grounds that private insurance companies are unwilling or unable to supply crop insurance in an efficient manner. This dilemma of "crowding out" or market failure has raged, at least in the U.S. economic literature, for decades. The issue needs to be recast as finding an appropriate facilitation role for the government and distinguishing clearly between disguised income transfers and risk management tools.

Thin International Reinsurance Market: The market for agricultural reinsurance is limited due to the high cost of reinsurance premiums and reluctance on the part of reinsurers to develop a cadre with the necessary specialized knowledge and information systems required to properly monitor and evaluate agricultural risks. Since crop yields are highly spatially correlated, private insurance companies cannot effectively pool risk at the regional or even at a country level, especially if it is a small country. The Maximum Probable Loss and Maximum Foreseeable Loss estimates would exceed capital reserves and thus the insurer needs to cede or transfer a portion of the portfolio risk to an external party, either an international reinsurance company, a national government, or a supranational government agency. International reinsurance companies have the capacity to absorb large insured losses and for years have done so, especially for major natural catastrophes. For instance, in 1992 international reinsures paid out $23 billion to cover insured losses association with Hurricane Andrew and in 2005 will pay out in the order of $60-80 billion for Hurricane Katrina. Agricultural losses due to drought or flood are likely to be less than the cost of a major hurricane or earthquake, but the levels could be appreciable and repeated from year to year. Accordingly, only a few of the international reinsurance companies have agricultural divisions. The combination of lack of analytical capacity and expensive reinsurance

premiums at the international level dampens insurers' capacity to offer crop insurance products at the national level. At present, only four of the more than 60 reinsurers worldwide have substantial agricultural portfolios, Munich Re, Partner Re, Hanover Re and Swiss Re. Two in particular have strong expertise in analyzing weather-based indexes, Swiss RE and ACE, because they hired many former Enron employees. Enron was the pioneer the use of weather index derivatives in energy markets in the early 1990s.

Given this list of formidable problems in the path of sustainable development of agricultural insurance, the question becomes what have we learned from previous experiences with crop insurance, what trends are discernible in Latin American markets, and what should be done to promote market development?

III. AGRICULTURAL INSURANCE OVERVIEW: MARKET TRENDS, PRODUCT EVOLUTION, LESSONS LEARNED, AND PROMISE OF NEW TECHNOLOGY

Market Trends

Overall, agricultural insurance is underdeveloped worldwide. In 2001, total agricultural premiums (including fishery and forestry) amounted to US$6.5 billion while the estimated total value of agricultural production worldwide was US$1.4 trillion. Thus, agricultural premiums as a share of output were a miniscule .4% (Schuetz, 2005). Moreover, the regional distribution of coverage is bimodal as can be seen in Table 4. Developed countries account for 87% of the agricultural premiums in that year as opposed for 13% for developing countries. Whereas 75% if the cultivated land in the US is insured, only five Latin American countries have more than 1% of cropped area insured, and only two, Argentina and Mexico exceed 10% (See Table 5).

Table 4:
Agricultural Insurance at a Glance

Region of the World	**Share of Agricultural Insurance Premiums 2001**	**Cumulative Share**
North America (U.S. and Canada)	55	55
Western Europe	29	84
Australia and New Zealand	3	87
Latin America and the Caribbean	**4**	**91**
Asia	4	95
Central and Eastern Europe	3	98
Africa	2	100

Source: Schuetz, 2005 (FAO)

In the developed countries, the four leading markets are found in the United States, Canada, Spain, and Japan. Within Latin America and the Caribbean, the leading agricultural insurance markets can be found in Mexico, Argentine, Brazil, and Venezuela. In Central America, the region most exposed to the widest number of natural hazards, only ten companies are active and a miniscule proportion of the cultivated area.[15] In many countries, there is no commercial agricultural insurance available: Bolivia, Suriname, Guyana, Belize, Bahamas, Jamaica,

[15]Honduras is the most developed market in Central America and only has 1.58% rate of penetration in 2003 (ratio of insured area/total cultivated area). Costa Rica has a state monopoly but the area insured is quite limited. In Panama and Nicaragua, publicly owned agricultural insurance companies, Instituto de Seguros Agropecuarios (ISA), and Instituto Nacional de Seguros y Reaseguros (INISER) exist but private companies are not barred, they have just not appeared. In Panama, only rice and corn are insured in high potential areas. In Nicaragua, only rice and peanuts are covered in certain areas. In Costa Rica, 90% of the portfolio is rice, grown on medium and large scale farms with a high level of technology. In El Salvador, the only crop insured is cotton and is due to government intervention. The government offers 50% subsidy on premium payments only for this product as part of a program to resuscitate the cotton subsector. In Honduras, BANDESA, a state agricultural bank, requires insurance as a condition for credit approval. See Carlos Puig's Etude Economique Conseil's report (2005).

Barbados, and Trinidad and Tobago.[16] In many of the countries, however, active efforts are being made to promote agricultural insurance.[17]

Products: Strengths and Weaknesses

There are four broad types of products that are offered in agricultural insurance markets: single peril, multiple peril, revenue and parametric. Historically, the first type of crop insurance to be offered was single peril for hail in Europe and North America in the 19th century. In the developing world, there were some early adopters of single peril and mutual insurance products--Uruguay (1914), Mexico (1926) and Mauritius (1945).

In the 1930s, the U.S. government started to experiment with multiple peril policies as a means to help farmers recover from the devastating effects of the Great Depression and the Dust Bowl (a prolonged drought that affected the Plain states). After WWII, the use of this product was introduced in Western Europe and Japan. Later on it spread to African, South Asian, and Latin American countries. Some of the developing country pioneers of multiple peril programs were Brazil (1954), Costa Rica (1970), Mexico (1971), India (1972), Chile (1980), Dominican Republic (1984), and Venezuela (1984).

By the late 1980s and early 1990s, however, most of the multiple peril programs in developing countries where experiencing substantial losses.[18] With the advent of structural adjustment programs and the general reduction in public subsidies available for the agricultural sector, reforms and retrenchments occurred.

In the 1990's, the U.S. started to experiment on a large scale with area yield, crop revenue, and income insurance products. In the developing world, India has been the leader in introducing area yield products. In most other developing countries, single and multiple peril products continue to predominate. In the late 1990s and early part of this millennium, Spain, Mexico, India, and Mongolia have either introduced parametric or indexed based products or have products under design. Canada has an area-yield product since the 1970s and India and Morocco have had such products since the 1990s.

[16] In Peru and Bolivia, international donors (World Bank and USAID) are financing pilot experiments with weather based index products.

[17] A Mexican firm, ProAgro, with the strong backing of Munich Re, an international reinsurer, is aggressively expanding operations throughout the region. It is now the largest agricultural insurer in the region. In addition, various Spanish government and private sector entities (ENESA, MAPFRE, and Agroseguros) are active in consulting and promoting agricultural insurance with several of the governments in the region, namely, Argentina, Brazil, Peru, and Uruguay. Among donors, the World Bank and the Inter-American Development Bank, and USAID are financing projects. FAO recently published a major study on the topic and IICA and IFAD are beginning to address the topic.

[18] The Mexican and Dominican Republic state agricultural insurances companies went bankrupt and had to be restructured in the early 1990s. The Brazilian and Costa Rican programs had very high loss ratios (indemnities/premiums) . In the case of Costa Rica, the non-agricultural portfolio has shrunk over time and is cross-subsidized by more profitable lines on insurance. In 1966, the Brazilian, state-owned National Insurance Company was disbanded. In 1994, the Brazilian system was restructured and one state entity only offers reinsurance and another credit guarantees.

Table 5:
Principal Characteristics of Crop Insurance Markets in Latin America and the Caribbean

Country	Types of System	Principal Crops Insured and Risks Covered	Typical Contract	Percent of Area Cultivated that is Insured	Public Subsidies
Argentina	Private	Grains, fruits, and livestock Hail, fire, frost, high winds, excessive rain, pest infestations, plant diseases, replanting, livestock death due to disease or accidents	Pay 60-90% of difference between actual and historic yield	30% in 2002	No
Brazil	Private	Most crops and livestock Climate, pests, disease, livestock death due to sickness or accidents	Contract 1: Cover cost of production; Contract 2: Cover the difference between expected and actual	.22% in 2000/01	No (Subsidy plan has been proposed in late 2003 and since 2004 a pilot has been operating in State of Sao Paulo)
Chile	Mixed (Public-Private)	Grains, pulses, vegetables, industrial crops Drought, excessive rain, freezes, hail, snow, and high winds	Difference between insured valor and actual yield	2% in 2002	Yes
Colombia	Mixed	Banana, cotton, potato, sugar cane Drought, flood, excessive moisture, hail, high winds.	Covers project investment costs, including use of borrowed funds	Less than 1%	Yes. Government pays between 10-45% of premium depending on crop
Costa Rica	Public Monopoly (Will liberalize by 2008-09 if CAFTA treaty is ratified)	Crops and cattle. Note: 90% of coverage is for rice, a "strategic" good. Uncontrollable climatic risk and death of cattle caused by accident or a few specified diseases	Cover total or partial losses produced by the risks stated in the policy	2% in 2000	Yes
Dominican Republic	Public	Rice All climatic risks and plant infestations and diseases	Covers losses	Less than 1%	Yes
Ecuador	Private	Banana, cotton, potato, sugar cane, cattle, horses	Cover losses realized.	Less than 1%	No

		Hail, drought, freezes, excessive moisture, high winds, pests, diseases, livestock death due to sickness, accident, or forced sacrifice			
Mexico	Climate, pests, diseases, livestock death	Most crops and most types of livestock	Many varieties of contracts offered (some cover production cost, other yield loss, revenue loss)	15% in 2002	Yes
Panama	Public	Rice, corn, vegetables, cattle, horses, Swine, and farm machinery/buildings	Covers production costs or market value of equipment.	Less than 1%	Yes (administrative costs of state provider)
		Climate, pests, disease, livestock disease			
Paraguay	Private	Wheat, soybean, corn	Covers actual value of actual losses	.1% en 2001	No
		Hail and fire			
Venezuela	Private		Covers the difference between average and realized yields.	4%	Yes

Source: ENESA, 2004

As can be seen from Table 5, the most common type of product offered in Latin America is a multiple peril product that covers natural and biological hazards. In evaluating insurance products, five variables are normally used: commodity coverage (number of products that can be insured); penetration ratio (amount of acreage insured as a share of total cultivated area); participation rate (number of farmers purchasing insurance); loss ratio (indemnities/premiums); and long-term viability (Indemnity Payments +Administrative Cost + Reinsurance Cost+ Capital Reserve Load +Profit)/ Premium <1). The financial performance of single peril products (loss ratio) has been impressive but coverage and farmer participation has been limited. In comparison, the financial performance (loss ratio and viability) of multiple peril products has been universally unsatisfactory despite massive public sector subsidies for premiums, operational expenses, and reinsurance. Parametric or index based products, on the other hand, despite noteworthy theoretical features has not been widely attempted and in the few places that it had introduced, acceptance has been limited. It is still a novel product that is seen as plagued with basis risk. The biggest practical success has been the program run by ICICI Lombard-BASIX in India. The program is still very young, three years old, and no rigorous and independent evaluation has taken place. In other areas of the developing world, several pilots are in various stages of development. The particular strengths and shortcomings of each product are briefly explained below (Table 6). In Box 1, parametric instruments are explained in further detail.

Table 6:
Summary of Types of Insurance Products Offered

Type of Product	Type of Coverage	Premium Subsidy Typically Provided	Strengths	Weaknesses
Single-Peril	Hail, fire, high winds,	No	Easy to observe and verify claim adjustments Ease to determine actuarially sound premium as long as long historical series of weather and loss data exists. Affordable premiums	Subject to Moral Hazard Problems Farmers may not take appropriate precautions against fire and wind damage.
Multiple Peril	Covers most all natural hazards: drought, flood, excessive moisture, hail, high winds, abrupt temperature changes, etc,	Yes	Attractive to farmers	Actuarially Unsound—essentially covering highly spatially correlated and uninsurable risks In the case of plant disease and pest damage, hard to disentangle management failures from external factors. Normal premiums would be exorbitant, therefore government subsidies are often needed to increase farmer participation rates; ends up being an income transfer scheme disguised as risk management tool.

				Subject to Adverse Selection Subject to Moral Hazard Costly to Administer
Revenue	Combines multiple peril yield protection with a price variability component. If crop prices at harvest time fall below a guarantee level based on futures prices a payment is made.	Yes	Very attractive to farmers.	Actuarially unsound. Basically an income transfer program. All of the above multiple peril weaknesses apply.
Parametric or Index Based	Covers yield losses due to an easily observable random variable that is highly correlated with particular crop yield, normally rainfall, irrigation water flow, days of temperature above or below a certain threshold	No	Not susceptible to adverse selection Less susceptible to moral hazard Low monitoring costs Affordable premiums Well suited for low-income, limited resources farmers in drought prone areas. Very flexible instrument, can be targeted to intermediaries and government disaster funds	Suffers from basis risk Very dependent on quality and quantity information available for developing risk models of probable loss. Best suited for regions or countries with long, historical data series, good coverage by weather stations and easy access to satellite imagery. Not appropriate in hilly, mountainous areas where a variety of microclimates exist, or where farmers are very risk adverse.

Box 1: Examples of Parametric or Index Insurance

Index products use any independent random variable measurement that is readily observable, protected from tampering, and is highly correlated with agricultural or livestock losses. Four examples are:

1. Weather based index uses a specific amount of rainfall or a certain number of days with temperatures in a particular range as a trigger. If the trigger is struck a payment is made. In use in Morocco, Mexico, and India.
2. Area yield Index. Uses the average crop yield in a country or particular jurisdiction as a trigger. If an individual farmer has a yield less than the reference average, an indemnity payment is made as a function of the degree of deviation from the norm. In use in the US., India, Brazil, and Quebec, Canada.
3. Satellite Vegetative Index: Satellite images are used to calculate the health of a pasture based on "previous" normal years and payment is made to the rancher based on degree of deviation. In use in Alberta, Canada and Spain.
4. Mortality Rates for Livestock: A yearly census of livestock is used as a reference point to estimate "annual average death rates" from yearly censuses comparing end of year to mid year points. The trigger will be a certain pre-fixed percentage of average mortality. When death rates surpass the "trigger" payments will be made. Under design in Mongolia.

Source: Skees, Barnett, and Hartell, 2005

Financial performance data are very scarce and difficult to obtain (See Tables 7, 8, 9). Part of the reason is due to the fact that agricultural insurance is a minor line of activity in most insurance companies and the information required for analysis is not reported in a disaggregated manner. Another reason is that the companies are reluctant to make public, information that may reflect poorly on them or give their competitors an advantage. The most painstaking and revealing analysis of financial performance is still from Hazell done in 1992. His analysis underscores the unsustainability of the multiple peril programs in six countries (Table 9). Only Japan had an actuarially sound program (I/P <1) but it came at the expense of very high monitoring costs to reduce problems of moral hazard (See Japan period 85-89 I/P and A/P columns in Table 9).

Table 7:
Performance Indicators for Southern Cone Countries for Crop year 2002/03

Variable	Argentina	Brazil	Chile	Uruguay
Number of Insurance Companies w/ Agricultural Portfolio	30	7	3	3
Value of Total Policies (US$)	2.542 billion	200 million	95 million	310 million
Value of Agricultural Polices (US$)	100 million	11 million	3 million	5.5 million
Hectares Insured	11 million	998,486	73,570	437,500
Number of Policies	102,204	66,043	10,515	2,755
Indemnities (US$)	77 million	Na	815,500	1.2 million
Premiums (US$ millions)	100	11	3	5.5
Loss Ratio (Indemnities/Premiums)	77%	Na	27%	21%

Source: Carlos Américo Basco,. 2005. "Agricultural Insurance" IICA 2005 at http://www.itf-commrisk.org/documents/meetings/AgInsurance%202005/Basco.pdf

Table 8:
Performance Indicators for Central American Countries for 2004

Variable/Country	El Salvador	Guatemala	Honduras	Nicaragua
Number of Countries w/ Agricultural Portfolio	2	2	3	1
Premiums			$793,900	
Number of Policies		267	2160	7
Hectares Insured	2,289	3,242	11,780	927
Penetration Ratio (Has. Insured/Total Has Cultivated	.34	.23%	1.33%	.09
Indemnities/Premiums			61.49%	

Source: Etude Economique Conseil: "Apoyo a la preparación del programa para el desarrollo de mercados de seguros agropecuarios en América Central (RG-M1029)" Informe de Consultoría para el Banco de Desarrollo Interamericano, May 2005.

Table 9:
Financial Performance for Selected Countries

Country	Period	I/P	A/P	(I+A)/P
Brazil	75-81	4.29	.28	4.57
Costa Rica	70-89	2.26	.54	2.80
Japan	47-77	1.48	1.17	2.60
	85-89	.99	3.57	4.56
Mexico	80-89	3.18	.47	3.65
USA/1	80-89	1.87	.55	2.42
	2002	2.71	.96	3.68
Spain/2	80-02	1.60	.18	1.78

Source: Hazell, 1992 /1 Figure for 2002 from Skees, 2000 /2ENESA 2004.

Experiences of Selected Countries with Well Developed Insurance Programs

USA

In the U.S. crop insurance is offered through the Federal Crop Insurance Program (FCIP), a public-private partnership between the federal government and a number of private sector insurance companies, created in 1938.[19] FCIP is a wholly owned corporation administered by the Risk Management Agency (RMA), an affiliate of the U.S. Department of Agriculture (USDA). The program officially aims to improve the social welfare of farmers as well as deliver insurance products in an actuarially sound manner. RMA helps design products and administer subsidies while the private insurance companies sell the products.

The government provides subsidies to farmers to pay the premium. In 2004, the average premium subsidy was 59%. In addition, the government reimburses administrative and operating expense for private insurance companies that sell and service FCIP policies. The reimbursement is approximately 22 percent of total premiums. Lastly, the government provides reinsurance to the private insurance companies at an estimated subsidy rate equivalent to 14 percent of total premiums. In total, the government is subsidizing 70 percent of the total cost for the FCIP. Net government costs for administering the program (total costs less premium paid by producers) have ranged from $1.1 billion in 1995 to $1.7 billion in 2000(EU, 2001). Recent estimates put the cost of crop insurance subsidies (2004-05) at approximately $3 billion.[20]

Commodity coverage is extensive. Policies cover over 100 commodities in 2004, up from 59 in 1994. However, four crops-- corn, soybeans, wheat, and cotton—accounted for 79 percent of the $4 billion in total premiums collected in 2004. Six different yield and revenue insurance products are offered, with the most popular being the revenue ones[21]. Approximately 70 percent of the nation's crop acreage (excludes pasture, rangeland, and forage) is insured, yielding a high penetration rate. The participation rate, however, is not so high. Approximately, 400,000 farmers out of 2 million farmers or 20% participate in the program. Actuarially, the programs are not sound and represent more of an income transfer program than a risk management tool. Over the period of 1980-98, the average loss ratio was 1.88, meaning that for every dollar in premium cost; a farmer was receiving a $1.88 (Goodwin, 2001). Also because of the high degree of variation in the distribution of subsidy benefits, cropping and acreage decisions seem to be have been affected. Some crops are being grown in high-risk areas than should be the case if subsidized insurance were not available(EU, 2001). One such example is cotton in Texas.

[19]Livestock insurance and single peril crop insurance (hail, fire) are offered by the private sector on a profitable basis.

[20]Email exchange with Jerry Skees, June 3, 2005.

[21]The products are Catastrophic Risk Protection (CAT) insures a minimum level of insurance coverage (50% of Actual Production History (APH) and 55% of expected market price at harvest time. Buy Coverage, allows the farmer to increase protection under CAT in 5% intervals up to 85% of expected yield. Group Risk Plan (GRP) uses county level average yield as a trigger to make payments to individual farmers. Income Protection (IP) guarantees revenue for a certain number of grain crops and cotton (expected yields x crops expected price). Crop Revenue Coverage (CRC) allows to farmer to cover 50-75% of expected revenue for selected number of crops in particular counties. Revenue Assurance (RA) allows a revenue guarantee based on multiplying APH yield by the expected price at a certain coverage level. The pilots are Adjusted Gross Revenue (AGR), which covers 50-60% of the farm income reported on Federal Tax returns, and Group Risk Income Protection (GRIP), which adds a revenue component to the Group Risk Plan (county level average yield multiplied by the harvest time futures market price).

(Goodwin, 2001) The program objective of promoting social welfare clearly outweighs the efficiency objective (Table 10). Premium rates tend to be very stagnant and farmers with long loss histories cannot be excluded from the program by law. Participation rate is approximately 20%.

Table 10:
Financial Performance for the U.S. Crop Insurance System: 1990-98

State/Crop	Real Liability (US$ millions of 1999 dollars)	Loss Ratio
Selected States		
Arkansas	4,744	2.97
California	17,218	1.71
Georgia	10,031	2.68
Illinois	22,446	1.12
Indiana	9,640	1.41
Iowa	41,469	1.01
Kansas	12,904	1.62
Minnesota	25,620	1.40
Nebraska	21,651	1.11
Texas	19,571	2.72
Wisconsin	4,473	1.48
Selected Crops		
Corn	90,075	1.33
Soybeans	55,415	1.65
Wheat	42,994	2.14
Cotton	20,782	2.55
Tobacco	17146	2.03
Peanuts	11,053	2.49
Sorghum	5,905	2.13
TOTAL	308,914	1.88

Source: Goodwin, 2001

Canada:

Crop insurance in Canada dates back to 1939 when the federal government started to provided disaster assistance to grain producers on the prairies. Since then, a tripartite system has evolved that consist of three separate programs: Crop Insurance (CI), the Net Income Stabilization Account (NSA), and the Agricultural Income Disaster Assistance (AIDA). The stated objectives are to provide income stabilization and a safety net to farmers and at the same time maintain actuarial performance. The programs are administered at the level of provincial governments and no private insurance companies are involved. The Federal government sets general frameworks and shares program costs with provincial governments, but the latter have flexibility to modify the products to suit the specific needs of farmers in their jurisdiction. In addition,

programs are highly participatory with farmers, provincial governments, and federal government participating in discussing surrounding product designs, rate setting, and performance feedback.

The Crop Insurance Program (CI) providing a yield guarantee based an historical yield data for the farm. If production falls below a yield trigger an indemnity will be paid covering 80-90% of the difference between the trigger and realized yield. The product is multiple peril, covering all losses due to natural hazards, excessive moisture, uncontrollable diseases, and pests and even damage caused by protected migratory waterfowl. In 1999, 100,000 or 50% of all farmers participated and 50 million acres where insured, constituting 55% of all crop and forage acreage (EU, 2001). For most of the 1990s, the loss ratio was favorable, less than one, except for 1992-93. The Federal and provincial governments each pay 25% of the total premium and 50% of the administrative costs. The combined cost to the Federal and provincial governments has been trending upward sharply, rising 34% from US$338 million in 1995 to US$454 in 1999 (EU, 2001). In addition to these costs, the Federal government has reinsurance agreements with four provinces and subsidies the reinsurance premium for two other provinces that purchase it in the private reinsurance market.

The second part of the system is the Net Income Stabilization Account (NISA) that is a matching savings program intended to help farmers achieve long-term income stability. Producers in all 10 provinces who file farm income tax statements can participate in the program along with farm related corporations, cooperatives and communal organizations.

The Government matches on a 1:1 basis deposits made by farmers in participating financial institutions of their choice up to 3% of eligible net sales income, which is the difference between gross sales and net purchases of primary commodities with the exception of diary, poultry, and eggs. Participants can add an additional 20% of eligible net sales without a match. Withdrawals can be made from the account when certain triggers are struck, either the Stabilization or Minimum Income Trigger. The stabilization trigger is when current year gross margin falls below the average of the last five years gross margins. The minimum income trigger is struck when net income falls below $10,000. At the end of 1999, the net assets in the NISA accounts were $2.7 billion, rocketing up from $443 million in 1991, the first year of the program. In 1999, 135,000 farmers or 60% of the eligible population participate and the average balance per farmer was $20,000.

The last part of the system is the Agricultural Income Disaster Assistance program. The program is designed to help farmers suffering from shocks that are threatening the viability of their farm business. The federal government funds 60% of the cost of the program and provincial governments the remaining 40%. In 2000, the total federal allocations were $1.07 billion. All producers, farm enterprises, and cooperatives are eligible. Maximum coverage is 70% of gross marginal average over the three previous years and the maximum payout to an individual is $175,000.

Spain:

Agricultural insurance dates back to the 1920s and has been marked with a strong mutualist tradition.[22] The current system dates to 1978 and builds on the previous experiences that we not always successful.[23] It is a public-private partnership involving three key actors. State Entity for Agricultural Insurance (Entidad Estatal de Seguros Agrarios (ENESA)), an agency of the Ministry of Agriculture, Fisheries, and Food, designs and administers the program while a pool of sixty private insurance companies, Combined Grouping of Spanish Agricultural Insurance Companies (Agrupación Española de Entidades Aseguradoras de los Seguros Agrarios Combinados (Agroseguro)), sells and services the policies. Consortium for Insurance Compensation, (Consorcio de Compensación de Seguros (CCS)), is a public enterprises under the control of the Ministry of Economy that provides obligatory reinsurance. Each year ENESA develops a an operational plan which stipulates which commodities will be insured and what risks to be covered, ranges of premium subsidies, and deadlines for purchase. AGROSEGURO specifies terms and conditions for each product and makes regional differentiations in premium rates in accordance with level of risk exposure and cost of administration and reinsurance. Then AGROSEGURO sells the policies through its network of 60 companies and each company is responsible for monitoring and loss adjustments for the policies it sold. Obligatory re-insurance is purchased from CCS and for particular lines and for particularly viable products, additional risk can be ceded to private reinsurance companies in excess of what CCS will accept. The objectives of the program is to achieve universal coverage, insure all agricultural risk, and provide income stabilization, while maintaining actuarial soundness. In addition, the system is highly participatory and marked by involvement of farmers in product design and constant change and reformulation based on feedback from farmers, extension agents, cooperatives, and insurance companies.

The system started out simple with a few products and now expanded rapidly, covering virtually all crops and the economically most important type of livestock. In 1980, 5 products were offered for 10 commodities. In 2000, 63 different products were offered covering 130 crops grown in the country, three types of livestock (cattle, sheep, and goats) and five types of fisheries. Four broad types of insurance are offered: products that reimburse for estimated economic damage caused by climatic and biological factors, yield guarantees, revenue, and livestock mortality and pasture health. Farmer participation is 31% and 45% of the cultivated area is insured. The most widely insured crop in are tobacco (90%), winter grains (80%), fruits (40-70%), citrus (30-50%), and vineyards (45%). The least insured commodities are olives, cotton, and vegetables.

Public subsidies go up 45% of the premium and average outlays in a year are about 151 million Euros. The average loss ratio for the period 1980-1999 was 113%. The program has been reporting loss ratios less than one for most of the 90s and in the first part of the new millennium. Overall, the system is not viable if the administrative subsidies are counted.

[22]One of the oldest insurance companies, MAPFRE, grew out of a farmers mutual insurance scheme in 1933, La Agrupación de Propietarios de Fincas Rústicas de España.

[23]It was not until 1971, that the rate of penetration surpassed the 5% mark. During the 1920s and 30s, the industry experienced many losses and reversals.

The strengths of the program are a participatory structure and excellent commodity coverage (130 commodities). The participation rate is 31% and a slew of actors are involved in the design of products, most importantly farmers themselves. The weaknesses are that the system lacks of efficiency and long-term viability. It attempts to insure all risks in virtually all conditions, when not all risks are insurable. Actuarial performance is purchase by substantial premium subsidization to avoid adverse selection and through massive investments in monitoring to control moral hazard. The plethora of products implies virtual custom designs for each region and each commodity. The 60 companies involved use a large cadre of well-trained and highly professional claims adjusters. The variety of products and intensive monitor combine to attract clients and reduce losses. The high fiscal cost (approximately Euro 255 million per year) is justified in a political economy sense. The argument goes as follows. A comprehensive ex ante insurance scheme minimizes the need to make extraordinary budget allocations for disasters. Thus, the total cost of subsidies is less than if Spain had to rely solely on ex post disaster relief and all the economic costs associated with uncovered dislocations. Since farmers are not eligible for disaster relief, if they have not purchased insurance if it was available in their region and for their principal crop or livestock, the effective demand for public emergency relief is lowered and a strong incentive provided to increase the demand for insurance. It is also justified by studies that claim that the social welfare gains farmers realize with insurance are less costly that with other interventions such as payment supports (Bielza, 2004 op. cit in ENESA Main Report, 2004).

Mexico:

Crop insurance in Mexico dates back to 1926. Many of the early schemes were mutualist in nature wherein agricultural cooperatives often constituted special funds to cover income shortfalls caused by natural disasters. The funds did not work well due to the long time needed to capitalize them and the frequency of shocks experienced. In 1955 the government attempted to provided reserves and guarantees to the mutualist companies. In 1961, the government through Aseguradora Nacional Agricola y Ganadera S.A. (ANAGSA) started to directly retail an all risk crop insurance product with a 45-61% subsidy in the premium. The most important feature of the ANAGSA program was that crop insurance was a prerequisite for approval from loans from the state owned agricultural development bank and indemnity payments were made via the bank so that the bank could cancel outstanding debts first before paying the farmer for losses. Thus this program was in essence “bank insurance”. Agricultural production expanded into marginal, high risk areas and the loss ratios (I/P) exceed one, 110.5%. Livestock insurance performed better and had loss ratios less than one. At its height, the state monopoly provided insurance for 7 million has. The high losses, high administrative costs, the premiums were set low and hardly varied. As a result, the company experienced repeated heavy losses, eventually forcing its closure in 1990. In that year, AGROASEMEX, replaced ANAGSA, as the state crop insurance company, but operated in a liberalized setting. It competed against five private companies under the same set of rules and regulations and all premium subsidies went directly to producers. With the technical support of AGROASEMEX some 200 mutual insurance funds benefiting groups of farmers. During the decade, AGROSASEMEX, offered multiple risk products for both crops and livestock. It insured 2.2 million has, used a premium subsidy of 30%, and diminished moral hazard problems by insuring 70-90% of total value as opposed to 100% value as was the case with ANAGSA. As a result of better use of modern underwriting

techniques, such as deductibles to combat moral hazard, the company posted loss ratios of 78.6% for livestock and 64.6% for crops in 1999. In 2000, AGROASEMEX transformed into a second tier institution primarily providing reinsurance and secondarily working to promote and development the industry by providing technical assistance to the mutual funds, developing innovative instruments (parametric and catastrophic bond products). Since 2000, AGROASEMEX had been profitable.

Lessons Learned

What can be gleaned from the previous country experiences are the following:

1. Delivering multiple peril crop insurance is complex and expensive. Multiple peril crop insurance fundamentally violates several of the "Golden Rules" of insurance and compensatory actions have to be taken to assure an economically sustainable product, i.e. massive investment in monitoring, careful selection of crop and area to be insured, constant adjustment of premiums.
2. The actuarial performance of multiple peril insurance products can be improved but as the expense of massive outlays for administrative and monitoring costs to handle moral hazard (See example of Japan in Table 9) or massive subsidies for premiums in order keep lower risk types in the pool. In summary, massive government subsidization is required to mask the underlying fundamental problems with risk classification and moral hazard.
3. For a system to be comprehensive, i.e. to cover a wide range of perils at a level of protection which in interest to the farmer, state involvement seems necessary, since private insurance companies alone would not have sufficient incentive to deliver it.
4. A publicly supported insurance program can be subject to rent seeking by influential commodity groups and private insurance companies that enter into partnership with the government to sell and service the products. Farmers can cajole and lobby for the implementation of programs that have not been sufficiently tested, not priced appropriately, and targeted for high-risk areas. Private companies that sell multiple peril crop insurance can create additional pressures on the government to provide operational subsidies. The smaller the farmer, the higher the cost of outreach. Reaching small farmers is normally a high priority with politicians.
5. Data is crucial. There is no substitute for accurate, reliable, and timely relevant data for the measurement, evaluation, and monitoring of agricultural risks.
6. Having a well-trained cadre of modelers, actuaries, meteorologists, scientists, agronomists, and loss claim adjusters is crucial.
7. Farmers have a wealth of information and knowledge that should be tapped in product design phase and a constant feed back loop should be established and maintained.
8. The design and pricing of insurance program can have equity considerations. When government subsidizes the premium, insurance favors the higher risk producer. Since premium rates are higher for more risky crops and more risky regions, the common method of providing a subsidy payment as a percentage of total premium cost to individual participants effectively generates large government transfers to riskier crops and regions. This may work at cross-purposes with other government programs that

attempt to mitigate risk exposure in agricultural production or to limit production in environmentally sensitive areas.

9. Free government disaster assistance can be thought of as ex post insurance. Disaster assistance should be carefully structure so as not to encourage additional risk taking.
10. Even in very well developed systems such as the USA and Spain, participation rates, 20% and 31%, respectively, are still relatively low indicating that effective agricultural risk management must be seen as an "integrated layer system" that includes on-farm, individual risk reducing and coping activities and strategies; informal group based or mutual insurance schemes, formal private market insurance programs, and government sponsored and financed catastrophic disaster relief programs. Insurance by itself is no substitute for good production practices, careful attention to crop mixes, financial savings, and price hedging. Insurance must be seen as a mechanism for removing residual risk that cannot be covered by on-farm or household actions.

Promise of New Technology and Modeling Capabilities

Several developments in the last 30 years are revolutionizing the risk management field and promise to make the design and monitoring of agricultural insurance contracts more cost effective and efficient. Innovations in financial markets may also allow the combination or packaging of insurance with other financial instruments to better satisfy the "Golden Rules of Insurance".

First, advances in remote sensing technology and drops in cost of use (satellites, aerial photography, automatic weather stations that transmit data on a daily basis, global positioning systems (GPS), etc) means that manual gathering and transcription of data is less critical.

Second, advances in optics and digital imaging, processing, and interpretation capability means that images at higher levels of resolution can be obtained and processed, interpreted, and transmitted with greater ease and speed. Chemical sensitive film does not have to be developed. Digital images can be quickly transferred from the capturing device to a computer, to a printer, to television, or to a website.

Third, advances in computer processing power (Moore's Law) and more importantly data storage capacity (within four years scientist hope to be able to store a tetrabyte of information on a square inch of magnetic disk) means that greater amounts of raw information can be more easily processed, stored, and analyzed than before. Geo-referenced datasets with thousands of layers of information are now commonplace compared to 15 years ago. More and more insurance companies have been using geographic information systems (GIS) as a tool to conduct pricing. Partner Re, one of the leading reinsurance firms and the one with the largest agricultural portfolio, has been using GIS since 1997 to model natural hazard risk.[24]

Fourth, advances in communication technology—the internet, broadband connections, wireless networks, etc.—means that information can be more rapidly and easily shared than ever before. The cost of transmitting kilobits per second continues to drop as telecommunication industries

[24]See Rick Thomas's article "Insurance Pricing with GIS: Its all About Business" http://www.partnerre.com/pdf/gis.pdf

are subject to more competition and the number of ISP users and networked computers increases rapidly. Two of the most relevant indicators to the development of agricultural insurance markets would be the number of broadband connections per 100 inhabitants and the affordability of tariffs per minutes of connection/per capita GDP. The development of agricultural insurance will hinge critically on how quickly and how cheaply digital images, weather information, and economic statistics can be transmitted. Unfortunately, these data are scarce. Most of the data that exist are for OECD countries and a few middle-income Asian countries. For these countries the trends are encouraging. In the case of broadband connectivity, not one Latin or Caribbean country ranks in the top 20 (International Telecommunication Union website). For a representative set of 40 countries, a Digital Opportunity Index (DOI) has been developed (ibid). This measure covers three aspects—opportunity (mobile coverage and affordability of networks), infrastructure, and utilization rates where 1 is the highest value. The six Latin American countries in the set (Chile (.43), Mexico (.36), Venezuela (.30), Colombia (.29), Peru (.28), and Brazil (.28), all were below the median of .51 and four were in the bottom ten (ITU website/KADO Digital Bridges Project). In contrast, South Korea (.77), Hong Kong (.68), Singapore (.64), and Taiwan (.64) were in the top ten (ibid). Although a digital divide does exists between the OECD/East Asian countries and the rest of the world, the rapid growth in cellular subscriptions in Latin America, South Asia, and Sub-Saharan Africa is likely to be a harbinger that improvements in broadband service will soon follow. The laggards are where the East Asia tigers were 10 years ago. Improvements in broadband connectivity will be a necessity in order to maintain business competitiveness. What is debatable is whether the predominant platforms with be mobile broadband or fixed broadband.

Fifth and most importantly, the development of more sophisticated meteorological, probabilitistic risk, and phenological models;[25] advances in econometrics and statistical analysis (e.g. popularization of generalized maximum entropy estimation that allows nonparametric analysis of very small data sets); advances in the development of algorithms to handle missing data and correct for out of range data points; combine to yield an increased capability to deal with highly spatially correlated risks and small datasets. For example, the East African Livestock Early Warning System (LEWS) in now capable for providing reliable 90 day forecasts of the health of grasslands and by deduction the health of herds.

Sixth, index insurance products can be combined with savings accounts to minimize basis risk such as in the ICICI Lombard-Basix pilot in India (Hess, 2002). Also index insurance can be purchased by financial intermediaries to reduce credit default risk, allowing them to reduce the rate of interest charged for agricultural lending. Income and revenue insurance products can be made more efficient and less costly by combining futures to cover price risk with parametric triggers to cover yield risk (See Box 2).

[25]See article by Ross Hoffman, "Controlling Hurricanes" in Scientific American October 2004 issue wherein a new technique called four-dimensional variational data assimilation (4DVAR) has been improvingly the quality of weather forecasts dramatically by combining all the observations collected by satellites, ships, buoys and airborne sensors before the forecast begins, with an educated first guess of the initial atmospheric state--a process called data assimilation. This first guess is usually a six-hour forecast valid at the time of the original observations. http://www.sciam.com/article.cfm?chanID=sa006&colID=1&articleID=000593AE-704B-1151-B57F83414B7F0000.

In summary, the number of impediments is formidable but not insurmountable. In the next section, new contract designs and advances in information and communication technologies hold promise.

Box 2: Minimal Data Needs for Design of Weather Based Indices

- Thirty years or more of weather data (precipitation, temperature, relative humidity, wind, barometric pressure)
- Limited missing values and out of range values
- Data and recording procedure integrity
- Consistency of observation techniques: manual v automatic
- Limited changes in instrumentation/orientation/configuration
- Little potential for measurement tampering
- Actual crop yield data at district level and preferably at the
- farm level.
- Agronomic crop yield models
- Metadata (Notations as to when and how changes were made in
- Instruments, location, and reporting methods)
- Availability of nearby weather stations for a "buddy check"

Source: Brian Tobben, (PartnerRE) presentation FAO, Rome May 5 and 6, 2004.

IV. LATIN AMERICAN AND CARIBBEAN CASE STUDIES

Dominican Republic:

***Agricultural Insurance Market Overview*:** There are 36 insurance companies active in the country but Aseguradora Agrícola Dominicana S.A. (AGRODOSA), is the only one providing crop insurance. This mixed public-private company (90% public capital-10% private capital) offers multiple peril policies that covers damages due to wind, excessive rains, flooding, drought, earthquakes, disease, pests, and hail that result in a yield inferior to the expected yield. The indemnity payment covers up to 70% of investments and is calculated on the difference between the actual and guaranteed yield level. The principal crop insured is rice. In 2002, AGRODOSA was active in five provinces (Northeast and North Central), issued 2,847 rice policies covering 15,817 ha or approximately 15.8% of the total area cultivated in rice. The value of agricultural insurance policies, however, is only 12.5% of the total value of policies sold in the country (755 million pesos out of 6.097 billion pesos in 2001).

AGRODOSA works closely with the state agricultural development bank, Banco Agrícola. The staff and branch offices of Banco Agrícola are used to sell and service agricultural insurance policies. Furthermore, Banco Agrícola conditions approval of credit for rice production in certain areas upon purchase and endorsement of an insurance policy in the name of the Bank. The insured value is closely related to the size of the loan. In order to help expand the market and keep premiums affordable, a 50% government subsidy is provided for the premium. In essence, AGRODOSA provides "bank insurance" and helps the agrarian reform sector. The principal crop covered is rice, a national food staple, and land reform beneficiaries tend to use the insurance product heavily.

AGODOSA is the successor organization to Aseguradora Dominicana Agropecuaria (ADACA) that operated between 1983 and 1998. ADACA was a wholly owned state entity that focused on insuring subsistence farmers (average farm size .7 ha) receiving credit from Banco Agricola. ADACA failed due to heavy recurrent losses and poor service. The Banco Agrícola, its de facto client, often failed to transfer premiums on times that were financed by loans granted to farmers. In turn ADACA was slow in paying indemnities causing farmers to lose confidence and there was no transparent manner to settle disputes over claim adjustments. AGODOSA differs some but not substantially from ADACA. Ten percent of AGODOSA's capital is private and the board has more private sector directors than public but the president of the Banco Agrícola is a prominent board member. AGODOSA has professionalized the claim adjustment process and has focused on limiting losses by focusing on rice producers with a moderate to high level of technology and recognized good practices. Nonetheless, the portfolio is overly concentrated in one crop and decisions seem more influenced by national level agrarian policy considerations than by purely technical considerations or the search for scale and viability.

***Principal Agroclimatic Vulnerabilities*:** The principal threat to Dominican agricultural production is hurricanes (See Table 11). Of all the natural disasters that have occurred between 1900 and 1996, hurricanes account for 64% of the events, floods account for 28%, and

earthquakes and droughts account each for 4% of all the recorded events[26]. Some individual crops, however, are more susceptible to damage from natural hazards, than others. As can be seen in the Table 11, hurricanes damage tree crops (oranges, mangos, avocados, bananas) and rice to a greater extent than other crops, with the exception of potatoes. Plant diseases, on the other hand, cause more damage to bananas than other of the reported crops by a wide margin. Infestations seem to affect rice and mangos to a greater extent that any other reported crop. Overall, when all the climatic and biological risks are combined, three crops emerge as particularly vulnerable and high risk: bananas, oranges, and rice.[27]

Rice and bananas (plantains and guineo) are widely cultivated (16% and 11% of total area cultivated in 2000, respectively) and are used mostly for domestic consumption.[28] In terms of economic value, rice is the most valuable crop, plantains are the fifth most valuable crop, and guineos are the seventh (rice RD$3.3 million; plantains RD$1.4 million, and guineos RD$.6 million in 2002). Oranges are produced mostly for the local market and a small surplus is exported. The value of orange exports has fallen from $2.9 million in 1996 to $1.2 million in 2001.

[26] CRED http://www.cred.be/centre/publi/142s-ch3.htm

[27] One may argue that climatic risks are totally uncontrollable while plant disease and infestations, can be controlled and mitigated to some degree through cultivation practices, preventive measures, and chemical treatments. Nonetheless, the ranking of susceptible crops remain the same even if the biological risks are removed.

[28] The plantain and guineo are members of the banana family and are main source of carbohydrates in the daily diet of Dominicans, especially the low-income. These varieties of bananas should not be confused with the varieties that are sweet and consumed primarily as a fresh fruit. Plantains and guineas are not edible in their natural state. They must be either boiled or fried.

Table 11:
Frequency (Percent) of Natural Hazard Events Resulting in Crop Loss or Damage (1998-2002)

Natural Hazards	Rice	Bananas (Bananas/ Plantains/ Guineo)	Oranges	Mango	Avocado	Potatoes	Garlic	Onions	TOTAL
Climatic Risks									
Hurricanes	8.8	7.9	15.8	10.8	9.3	9.7	4.3	2.2	8.4
Storms	2.2	.4			.4				.1
Floods	1.2	1.6	.5			.2	.5	1.9	.8
Excessive Rains	.4	.8	.9			1.6	1.9	4.4	1.3
Droughts	2.5	12.1	7.9	1.1	4.0	3.5	6.7	3.1	5.4
Tornados	2.2	1.8			.4	.2		.6	.7
Hail	2.2					.2	.5		.4
Abrupt Temperature Change	.6	1.3			1.7	.4	1.7	1.3	.6
SUBTOTAL	20.1	24.8	25.1	11.9	15.6	15.8	15.6	13.5	17.7
Biological Risks									
Diseases[29]	5.9	14.3	5.8	.5	3.6	4.9	3.6	6.9	5.8
Infestations[30]	8.0	3.2	4.4	7.6	1.2	.4	1.2	5.7	4.4
SUBTOTAL		17.5	10.2	8.1	4.8	5.3	4.8	12.6	10.2
GRAND TOTAL		42.3	35.2	20.0	20.4	21.1	20.4	26.1	27.9

Source: ENESA conducted survey on risks and vulnerabilities 2003.

The principal crop producing regions are the Northeast, the Central, and Southeast. The majority of hurricanes tracks recorded between 1873-2000 can be divided into five periods. The frequency, severity, and tracks tend to vary in blocks of 25-30 years. Since 1995, the North Atlantic hurricane zone has entered a "peak" activity period where the more tropical depressions form and intensify into more tropical storms and hurricanes. In the case of the Dominican Republic, most of the tropical storms and hurricanes are tracking across the Central, North Central, South, and North regions of the country, normally making landfall on the Caribbean coast and exiting through Haiti on a western or northwestern track. In this most recent period, the least affected regions of the country are the East and Northeast. When the entire time series is analyzed (1873-2000), the four areas most affected by windstorms are East (19.31%), the Southeast (17.81%), the South (14.86%), and the Central (13.71%). The most destructive windstorms are categories 3, 4 and 5 hurricanes as ranked on the Saffir-Simpson Scale and they are progressively less common as severity increases. For the period 1502-2000, only 16.2% of recorded windstorms affecting the DR have been category 3 or higher.[31] However, when these powerful hurricanes strike, agricultural growth rates can be slashed in half.[32]

[29]The most common plant diseases are rust fungus.
[30]The most common infestations are white fly and rats. Forty percent of recorded disease and infestations problems occur in 4 Central and Northern provinces: Santiago, La Vega, Espaillat, and Azua).
[31] www.acqweather.com/huracanes.htm
[32] See ENESA's Programa de Manejo del Riesgo Agropecuario en Republicana Dominicana p. 55. Hurricane George (H3) in 1998 caused US$ 434.8 million in damage and cut agricultural growth rate from 2.15 % to 1.08%.

In terms of threats to livestock, the most important one is droughts that reduce pasture productivity and cause cattle to lose weight and lower milk production. In general, climatic shocks affect livestock to a much lower extent than crop production as can be seen in Table 12. Animal health inspection and control programs are in place and have succeeded in controlling Newcastle disease in poultry and brucellosis in cattle. Unlike other countries in Latin America, the DR has never had problems with List A diseases such as foot and mouth disease. The current threats are classic swine fever on the Haitian frontier and an increasing number of cattle tuberculosis cases.

Table 12:
Frequency of Natural Hazard Events Resulting in
Damage and Economic Loss in Livestock Production (Percent)

	Poultry	**Cattle**	**Pigs**
Hurricanes	3.1	5.6	.8
Storms		.2	
Excessive Rains			.2
Drought		15	
Abrupt Changes in Temperature	.9		5.0
Diseases	7.2	1.4	9.0
Pests		3.0	1.6
Total Natural Hazards	11.2	25.2	16.6

Source: ENESA Survey on Risk and Vulnerability 2003

Farmer Preferences: No formal elicitation of farmer risk attitudes have been conducted but qualitative survey work suggests that farmers are quite interested in insurance. According to ENESA, most interviewed farmers are interested in insurance, especially against wind damage caused by hurricanes and droughts that reduce the productivity of pastures. However, the highest priority of farmers was price stabilization. Price volatility is higher than yield variation (See Table 13).

Table 13:
Yield and Price Variability:

	Yield (Coefficient of Variation 1989-2001)	Prices (Constant, base 1989)
Banana	2.07	22.77
Rice	6.71	34.69
Sugar Cane	13.22	15.88

Source: FAO op cit ENESA, Dominican Republic Report, 2004

ENESA calculated risk premiums for the following three major crops (Table 14).

Table 14:
Yield Risk Rates

Crop	Yield Risk Rates (Normal Curve)[33]
Rice	8.09%
Banana	7.96%
Sugar	8.63%

Source: ENESA Dominican Republic Report, 2004

Adequacy of the Legal and Regulatory Framework: The current law governing insurance dates to 1968. It needs updating to international insurance standards. It also grants a great deal of discretion to the superintendent in establishing reserves for current risks and special reserves and how they are invested. It also facilitates reinsurance, by allowing two reinsurers to divide and share the same risk. Most importantly, it places few restrictions on who can be an insurance agent, runner, or claims adjuster but it not clear how well they are supervised to protect consumer interests. The most relevant implication of the framework would be the need to constitute large reserves for agricultural operations in order to insure solvency.

Recommendations: The Dominican Republic is struggling to develop a viable model of agricultural insurance. Due to the catastrophic level of damages that hurricanes can inflict, insurance companies are very reluctant to enter the market. The government-led intervention through AGODOSA has been modest but needs reassessment as to its long-term viability. The main issue is that repeated exposure to wind storms may require a different type of risk management architecture, a layering of risk, where most of the windstorm related risk is transferred off island through catastrophic bonds or a regional disaster funding mechanisms. The other types of climatic and biological risks could be managed by more self-sustaining local risk management instruments.

[33]See Ray, P.K. 1881 Agricultural Insurance: Theory and Practice and Application to Developing Countries. Pergamon Press Formula: L=(A*(C-Y)+ Delta *d where L=pure risk premium, Y=actual yield C= level of coverage or indemnity; A=proportion of area with yields less than expected amount; Delta =standard deviation in yield for distinct parcels; and d= probability of realizing maximum indemnified yield

Peru:

***Insurance Market Overview*:** Peru is a country where some of the fifteen active and regulated private insurance companies offer single peril insurance products (fire, hail) to producers.[34] However, the data on single peril agricultural coverage is not disaggregated and is classified as general insurance. The total amount is assumed to be modest. The existing companies focus on life and automobile insurance and the growth rate for these lines are positive (18-20% per year). The Government, however, has demonstrated an interest in the topic and in June 2003 formed an Agricultural Insurance Commission, comprised of various stakeholders groups and whose mission it is study the feasibility of introducing and expanding agricultural insurances so as to permit diversification into more profitable but riskier crops, provide income stabilization for farmers, and improve farmer access to formal credit. The mission of the commission is to draft agricultural insurance legislation. To date the Commission has calculated risk premiums for a number of crops, agreed to work with both ENESA and the World Bank in conducting feasibility studies and pilots.

***Principal Agroclimatic Vulnerabilities*:** The most common risk that farmers face in Peru is flooding (Table 15).

Table 15:
Frequency of natural disasters in Peru 1970 -2001

Event	Event Frequency	Percent	Accumulated Percentage
Floods	2877	15.04	15.04
Earthquakes	1909	9.98	25.04
Excessive Rains	1893	9.90	34.92
Alluvial deposits	1659	8.67	43.59
Epidemics	1375	7.19	50.78
Fire	1335	6.98	57.76
Pollution	1311	6.85	64.61
Land slides	983	5.14	69.75

Source: DesInventar Peru, op cit ENESA Peru Report, 2004

The departments that are most prone to natural disasters recorded in the last 30 years are Lima (20.63%), Arequipa (11.70%), Junin (8.87%), and Ancash (8.03%), Cusco (7.46%) and Piura (5.65%). The most agriculturally productive part of the country is the irrigated coastal valleys. In this zone, according to a subsample of a national survey (Encuesta Nacional Agropecuaria de Producción y Ventas) conducted by the Ministry of Agriculture in 2003, plagues are the most common threat to agricultural production (58%) followed by lack of sufficient irrigation water (15%), then by frost (8%). Floods were a minor threat in the irrigated valleys (2%). In sampled valleys, unforeseen and uncontrollable threats far surpassed expected threats such as output price

[34]The active insurance companies are : General Peru, La Positiva, Rimac Internacional, Sul America; El Pacifico Peruano Suiza, Mapfre Peru, Royal and SunAlliance, Secrex, Altas Cumbres, El Pacifico Vida, Interseguros, Mapfre Peru Vida, Royal and Sun Alliance Vida, Santander Vida, Wiese Atenia Vida.

uncertainties. The crops in sampled valleys that were most exposed to severe losses (>30% of expected income) were beans, cotton, and cotton. The least vulnerable crop was sugar cane. In the case of threats to livestock, are vesicular estomatitis, classic pig fever, rabies, brucellosis and tuberculosis. Foot and mouth disease use to be a problem but since 2000 there have been no reported incidents.

Beyond doubt, the largest systemic threat Peru faces is the El Niño phenomenon that occurs every 6-7 years (Table 16). The agricultural losses caused by the phenomenon are high. Anywhere from 6-47% of the entire cultivated area could be affected. The most vulnerable areas are in the north (Piura, Tumbes, Cajamarca) and the south (Tacna, Arequipa), and the most vulnerable crop is potato, a national food staple.

Table 16:
Impact of El Niño on Peruvian Agriculture

Years	Estimated Economic Losses to Agriculture (US$ millions)
1982-83	446.98
1996-1997	59.94
1997-1998	174.06
1998-1999	36.55

Source: Ministry of Agriculture Peru op. cit. ENESA Peru Report, 2004.

The three principal meteorological events associated with the phenomenon are heavy rains, high temperatures, and drought. The first two combine to produce a series of costly effects: flooding, reduced yield due to heat stress, landslides, damage to irrigation and transportation infrastructure, soil erosion, lower quality in harvested product, and an increase in the number of fungical infections and diseases due to high moisture and humidity levels. Sometimes the principal effect is drought resulting in diminished yields, increased infestations and diseases, and loss of pasture productivity. Often one part of the country can be affected by excessive rains and flooding and another part of the country can be affected by drought.

Yield Variability: The most two crops that exhibit the greatest amount of yield variation over time are corn and potatoes, two staples (Table 17). This would imply that these are the most risky crops to insure because losses are likely to occur frequently. Because of a higher expected loss frequency, the premiums for these crops would have to be higher. Since low-income farmers mostly grow these crops, the issue of affordability could emerge.

Table 17:
Yield Variability for Major Crops in Peru 1970-2002

Crop	Coefficient of Variation (SD/Mean*100)
Corn	24.6
Potatoes	19.9
Rice	16.6
Wheat	15.6
Sugar	13.6
Barley	12.8
Coffee	10.2

Source: FAO op. cit. ENESA, 2004.

ENESA calculated pure risk premiums using different estimation techniques. The results follow in Table 18.

Table 18:
Calculated Risk Premiums

Crop	Yield Risk Rates (Normal Curve)[35]	Monte Carlo Simulations for both Yield and Catastrophic Risks
Rice	4.38	8.10
Coffee	4.92	7.10
Sugar	6.06	Na
Corn	4.45	7.24
Potatoes	4.12	7.44
Wheat	5.10	7.20

Source: ENESA Peru Report, 2004.

As can be seen from the tables, the different techniques yield a different ranking of crops. The Monte Carlo combines both degree of variability in historical data with an allowance for major shocks. The weighting used for the probability of major shocks and estimated economic value of the crop losses are P=.86 Damage 0; P=.01 Damage=.1; P=.04 Damage=.5; P=.09 Damage =1. Under the simulations, rice, corn, and potatoes emerge as the riskiest crops. Of these crops, rice has the highest profit margin making it a more attractive crop to insure from the perspective of an insurance company.

[35] See Ray, P.K. 1981 Agricultural Insurance: Theory and Practice and Application to Developing Countries. Pergamon Press Formula: L=(A*(C-Y)+ Delta *d where L=pure risk premium, Y=actual yield C= level of coverage or indemnity; A=proportion of area with yields less than expected amount; Delta =standard deviation in yield for distinct parcels; and d= probability of realizing maximum indemnified yield

Farmer Risk Preferences: Farmers groups in general express an interest in insurance protection. Exporters tend to be more interested in price hedging while domestic producers are interested in yield protection. The ENESA work did not elicit farmers risk preferences but work financed by the USAID to be undertaken by Grade, a think tank, will do so within the next year[36]. The economic literature suggests that low-income developing country farmers tend to be risk adverse. If that is the case in Peru, then the demand for insurance products should be strong. The most risk averse a person, the more willing they are to foregone income in order to avoid stochastic losses.

Adequacy of the Legal and Regulatory Framework: The General Law that governs insurance in the country (Ley General del Sistema Financiero y del Sistema de Seguros y Orgánica de la Superintendencia de Banca y Seguros, Número 26702) is reported to be generally adequate. The main objective of the norms governing insurance is to assure stability of the system and the ability of companies to cover obligations. In order to do this, the authorities demand minimal capital adequacy, solvency margins, and set reserve requirements. One possible area of concern for companies interested in offering crop insurance on a large scale is the requirement for catastrophic reserves. From the perspective of the regulator this is appropriate. Because El Niño generates such significant losses, the reserve loading in the calculation of the premium for multiple peril crop insurance products could vastly increase the cost of the product to a farmer and render it unaffordable, unless there is international reinsurance. The implications are that insurance companies will have to focus on designing single peril or parametric products that are attractive to farmers yet very affordable and which can comply with the reserve requirements or insurance companies will have to depend on government premium subsidization.

Recommendations: The Insurance Commission is continuing its work and within the next year plans to have to pilot experiences operating that will serve to better inform them on how to proceed. One pilot will be financed by the Commodity Risk Management Group of the World Bank to experiment with indexes and another financed by USAID will experiment with an index based on changes of water temperature in the Pacific (El Niño) and will be aimed at microfinance intermediaries in the Department of Piura. Spain's ENESA is also active and is giving advice on how to introduce and finance a multiple risk insurance scheme. The most critical needs that Peru faces are to improve the quality of weather and production information; to train a cadre of persons knowledgeable about the intricacies of agricultural insurance; and to learn from pilots.

Uruguay:

***Agricultural Insurance Market Overview*:** Until 1993, insurance was a state monopoly. Since then the industry has liberalized and there are a total of eighteen companies but in the area of agricultural insurance, only three entities are active—Banco de Seguro del Estado (BSE), MAPFRE, and La Compañia Cooperativa de Seguros (SURCO).[37] In addition, to these companies there are a few mutual insurance funds. The two private insurance companies have signed agreements with the state entity, BSE, which is the dominant actor, and they all offer very

[36]Proposal of Eduardo Zegarra and Carlos de los Rios of Grade to USAID BASIS Project, "Agricultural Insurance Policy and Farmers' Exposure to Idiosyncratic and Covariate Risk in the Peruvian Coast, April 2005

[37]The state entity, Banco de Seguros del Estado, retains a monopoly on policies covering worker accidents.

similar multiple peril policies and rely on a 35% government subsidy for premiums. The basic policy covers estimated yield losses from hail with additional buy up polices available for fire, frost (< 0 degrees Celsius varying with altitude), excessive rain, and wind (>80 km/hr). Levels of coverage vary by risk—100% guarantee for hail damage, 80% guarantee for fire damage, and between 80-100% for other perils. The main difference between the companies is the period granted to make an indemnity claim. It varies from 48 hours for MAPRE up to 96 hours for BSE. The claim adjustment process is identical for all three companies. The policyholder or legal representative of that person must accompany the claims adjustor in the field and payments are made based on calculated damages. If there is a dispute, it is settled by arbitration. Below is a list of the crops covered (Table 19).

Table 19:
Principal Crops by Category

Category	Specific crop
Winter Grains	Wheat, barley, oats, rye, canary seed
Summer Field Crops	Cotton, rice, sunflower, corn, peanuts, soybeans, sorghum, tobacco, forage
Oilseeds and forage	Rapeseed, linseed, clover, alfalfa, roots,
Vegetables	Garlic, beans, eggplants, onions, asparagus, spinach, melon, potatoes, cucumber, watermelons, tomato, carrots
Vineyards	Grapes and rootstock
Fruits	Peaches, apples, pears, cherries, quince
Citrus	Mandarin, orange, grapefruit.

Source: ENESA Uruguay Report, 2004.

The agricultural insurance market is quite small. In the crop cycle 2000-01, 1,400 policies were issued, insuring 160,887 ha or a value of $44 million. The premium volume was US$2.3 million. This means that 2% of the farmers were insured and less than 1% of the total cultivated area. In addition, to company issued insurance, there are the mutual insurance funds, Fund for the Integral Protection of Vineyards, Fund for Rice, and Fund for Barley. These funds are organized by producer associations and leading agroindustries and pay up to maximum limit for realized losses to participants. The principal purpose is to share losses suffered by hail damage. In the case of the Vineyard Fund, the government contributes to the fund while in the case of the other two; producers make direct payments into the funds.

The main reasons that agricultural insurance is limited in Uruguay is due to the caution of insurance companies to offer mostly hail policies due to high losses with multiple risk policies and the budget constraints that limits the amount of subsides for premium available from year to year. An interdepartmental working group that includes persons from the Ministry of Livestock Food, and Fisheries (MGAP), the Weather Service, the National Agricultural Research Institute, was formed in 2003 to promote the introduction of agricultural insurance has been formed with the stated purpose of drafting a new law and in starting a pilot with BSE, MAPRE, and the MGAP. A draft Agricultural Insurance Law that replicates the ENESA model from Spain has been prepared and the pilot launched. MGAP has been receiving technical assistance from

Agroseguros, a Spanish consortium of insurance companies, and AECI, the Spanish Agency for International Cooperation on the topic for several years.

Principal Agroclimatic Vulnerabilities: Uruguay is a temperate country and the principal risks are rank order for intensive field crops are (1) frost; (2) strong winds; (3) hail; (4) excessive rains; (5); problems with budding; (6) and drought. For extensive field crops such as grains, pasture, and forage the principal threats are hail, excessive rains, and droughts (Table 20).

Table 20:
Principal Threats for Specific Crops

Crop	Climatic Threat
Rice	Hail Cold spell during blossom Excessive rains at the time of planting and harvest
Grape	Hail Strong winds Excessive rains at the time of harvest
Citrus	Hail Low temperatures Frost Strong winds
Fruits	Hail Excessive rain

Source: ENESA Uruguay Report, 2004.

In the case of livestock production, the principal threat is foot and mouth disease. Other diseases threats are bovine brucellosis, and bovine tuberculosis. The last reported cases of foot and mouth were in 2000 but in 2002 there were over 120 outbreaks of bovine brucellosis and tuberculosis, affecting more than 3000 animals.

Yield Variability: In the case of the eight major agricultural commodities produced in Uruguay, all with the exception of irrigated rice demonstrate a high level of yield variability, especially when compared to statistics from the Argentine pampas, an area similar to a large section of Uruguay in climate, soil, and topography (Table 21).

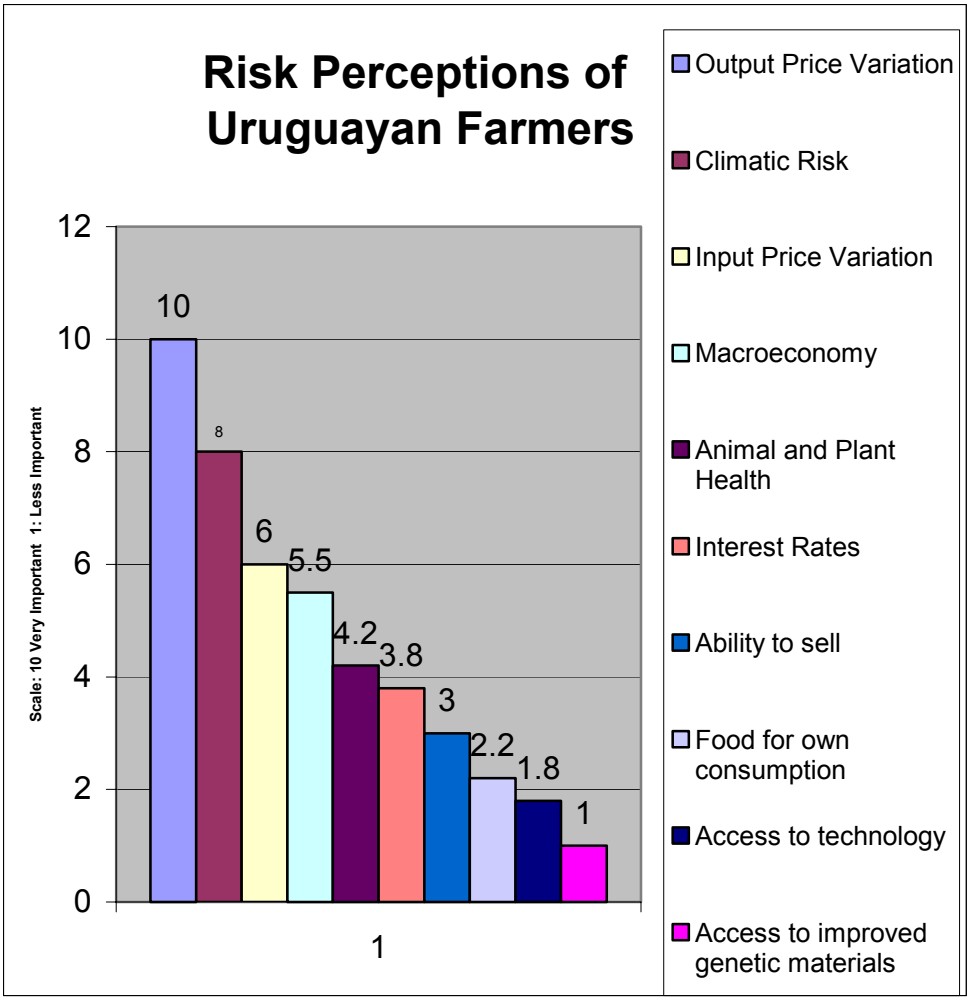
Table 21:
Yield Variability

Crop	Coefficient of Variation	Series
Rice	8	1998-2003
Wheat	28	1998-2003
Barley	32	1998-2003
Sunflower	23	1998-2003
Corn	29	1998-2003
Sorghum	49	1998-2003
Potatoes	40	1970-2003
Apple	15	1985-2002
Orange	12	1970-2003
Grape	37	1970-2003
Argentine Pampa		
Wheat	6	1998-2003
Corn	6	1998-2003
Sunflower	5	1998-2003

Sources: Uruguayan Ministry of Agriculture and FAO op. cit in ENESA Uruguay Report, 2004.

Farmers Preferences: In Uruguay, no formal studies have been conducted on farmer risk attitudes nor on capacity to pay for insurance but farmers are reported to be seeking greater access to insurance products and financial risk management tools (Table 22). According to studies conducted by the Uruguayan Ministry of Agriculture the main perceived risks of farmers are price volatility followed by climatic risk (Figure 7). Risk premiums were calculated and are presented in Table 23.

Figure 7:
Risk Perceptions of Uruguayan Farmers



Source: ENESA Uruguay Report, 2004.

Table 22:
Overview and Demands of Uruguayan Farmers

Extensive Agriculture Subsector (Grains, oilseeds, forage, cotton)	
Basic Characteristics	High level of technology used and high level of specialization but highly indebted
	High degree of vertical integration
	Predominantly export oriented
Current Insurance Products Offered	Private insurance companies offer predominantly hail coverage.
	Terms are supposed viewed as harsh given large losses in the 1990s and problems attracting international reinsurance
Farmers´ Specific Demands	Want coverage for drought, flooding, excessive rain, and plant diseases derived from an excess of humidity and dampness for a prolonged period
Horticultural Subsector (Vegetables, fruits, flowers, citrus)	
Basic Characteristics	Highly fragmented subsector. There are many vegetable producers on many small plots with a wide diversity of management practices and different types of technology applied. The citrus producers are divided into two groups, small producers orientated to national markets and larger producers orientated to international markets. This subsector benefits from many government programs.
Current Insurance Products Offered	Hail insurance.
Demands	Want more coverage for frosts, excessive rains, and strong wind
	Export producers want coverage for diminished quality not just full loss.
	Want more easy to understand and transparent written contracts and especially the claim adjustment process.
Winery subsector	
Basic Characteristics	The producers are segmented into large and small (bulk) and (specialty). A fair high degree of vertical integration exists.
Current Insurance Products Offered	Mostly hail. Fund for Integral Protection of Vineyards compensates members who have suffered losses greater than 30% regardless of cause.
Demands	Larger number of insurance products and coverage especially for frost and strong winds. The more technologically advanced vineyards what coverage for quality damage.
Livestock Subsector	
Basic Characteristics	High level of indebtedness. Diary sector experiencing import pressures due to trade liberalization. New investors are seeking assurances.
Current Insurance Products Offered	No product offered
Demands	Insurance that would cover losses due to accidents, deaths, and diseases such as foot and mouth and brucellosis.
Forestry Subsector	
Basic Characteristics	The subsector is expanding. Private investors want assurances that their investments in plantations will be protected
Current Insurance Products Offered	Three products are currently offered: (1) insurance for standing forests (2) insurance for nurseries; and (3) insurance against fire.
Demands	Forestry producers have few demands; they just request refinement of existing products.

Source: Vila-MGAP op. cit in ENESA Uruguay Report, 2004.

Table 23:
The calculated rates of risk premiums follow

Calculated Risk Premiums	
Crop	**Calculated Risk Premium**
Potatoes	4.31%
Rice	2.74%
Barley	3.80%
Wheat	3.10%
Sorghum	3.16%
Soybeans	3.79%
Corn	4.87%
Vineyard	4.24%
Apple	7.35
Peaches	6.26
Oranges	4.81
Vegetables	3.66
Average	4.34

Source ENESA, 2004.

Adequacy of the Legal and Regulatory Framework: The legal and regulatory framework of the country is generally open. It does not have undue barriers to foreign companies but in terms of reserves, those companies interested in crop insurance are required to establish reserves equal 70% of premiums. This level may or may not correspond well to real risk. It is a rather broad-brush approach given that Uruguay is not as vulnerable to catastrophes like the Dominican Republic or Peru. No detailed information however, is available on licensing of agents.

Recommendations: Uruguay is faced with a twin dilemma. First, farmers want comprehensive insurance coverage that would require massive fiscal outlays at a time that the Central Government is fiscally constrained. Given the tight budget situation, the Central Government should carefully reconsider the proposition of introducing a very expensive crop insurance program and seek alternative ways to mitigate risk on farm though better extension services and by experimenting with instruments that imply less administrative costs such area-yield and parametric products. Second, agricultural insurance in Uruguay for a long time has been seen as a "government endeavor" and private companies and reinsurers have expressed little interest in this market segment. Therefore, more of an active outreach to private companies via investment in the creation of a consolidated data base and staff training as well as the modifications of the regulatory framework may be necessary to broaden the market otherwise the development of agricultural insurance in the country will be a function of how much government subsidies are available.

V. POLICY RECOMMENDATIONS FOR SUSTAINABLE MARKET DEVELOPMENT

The development of agricultural insurance markets as can be seen in the previous exposition is saddled by inertia, lack of actuarial and agriculture specific knowledge, lack of information, and in some cases weak legal and regulatory frameworks. One of the key debates in the promotion of agricultural insurance revolves around the question of the role of public subsidies. This section discusses the pros and cons of subsidies and sets theoretical and practical guidelines for the use of subsidies and delineates the short and medium steps that national donors, donor organizations, insurance companies and farmers should follow to develop a sustainable, broad-based and competitive agricultural insurance markets.

The Role and Allocation of Public Subsidies

Many industry representatives vehemently claim that agricultural insurance can only be developed with government subsidies for premiums and operational expenses. The traditional argument for government subsidies, especially for premium payments is based on three elements. First, farmers have repeatedly expressed more of an interest in purchasing multiple peril and revenue/income insurance, than single peril or parametric instruments, which are still a novelty. Thus, if a large market is to be developed, as measured by insured area cultivated, value of policies, and number of participants, then the desired types of insurance products must be offered. Second, these two types of products are so costly to deliver to the majority of farmers that government subsidies are required otherwise the charged premiums would be unaffordable and no market or a very small market comprised only of the largest farmers will appear. Third, agrifood sector is too politically sensitive to consign to this quandary of suboptimal risk management due to "market imperfection". Therefore, on political economy and social benefit grounds, the intervention of the state can be justified to enhance national welfare, otherwise society will suffer the negative effects of fluctuating agricultural supplies and prices, the economic and social dislocations associated with the distressed farm families and communities, as well as the probable loss of international competitiveness when foreign producers have access to insurance. According to the proponents of this argument, the three roles that the state can play a role is (1) providing a subsidy directly to farmers to help play for the premium; (2) providing a subsidy to help private insurance companies obtain reinsurance, and (3) providing direct subsidies to private insurance companies in order to help defray the high costs of serving numerous, dispersed, small-scale rural clients.

This paper argues that insurance market development does indeed require government assistance and investment but that public subsidies should be more orientated to providing "public goods" that will help lay the foundation for private risk taking and less on providing "income transfers" as occurs when the emphasis is on providing subsidies in the premium in order to make the product more affordable to a larger set of farmers. In the context of fiscally constrained treasuries, public expenditures should be rationalized and allocated to the ends that would generate the highest economic return. Moreover, developing countries have a much larger farm population than developed countries, making the implementation of a comprehensive and broad-based program extremely expensive and failing universal reach, prone to politicization. For

example, the farm population (owners/operators) of the U.S. is 2 million out of a total population of 295 million (.6%) whereas the farm population (owners/operators) of Bolivia is 660,000 out of total population of 8 million (8%). The US spends approximately $3 billion on crop insurance subsidies per year or approximately $1500 per each farmer to get 72% of cultivated area covered.[38] Using extrapolation, Bolivia would have to spend $990 million to get significant coverage. Bolivia, however, is a much smaller economy than the U.S. $22.33 billion (PPP est. 2004), vs. 11.75 trillion (PPP est. 2004), meaning that Bolivia would be spending approximately 4% of its GDP on crop insurance subsidies annually, whereas the US is spending .0002% (CIA World Factbook). The question becomes one of cost effectiveness. Given all of the pressing investments needs in such a low-income country as Bolivia, would spending scarce public monies on crop insurance yield a higher rate than on other activities such as rural education, rural roads, potable water, electrification, agricultural research, extension and marketing services?

Favored Uses of Public Subsidies to Promote Agricultural Insurance:

Public subsidies and monies can and should be used to the following activities:

1. Market Development
    a. creation and maintenance of information databases including purchase of data and images
    b. promotion of innovative products and their pilot testing
    c. training of staff in insurance companies (actuarial sciences, risk modeling, claim adjustments, analysis and familiarization with agricultural commodity markets)
    d. measurement of farmer's risk attitudes so that coefficients of risk aversion can be used to setting pricing
    e. education of farmers on insurance products and contracts
    f. education of government policy makers on how to create favorable settings for the introduction of insurance products.
    g. purchase, installation, and maintenance of weather stations
    h. payment on a permanent or declining basis the cost of broadband internet and satellite connections the entity consolidating the information and transferring it to private users.
    i. development of sophisticated models of weather phenomena
    j. acquisition of computers with greater and faster processing capacity.
    k. acquisition of data storage devices.
    l. modeling impacts of climate change on precipitation patterns and extreme weather events
2. Legal and Regulatory Reform
    a. Hiring legal and economic consultants to determine if biases against agricultural insurance products exist in the regulatory framework and to determine the most logical way to remove them without jeopardizing the soundness and solvency of the entire insurance industry.
    b. Hiring legal and financial sector consultants to help draft laws and regulations
    c. Educate and train staff responsible for the supervision of the insurance industry
    d. Help improve contract enforcement and consumer protection mechanisms

[38]Source: Interview with Jerry Skees, professor at the University of Kentucky and crop insurance expert.

3. Reinsurance
    a. Provide assistance to the local insurance industry in attracting private reinsurers interested in agricultural portfolios
    b. Provide subsidies to private insurance companies to purchase reinsurance or facilitate in bundling contracts
    c. Act as a co-reinsurer or direct reinsurer as a last resort
4. Disaster Relief Funds
    a. Design and financing of disaster preparedness and emergency relief funds aimed at dealing with the consequences of low probability but catastrophic events.
    b. Use innovative index insurance and bond instruments to transfer catastrophic the risk to international markets

Unfavored Uses of Public Subsidies to Promote Crop Insurance

In practice, special interest groups mobilize and lobby for a subsidy that benefits them but rarely is it known if the impact would be broader if the scarce public monies were spent on public versus private goods or one particular industry/sector versus another. Recent work by Ramon Lopez suggests that countries that dedicated a greater share of rural public expenditures dedicated to public goods rather than private goods, scored better on variables of policy concern, i.e. growth in agricultural output, reduction in rural poverty, and increase in rural employment (Lopez, 2004). A public subsidy toward the payment of a crop insurance premium is more of a private good than an expenditure on the eradication of an animal disease or investment in a rural university with research, teaching, and extension mandates. In the case of a catastrophe, where the welfare of many has been reduced and it has serious negative externalities, transfers to private individuals are warranted.

In general public subsidies should not be used for premium because of a host of implementation problems—identification, sustainability, development effectiveness, efficient targeting, and adverse selection

Theoretically, a case could be made to subsidize only the operational and administrative cost elements in the premium and not the pure risk element, otherwise investment decisions could be skewed to favor riskier crops than would be the case without the subsidy. It would be possible to raise a farm household out of poverty by providing subsidized insurance (Expected Utility with insurance could be concave curve greater than Expected Utility without insurance over a range). The beneficiary household could be placed on a higher income growth trajectory that would get it out of poverty and keep it out of poverty over time.

In practice, however, implementation problems loom large. Therefore, it is advisable le to apply scarce public subsidies to market development efforts rather than to private participation incentives. The implementation problems are listed below.

First, it is difficult to distinguish between what is the risk element and the other non-risk element in the premium—the identification problem. See the significant differences reported in risk premiums in section 4 using different estimation methodologies. In practice, the subsidy is

applied as a percentage of the total premium cost. To be theoretically consistent, one would have to calculate the "pure risk premium" for each policy or product and try to be certain that the correct yield distribution is being used. The additional effort and costs required to correctly "identify" the acceptable subsidy would be costly and even counterproductive.

Second, even if the identification problem could be solved, the non-risk elements could easily dwarf the pure risk premium and still signify large fiscal outlays. Overtime, the central government may find it difficult to continue making these outlays and the market will tend to grow only as a function of subsidy availability (sustainability). In practice, one sees start and stop patterns in the data and in several cases it can be traced back to the availability of subsidies, i.e. BANDESA in Honduras and Banco Agrícola-AGODOSA in the Dominican Republic.

Third, if the government is interested in pro-poor growth and reducing inequality as rapidly as possible, then a cost-benefit analysis may be warranted to determine how best to allocate scarce public monies. Government authorities should empirically decide whether if subsidizing crop insurance would generate higher rates of return than would the subsidizing other productive support services or investing in infrastructure such as rural roads, rural education, health services, potable water, sanitation, electrification, vocational training, agricultural research, or agricultural extension services (development effectiveness).

Fourth, government subsidy programs tend to be captured by the higher income persons unless mean testing or targeting is used. Historically, the subsidy on insurance premiums has tended to be captured by larger farmers in both the developed and developing world (Skees, 2002 and 2005; Goodwin, 2001; Makki, 2001; and Hazell, 1986 and 1992). Differential subsidies can be paid, wherein smaller farmers can benefit more but this would imply additional administrative costs to identify and verify who is a small farmer. Thus, a problem of efficient targeting problem may arise (efficient targeting).

Fifth and lastly, subsidies in practice tend to be a palliative for the problem of adverse selection. Insurance companies depend on premium subsidies to grow markets and overcome adverse selection. Without the subsidy, the lower-risk candidates would opt out of the market (Goodwin, 2001; 1993; Makki; 2001; and Just et. al., 1999).

In conclusion, it would be advisable to focus scarce public monies on developing the conditions favorable for the emergence of insurance markets and the development of low cost insurance products such as weather and area-yield indexes where the premium would be affordable without the need for a subsidy.

Recommendations

Fiscally stressed, low-income countries would do best on developing an integrated and layered risk management system and not view crop insurance as a panacea. Crop insurance is but one element in an arsenal of instruments and policies that a government may need to rely on in order to spur agricultural growth, improve agricultural competitiveness, and reduce farm poverty.

Adopt an Integrated Risk Management Strategy

A "layered risk management strategy" should be followed wherein a series of coordinated and reinforcing activities are pursued. The government, international reinsurance companies, national insurance companies, insurance supervisors, and farmers have to work together.
The cornerstone of the strategy is an effective and improved agricultural extension service that helps farmers educate themselves about risk management and to take individual on-farm actions to reduce vulnerability and mitigate risks.

1. Improved Extension Services
    a. Use improved seed and animal breeds
    b. Site plots away from flood plains, areas susceptible to land and mudslides, and avoid planting on easily erodible soils.
    c. Planting on time
    d. Use soil and water conservation aimed at improving fertility, increasing soil moisture, reducing soil borne diseases, maintaining soil structure, and reducing water run-off
    e. Use Integrated Pest Management whenever feasible
    f. Make environmentally sound use of pesticides and herbicides
    g. Apply fertilizer at the right time and the right amount
    h. Make greater use of drip irrigation
    i. Engage in crop diversification and rotational cropping
    j. Use good animal husbandry practices
    k. Use intercropping
    l. Adhere to animal and plant health inspection and control protocols
    m. Use of custom hire labor and equipment for timely harvest and post-harvest responsibilities

Once the farmer has adopted as many of these good management practices as possible, the farmer should try to avail him/herself to formal financial instruments and marketing contracts that are within reach in order to further reduce risk exposure.

2. Financial Market Improvements
    a. Use of formal savings
    b. Use of futures, options, sales contracts, guaranteed marketing schemes to control price risk
    c. Use of single peril insurance for idiosyncratic risks
    d. Use of area-yield and weather index insurance for non-catastrophic, covariate climatic risks
    e. Use of multiple peril, income, and revenue insurance products to stabilize income
    f. Use of reinsurance to lower premium cost and transfer risk outside the country to parties willing to bear it.

For risk that is not covered by these financial and market contracting instruments, such as severe earthquakes, massive volcanic eruptions, hurricanes of category 3 or greater intensity, massive flooding etc, the farmer will need to depend on government emergency assistance.

3. Improved Emergency Disaster Relief Systems.
    a. Non-reimbursable cash payments for immediate survival needs
    b. Temporary housing and allowances for relocation if necessary
    c. Distribution of in-kind materials
    d. Refinancing of existing loans
    e. Emergency low-interest loans for rebuilding and farm recovery

The government, however, should condition the level of assistance on demonstrated prudence and diligence--the adoption of good management practices, avoidance of excessive risk, and the use of formal financial instruments whenever feasible prior to the event.

Develop Crop Insurance Markets Sequentially

Interested parties should focus on the following sequential activities.

First, review of the legal and regulatory framework with particular attention to the following common impediments:

(i) Barriers to entry. Foreign companies should be free to enter as long as they are solvent and have a track record. Exclusion of foreign companies and reinsurers impedes the diffusion of technical know-how as well as price competition.

(ii) Reserve policies: The amounts that have to set aside for current risks should be consistent with the duration of the agricultural insurance policy and the loadings should not be for a catastrophic level.

(iii) Agents: Few restrictions as to who can be an insurance agent capable of selling insurance should apply. i.e. only an individual with specific training. Greater flexibility should be allowed for legal entities such as NGOs, cooperatives, farmer and community associations, and credit granting institutions to affiliate with a recognized insurance and serve as an indirect delivery platform. In the developing rural areas, indirect delivery mechanisms may be preferable to direct mechanisms in order to lower the fixed costs of establishing an extensive branching system.

(iv) Recognition of Parametric Instruments as Insurance Products and not as Derivatives: If parametric instruments are governed by capital market security frameworks, parametric instruments may never be widely adopted by farmers. It would be an instrument used primarily by corporations.

After a thorough review, steps should be taken to remove biases and to educate insurance market supervisors about recent developments in agricultural insurance. Because agricultural insurance is such a tiny fraction of the total policies, many supervisors are not knowledgeable about this specialty market.

Second, construct an information depositary that is easily accessible to insurance companies. The depositary would capture, transform, and clean data relevant to the design and monitoring of insurance products and policies. Information is vital to the measurement and evaluation of risk and is the bedrock of insurance underwriting. To design and price an agricultural insurance

product a slew of different type of information is needed. Some of the needed data are listed in the following table (Table 25).

Table 25:
Information Needs for the Development of Agricultural Insurance Products

Variable	Minimum Frequency of Capture	Ideal Frequency of Capture and/or Preferred Storage Form
Air Temperature	Daily Average with Max and Min. Range	Continuous Digitized
Soil Temperature	Daily Average with Max and Min. Range	Continuous Digitized
Precipitation (rain, snow, hail)	Daily, Weekly, Monthly, Yearly Cumulative by type and total	Intensity per interval Digitized
Wind	Avg. Daily Vector, Speed, with Max and Min. Range	Continuous Digitized
Relative Humidity	Daily Average with Max and Min	Continuous Digitized
Evapotranspiration	Daily, Weekly, Monthly Cumulative	Peak Periods in the day
Light Radiation	Daily, Weekly, Monthly	Digitized
Degree of Cloud Cover	Daily, Weekly, Monthly	Digitized
Hydrological flows in rivers as well as height of crests	Avg. Daily Volume, Weekly, Monthly. Daily highpoint, Daily low point	Continuous Digitized
Soil Moisture	Avg. at various depths that correspond to root zone of principal crops.	Digitized
Maps of Soil Types		Digitized and in GIS
Map of Cultivable Area		Digitized and in GIS
Map Relating Crops with Ideal Soil Types		Digitized and in GIS
Topographical Maps		Digitized and in GIS
Land Use Maps		Digitized and in GIS
Map of medium and large scale Irrigation Systems		
Demarcation of watersheds		Digitized and in GIS
Map identifying Flood Zones		Digitized and in GIS
Map identifying areas prone to Avalanches and Landslides		Digitized and in GIS
Maps with Political Jurisdictions		Digitized and in GIS
Overhead Images of Manmade Structures		Digitized and in GIS
Maps with Property Boundaries		Digitized and in GIS

Maps with title deed information		Digitized and in GIS
Satellite Images with False Colors to determine health of pasture, range, and forestry resources	Monthly	Digitized and in GIS
Satellite Images of National Territory and nearby area to track weather systems	Real Time	Digitized and stored as video stream
Yield	By crop by smallest political jurisdiction	By crop, by farm, Digitized
Prices	By crop, by time of year, by major marketing sites	Digitized
Area Cultivated	By crop	Digitized
Area Harvested	By crop	Digitized
Socioeconomic data from census or household surveys	By major producing regions	For whole country, all crops, all farm households
Cost of Production	By crop, by level of technology used, by region	
Farmer's Risk Attitudes	Representative Sample	Sufficiently large and disaggregated to permit comparisons by location, age, gender, race, level of education
Farmer's Willingness and Capacity to pay for insurance	Every 2-3 years	Every year
Income/Consumption/Wealth Survey	Every 5 years	Every 2-3 years
Agronomic Crop Growth Models that specify nutrient requirements (radiation, water, chemicals, minerals) and tolerances (to temperature, humidity, wind, etc.) through various stages of plant development.	For principal crops in major agroecological growing zones	For most crops grown in most agroecological zones
Input Use Surveys	Amount of chemical inputs used by typical farm households	Stratify and differentiate by various variables.
Livestock Consensus	Headcount updated every few years.	At least very 10 years
Map of Incidence of Plant Diseases	By major crops grown	Digitized
Map of Incidence of Infected and Sick Livestock	By most significant type of animal economically	Digitalized

Information systems that capture most, if not all, the above information and organize, clean, standardized, and made it readily available to the general public would greatly reduce the cost that each insurance company must bear at present if it wants to enter into agricultural insurance.

By having all the information consolidated in one place and to be confidently cleaned, and transformed, and standardized, would represent a tremendous savings to insurance companies and other interested parties.

Starting in the 1990s, public information systems began to appear in Latin America largely financed by international technical cooperation with the express purpose of facilitating better land use planning and land title regularization. These entities capture data from public as well as private sources of information. Once the information is cleaned and transformed it can be placed as layers in geo-referenced data facilitating spatial analysis of the data. More importantly, a wide number of different actors can use the same information for different ends. For example, banks can use the database to check title registrations and existence of liens for loan applicants. A hotel resort developer can search for the ideal location taking into account road access, location of major population centers, weather patterns, and scenic attractions. An insurance company can use the topological, crop use, and weather data and agronomic model to determine exposure to risks and calculate probable losses, i.e. a risk map.

In Central America, there are four public information systems.[39] The most advanced being Sistema Nacional de Información Terretorial (SINIT) in Honduras which by law receives data from a number of public agencies and then complements it with information from private sources such as Tela Rail Company and Standard Fruit to maintain a GIS database with over 3,000 layers. Via the web anyone can access the information and download it. The principal users are other government agencies. Other countries in Latin America should emulate this example.

Third, finance pilot experiments and support training for staff in the insurance industry. Agricultural insurance requires specialization and since it is an underdeveloped market segment, there are few people in developing countries who dominate all the intricacies. The pilot experiments should strive to develop products that are low-cost to administer, actuarially fair, easy to understand, and attractive to clients. Client participation in the design should be high.

Fourth, monitor and evaluate the pilots rigorous and make necessary changes.

Fifth, scale-up the experiences that are documented to be successful.

Sixth, educate farmers and policy makers about the limits and benefits of insurance.

Seventh, invest in and maintain the infrastructure and recurrent activities necessary to support information flows, i.e. weather stations, household surveys, marketing information (volume, price, grade transacted in different places), agricultural censuses, broadband internet infrastructure, aerial photo surveys, obtaining satellite images documenting land use and monitoring in real time of weather systems, improved internet connectivity and affordability, and construction of relational geographic databases.

[39] The systems are in Honduras, El Salvador, Nicaragua, and Guatemala and all grew of international cooperation projects to improve land use planning and title registration. Honduras is fully operational and open to the public. El Salvador and Guatemala should be on–line and fully functional within a few months.

Bad Practices to Avoid

Mandatory Insurance: Governments interested in promoting agricultural insurance policies should shy away from making agricultural insurance mandatory to access credit or guarantee loan programs. The insurance product, accordingly, converts into being "bank insurance" and do not force lenders and insurance companies to adequately measure and evaluate risks. Invariably, the private insurance companies demand backing from government to participate in such schemes or only publicly owned insurance companies would participate. At the end of the day, the government is using a roundabout scheme to guarantee a loan. The challenge is to reduce asymmetric information problems, reduce transaction costs, and increase profitability at the farm level.

Premiums Need to Adjust Frequently as New Information Becomes Available: Government run insurance programs tend to be reluctant to adjust premiums from year to year based on loss ratios and new available information out of political sensitivity. Policyholders tend to complain vocally about high premiums. The failure to adjust premium rates undermines program viability.

Set Insurance Sale Dates Well in Advance of Harvest Time and Honor Them: Selling insurance policies after closing dates, invites opportunistic behavior. More reliable and accurate information on weather becomes available the closer one gets to planting time. Farmers will use this information to their advantage. They will not buy if the weather forecasts are good leading to low income for the insurance company or they will pay buy if the forecasts are bad, leading to heavy losses for the insurance company.

Extending Insurance Coverage to All Regions and Most Crops: For political reasons, many government backed comprehensive agricultural insurance programs seek to extent "affordable" insurance to high-risk areas and to accept all clients regardless of management skills, character, and risk profile. This violates one of the Golden Rules—all risks are not insurable. Either the premiums should be set sufficiently high, active client screening engaged in, or the insurance company should withdraw.

Using Third Party Claim Adjusters: The monitoring and claim inspections cannot be delegated to third parties or strategic allies. The staff of the insurance company underwriting the policy should make the physical inspection to verify and make claim adjustments. To use third parties creates the risk of collusion and fraudulent manipulation between the policyholder and the third party.

VI. CONCLUSION

Agricultural insurance is a complex and difficult product to deliver in a sustainable manner. In the region, the agricultural insurance market is nascent but there are encouraging signs. More and more policymakers and farmers recognize the need for more modern risk management systems in order to stabilize incomes, prevent asset depletion, and to enhance competitiveness. Traditional risk management systems sometimes are not sufficiently robust to deal with the vagaries of weather and disease and as a result these uncontrollable events cause significant economic losses that negatively affect households, communities, and government themselves. Nonetheless, yield insurance must be kept in perspective. It should not be seen as a substitute for unprofitable farms, failures of farm management, changes in technology innovations, market access, disaster aid, or government policies that suddenly affect the rate of return. Neither should the provision of insurance be seen as a sufficient condition in order to improve agricultural competitiveness. If other necessary investments are not made in rural infrastructure, market information systems, and production support services, competitiveness will not improve.

Insurance, however, can be beneficial in improving access to credit by serving as a guarantee against involuntary default. On the other hand, insurance policies should not be made a mandatory condition to access credit because invariably such a dictum undermines both the bank's and insurance company's capacity to evaluate creditworthiness, measure risk, and assess farmer management capacity. Some farmers may have adequate on-farm risk management strategies and will be forced to bear additional financial costs in order to access credit. Many others will have no incentives to engage in on-farm risk management activities and will increase the loss probabilities of the insurance company. Markets that evolve spontaneously and are based on solid fundamentals tend to be deeper and more efficient in the long-run, i.e. Mexico since 1990 vs. state banks in Honduras and the Dominican Republic that depend on mandatory purchase of insurance in order to access credit.

Last but not least, developing countries should not convert crop insurance into an entitlement or disguised income transfer tool. Many do not have the economic wherewithal and it would be more advisable to keep insurance as a risk management tool.

In developing agricultural insurance markets, the role of governments is crucial. An action agenda was laid out—adjusting legal and regulatory frameworks, if necessary; developing public information depositaries easily accessible by insurance companies and others; training staff; educating farmers, policymakers, and superintendents; conducting pilot experiments; scaling-up activities; designing catastrophic disaster relief programs that do not undermine incentives to undertake on-farm risk management activities and/or to purchase formal insurance---that could serve as a model for operations. Moreover, it was argued that in this model, all public money should be spend on creating public goods and sustaining favorable conditions and not necessarily on subsidizing the insurance premium. The principal reasons for this allocation are based on efficiency and sustainability. Several different types of insurance products were reviewed—single peril, multiple peril, parametric, and revenue--- and their respective strengths and weaknesses were noted. Regardless of the product, the guiding criteria for design and implementation of products should be based on achieving the lowest administrative cost

possible, pricing for actuarial soundness, fostering transparency, and maintaining affordability. A tradeoff, however, does seem to exist between actuarially fair crop insurance schemes and the limited financial means of farmers in developing countries. Farmers prefer individual, multiple risk coverage but an actuarially fair premium would be unaffordable for most. Parametric products (indexes based on area yield averages or weather triggers) are less costly but imply basis risk and would be attractive to less risk adverse farmers. The historical record for writing multiple peril products is generally unsatisfactory and great caution should be exercised in expanding these products unless historical data exist that would permit reliable loss estimations and actuarially sound premiums are charged (UNCTAD, 1995; Hazell, 1992, Just, et. al, 1999). Greater emphasis and government support should be given immediately to developing information systems, modeling yield losses, quantifying degrees of risk aversion, determining better fits between individual losses and aggregate triggers so that less costly insurance schemes can be introduced that are attractive and of interest to low-income farmers. In the short- to medium-term, more attention should be paid to promoting better on-farm risk reducing and risk coping strategies through better extension services and the use of single peril and parametric products. Much work remains to be done to further develop agricultural insurance in Latin America and the Caribbean. Ripe areas for research and pilots include eliciting farmer risk attitudes, blending crop insurance with other financial products; using modern information technology to reduce costs; better modeling and understanding of weather phenomena and the impact of climate change; and improving reinsurance capabilities.

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