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**AGRICULTURAL INSURANCE
IN MESOAMERICA:
AN OPPORTUNITY
TO DEEPEN RURAL
FINANCIAL MARKETS**

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PREFACE

Agricultural insurance helps agricultural producers mitigate the effects of natural hazard shocks and enhance the efficiency of resource allocation. Interest in developing insurance products in the agricultural sector is growing in both the public and private sectors of Mesoamerica (Mexico and Central America). Demand for such insurance will increase as trade is liberalized, providing many opportunities for improving the competitiveness of the region's agriculture sector. Moreover, recent innovations in agricultural financial risk management offer possibilities for the region to overcome many of the limitations of traditional agriculture insurance. This study analyses the opportunities and challenges presented by agricultural insurance instruments in the deepening of financial services in rural areas in Mesoamerica. It outlines a public policy framework to guide the decision-making process. It concludes that, in order to support the competitiveness of the agricultural sector in the light of increasing trade liberalization and natural hazard risks, agricultural insurance should be at the forefront of the set of financial instruments to be developed.

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ABBREVIATIONS

AGROASEMEX	Agricultural Insurance Company of Mexico
AIP	Agricultural Insurance Pool
ANAGSA	National Crop and Livestock Insurance Company (Mexico)
ANFA	Asociación Nacional de Fondos de Aseguramiento (México)
AUR	Asociación de Usuarios de Riego - Water User Associations (México)
BANRURAL	Banco Nacional de Crédito Agrícola (México)
CAFTA	Free Trade Agreement between Central America and the United States
CNA	National Water Authority (Mexico)
DRP	Disaster Response Product
FIRA	Fideicomisos Instituidos en Relación con la Agricultura (México)
FONDOS	Mutual insurance funds (Mexico)
INETER	Instituto Nicaragüense de Estudios Territoriales (Nicaragua)
INISER	Instituto Nicaragüense de Seguros y Reaseguros (Nicaragua)
INS	Instituto Nacional de Seguros (Costa Rica)
ISA	Instituto de Seguro Agropecuario (Panama)
MFI	Microfinance Institutions
NAFTA	North American Free Trade Agreement
RPG	Regional Public Good
SINIT	Sistema Nacional de Información Territorial (Honduras)
SNET	Servicio Nacional de Estudios Territoriales (El Salvador)
SNIG	Sistema Nacional de Información Geográfica (Guatemala)
SPRV	Special Purpose Reinsurance Vehicles
SRL	Sociedad de Responsabilidad Limitada (México)
VAR	Value at risk
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Agricultural insurance can help producers manage their financial exposure to natural hazard shocks and enhance the efficiency of resource allocation. Agricultural insurance markets in Mesoamerica, however, are underdeveloped. Moreover, in developed and developing countries alike, agricultural insurance is often used as additional income transfer mechanisms by governments, which results in market distortions, making the impact of future natural hazard shocks even worse. Some recent innovations in agricultural insurance instruments have the potential to serve as an effective tool in Mesoamerica to deepen rural financial markets, overcoming many of the limitations of traditional insurance instruments in reaching small-scale agricultural producers.

This study analyses the opportunities and challenges presented by agricultural insurance instruments to deepen financial services in rural areas in a sustainable manner. It presents a public policy framework to guide the decision making process of public support and interventions. The focus is primarily on the role of insurance to financially manage (and transfer) agricultural production risks that are too large for self-insurance to cover, yet not catastrophic to the point that government and international disaster aid would be necessary.

Trade liberalization will provide many opportunities for increasing the competitiveness of the region's agriculture sector, and thus increase demand for financial risk management instruments such as agricultural insurance. All the countries in Mesoamerica are increasingly moving toward trade liberalization: notably Mexico (through NAFTA); Panama (in negotiations with the United States); and the rest of Central America (except Belize) (through the recently signed Free Trade Agreement with the United States, CAFTA). The necessity of improving the competitiveness of the agriculture sector within a given time frame is another compelling reason to support the development of agricultural insurance. The challenge and opportunity lie not only in increasing coverage for export crops but also in reaching producers of staple crops, who are mainly the rural poor. Index-based insurance instruments can play a pivotal role in bringing financial services to rural areas and to small-scale farmers that will be in much need to adjust to new market conditions.

A paradigm shift is underway in the way agricultural insurance contracts are structured. The recent innovations range from institutional and technological advances that reduce the cost of product delivery and verification of losses under traditional schemes to a complete restructuring of risk analysis and insurance contracts being offered. The restructuring of the risk analysis and insurance contracts is index-based. When combined with the different instruments offered by financial markets, it offers a radical change in the approach to agricultural production risk management—one that improves upon the drawbacks of traditional insurance. The index-based insurance instruments present some challenges, most of them surmountable.

Especially in Central American countries that are not be able to afford direct agricultural insurance subsidies for all producers, the public sector must focus on supporting innovative agricultural insurance instruments that have the potential to reach the rural poor, such as index-based products.

Mesoamerican governments should consider supporting the development of the agricultural insurance market with great interest, but also with great caution. Public policies, as the vast

international experience demonstrate, could also result in the opposite effect, making future natural catastrophes even worse. In Mesoamerica and especially in Central America, where public resources are scarce, programs should follow a strict analysis of the social opportunity costs of such public investments and the effects that these may have in distorting agriculture production decisions—and thus making the sector less competitive in the current trade liberalization environment.

Thus public policy intended to support the development of the agricultural insurance market must start by layering the risks and addressing the necessary public goods and services for buyers and sellers of such instruments to expand the market and innovate to accelerate expansion. Policy areas that top the list are an adequate regulatory and legal framework, a reliable and extensive public information system (including the necessary infrastructure to collect and process climatic and agricultural data efficiently), clear rules for catastrophic interventions in rural areas, and a regional integration (harmonization) of such public goods and services to make it more attractive for private insurance and reinsurance companies to enter the market.

If and only if the necessary public goods and services are being provided to their fullest potential should direct support to the sector be considered—keeping in mind that such incentives for the supply and/or demand of insurance must be efficient, equitable, and should not distort production decisions by farmers.

Countries with publicly owned insurance companies should consider further opening the market to private firms. All countries should focus on providing the public goods and services needed to lift the barriers for market development. The Mesoamerican agricultural sector is increasingly more integrated with international markets. To support the transition of small-scale producers toward higher value added crops and to increase the competitiveness over time of agro-exports, agricultural insurance should be at the forefront of the set of financial instruments to be developed to help rural producers reach higher sustainable levels of welfare over time.

I. INTRODUCTION

A. A Typology of Agricultural Risk

Farmers face a variety of risks that call for agricultural insurance. These risks include both natural hazards and man-made risks (see Table 1.1). Some agricultural risks are beyond the control of the farmer (natural catastrophes, international financial crisis). Others are controllable, such as reduced variations in river water flows. Some are controllable to a certain extent, such as the effects of local institutions and certain plagues and diseases. The occurrence of these events is not necessarily predictable and thus producers are not necessarily equipped to manage the risks. The welfare benefits to farmers of having agricultural insurance have been clearly demonstrated (see Appendix A). Conversely, uninsured natural hazard risks, such as excess or deficit of rainfall, are a significant cause of lower efficiency and lower average incomes, as well as higher income inequality (Rosenzweig and Binswanger 1993).

Table 1.1 Agricultural Risks

Climatic	Hail, frost, drought, flood, wind, fire, snow, ice
Biological	Plagues, diseases
Geological	Earthquakes, volcanic eruptions
Market	Domestic and international price variability and changes in quality standards
Man-made	War, financial crisis, collapse of legal institutions

Source: Zorilla (2002).

Risk can be managed before and after the fact (*ex ante* and *ex post*). Three main approaches can be used: risk reduction (*ex ante*); risk mitigation (*ex ante*); and risk coping (*ex post*). *Risk reduction* can occur in several ways: through the diversification of income sources, such as through off-farm employment; through migration (away from hazardous areas); and through investments in hazard-resistant technology, such as irrigation systems and pest-resistant seed varieties. *Risk mitigation* activities include crop insurance and saving. *Risk coping* strategies can range from reduced consumption to selling assets to obtaining loans from formal or informal sources (Charvériat 2000; Larson, Anderson, and Feder 2005; Skees and others 2002).

An important consideration is whether risk is systemic or idiosyncratic. *Systemic risk* affects an area, sector, or group of people aggregately. It cannot be mitigated by diversification of production (Ibarra 2003). *Idiosyncratic risk* affects areas, sectors, or individuals heterogeneously: that is, one person or area is affected differently than others. It can be offset by the diversification, such as diversification over space (working and/or owning various plots in different geographic areas), diversification of inputs (depending on various sources of water, labor, fertilizers), and diversification of crops.

Numerous factors influence whether a risk is idiosyncratic or systemic. For example, the way in which risks are pooled can determine how individuals are affected by the risk. Geographically diverse pools of agricultural risk tend to be less systemic, some analysts assert (see Larson, Anderson, and Feder 2005). However, since individuals are unable to control the geographic

environment in which they reside, unless they choose to migrate, a greater concentration of individuals may choose to dwell in areas offering more opportunities. Those areas are often homogeneous in agroecological and geographical characteristics. Thus the risks borne by individuals in those areas are often more systemic than idiosyncratic.

Natural hazards can be both systemic and idiosyncratic. The classification can vary across levels, such as geographic location. For example, an earthquake may be a systemic risk for all households within a specific community that lives near a fault line; however, a comparison of communities that live close to and far from the epicenter may indicate the risk is idiosyncratic at the community level. Similarly, hail poses an idiosyncratic risk; the effects are random and adversely affect individuals differently.

The ability of a household to preserve a consistent level of consumption over time, despite risks, is what determines the efficiency of financial risk management tools. The greater the component of systemic risk, the lower the probability of being able to manage risk effectively and independently through informal mechanisms, such as borrowing among family members, neighbors, and friends (Larson, Anderson, and Feder 2005).¹ So, although households may have a diverse set of alternatives (mostly informal strategies) available to protect assets and maintain stable consumption, these options are limited in the extent to which they can contain risk, particularly when risk is systemic.

Systemic risk in agriculture is characterized by the presence of *covariate risk*. That is, when one producer is hurt by an event, it is likely that other producers will also suffer. This relationship applies at a more macro level, as well. If the agricultural sector is hit hard by some natural or man-made phenomenon, sectors that are linked to agriculture—such as the rural non-farm sector—will suffer correspondingly.

Agriculture risks that are beyond the control of individual farmers can be divided into production and price (or market) risks. *Production risk* relates to the climatic, sanitary, and geological risks that have a direct effect on agriculture production. *Price risk* relates to market fluctuations (see Table 1.1). This study focuses only on managing and transferring production risks. However, a growing literature and a number of initiatives have developed promising instruments for developing countries to hedge price variations in their crops (for a discussion of price risk management in developing countries, see Varangis and Larson 1996). Furthermore, according to the recent survey of the insurance industry by the Inter-American Development Bank (IADB) and the Inter-American Federation of Insurance Companies (FIDES), demand for revenue-based agricultural insurance (an insurance instrument that provides coverage under a combination of the quantity and selling price of a crop) is an area of growing interest from the private and public sectors in developed and developing countries (Webb, Masci, and Velarde 2005).

B. Objectives and Structure of the Study

Innovations in agricultural insurance instruments have recently been introduced in developing countries and have the potential to overcome many of the limitations of traditional insurance in reaching small-scale agricultural producers. Recognizing the increasing interest by the public

¹ Such informal networks are part of the risk management tools that households in rural areas use to smooth consumption over time.

and private sectors of Mesoamerica in developing agricultural insurance products, this study analyses the opportunities and challenges presented by agricultural insurance instruments to deepen financial services in rural areas in a sustainable manner, and presents a public policy framework to guide the decision making process of public support and interventions.

The study is structured as follows: Section II describes the shortcomings of traditional insurance instruments in reaching small-scale producers in developing countries. Section III reviews the opportunities and challenges of innovative agricultural insurance instruments. Section IV presents the agricultural insurance market situation in Mesoamerica. Section V addresses the public policy issues related to the development of the agricultural insurance market in the region. Section VI summarizes and concludes with some basic public policy recommendations for the development of the agricultural insurance market in the region.

II. PARADIGM SHIFT IN THE AGRICULTURAL INSURANCE MARKET

A. Some Limitations of Traditional Agricultural Insurance

Traditional agricultural insurance consists of multi-peril or single-peril insurance instruments that require an insurance adjustor to physically verify assets (*ex ante*) and losses (*ex post*) on an individual farm basis. Under *single-peril insurance*, indemnities are paid for losses incurred for a single risk, such as hail or fire. Under *multiple-peril insurance*, indemnities are paid for losses incurred from a broad range of risks.

Generally, the availability of insurance (of all types) for agriculture has been limited. Certain developing and developed countries have well-established and functioning insurance systems. However, most of these systems have traditionally been run and/or heavily subsidized by federal governments and operate in incomplete markets. This has undermined their efficiency, as well as the extent to which producers can obtain access. Small producers may easily be excluded from such traditional insurance schemes because of their inability to pay the premiums charged by insurance companies.

Traditional agricultural insurance products are limited in their ability to protect most agricultural producers efficiently and effectively because of their numerous structural design characteristics. These can be classified into market and government failures (see discussion below). These failures and limitations are demonstrated by the high expense-over-revenue ratio of some government-subsidized insurance programs (see Table 2.1). This ratio, also called the Hazell ratio, is calculated by taking the proportion of indemnities paid (I) plus administrative costs (A) over the premiums collected (P). If the Hazell ratio is more than 1 (as is the case for all of the countries in the sample), the program is not financially sustainable on its own and needs external (usually fiscal) support to operate. A Hazell ratio of more than 1, and especially of more than 2, also reflects weak justification for such instruments in terms of economic efficiency, since such programs become simply an additional channel through which to provide resources to farmers.

Table 2.1 Agricultural Insurance Programs: Costs vs. Premiums

Country	Time period	(I + A)/P
Philippines	1981–89	5.74
Brazil	1975–81	4.57
Japan	1985–89	4.56
United States	1999	3.67
Mexico	1980–89	3.65
United States	2004	3.60
Canada	2004	2.90
Costa Rica	1970–89	2.80
Japan	1947–77	2.60
United States	1980–89	2.42

Source: Skees and others (2002); Pikor (2004).

Like many other forms of insurance, traditional agricultural insurance suffers from the problems arising from asymmetric information: that is, insurers have different knowledge about the risks facing the insured than the insured themselves. The asymmetry of information produces adverse selection and moral hazard problems.

Adverse selection in insurance markets refers to the situation in which insurers find it impossible or very expensive to distinguish between high-risk and low-risk insurance applicants. Thus they price insurance contracts at the average premium for all individuals. This results in undercharging high-risk customers and overcharging low-risk customers for identical contracts. Over time, the low-risk clients drop out of the market. The insurance company is left with a pool of very high-risk clients with higher than expected indemnities, which negatively affects the insurer's profitability. *Moral hazard* refers to the situation where the granting of an insurance contract can lead clients to reduce their use of good husbandry practices or completely alter their production practices, resulting in higher loss claims (Wenner and Arias 2003).

These two problems affect all insurance markets, but are worse in agricultural ones because obtaining information on clients is more difficult and monitoring client behavior is more costly. Because clients in rural areas are geographically disperse and the production characteristics of each farm are highly differentiated, the administrative costs of effectively monitoring effort and differentiating between legitimate and fraudulent loss claims can be prohibitive. On the other hand, if the "coverage of loss" is set too low, to discourage carelessness and negligence, the market can become very thin and the advantages gained by pooling risk types—the essence of insurance intermediation—is lost. As a result of these two incentive problems—adverse selection and moral hazard—private insurance is generally not available, and if it is available, it is not affordable to the majority of farm operators.

As for public support to manage agricultural production financial risk, government assistance has been characterized by subsidies to insurance schemes and the provision of disaster aid. When

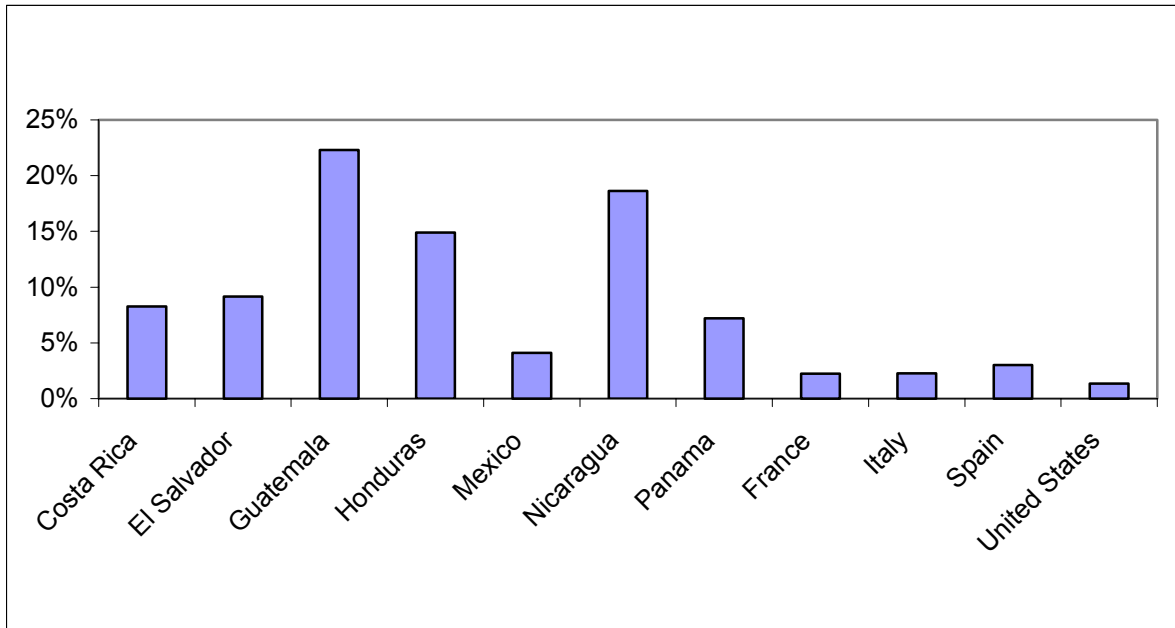
events prove to be sufficiently catastrophic, governments dispatch such disaster aid, usually with the support of the international community. The government's participation in any market has the potential to crowd out the private sector. Agricultural insurance markets are no exception.

The way in which disaster aid is offered and administered by governments and the international community introduces further distortions since free and un-explicit assistance is provided when damages prove to be sufficiently large, thus reducing potential clients' interest in and willingness to pay for insurance. The ambiguity of a threshold for the provision of disaster aid creates additional distortions that make it difficult for private markets to operate and reduces the willingness of potential clients to purchase insurance (Skees and others 2002). From the supply side, insurers may be reluctant to offer agricultural insurance if it is unknown at what point and level the government will intervene to provide assistance. However, if government actions and decisions are clear and transparent, insurance providers will have more confidence operating in the market. On the demand side, agricultural insurance, offered at market prices, is less desirable to producers if they expect the government to provide either subsidized insurance or free assistance. A producer would have to be highly risk-prone and risk-averse to purchase agricultural insurance in the presence of potential, yet unconfirmed, government interventions. Additionally, the government's presence in financial agricultural risk management has the potential to foster riskier behavior by producers (Mahul 2001). In general, agricultural producers should not rely on disaster aid since it does not apply to all agricultural production risks. It is generally allocated for sudden, large-scale natural events (such as hurricanes) but rarely for those events that materialize over time (such as droughts) but which are a major source of production insecurity for producers (Skees and others 2002).

Overall, traditional insurance has many limitations in developing countries with a productive structure that is heavily composed of small and medium-size farmers and that have a relatively large agriculture sector relative to the overall economy (see Figure 2.1). Furthermore, the fiscal costs for Central American countries to provide a direct subsidy to agricultural insurance instruments at the level of developed countries in an equitable and efficient fashion will prove prohibitive.

Beyond the informational asymmetries that distort the soundness of the insurance market, the market is segmented by its inherent structure and potential clients' capacity and willingness to pay. Clients that are potentially excluded include the rural poor and the landless. The rural poor are often excluded since premiums may be set above their ability and willingness to pay for insurance. Individuals that work on other farms go unprotected since traditional insurance is linked to farmers' own crop production. Finally, insurers in the agricultural sector of developing countries also suffer a degree of marginalization in seeking to transfer and share their risk through reinsurance markets; reinsurers are biased toward serving the larger U.S. market (Skees and others 2002).

Figure 2.1 Share of Agriculture in GDP, Mesoamerica, 2003 (Constant US\$2000)



Note: Figures are computed in constant U.S. dollars.

Source: World Bank (2004).

As noted, traditional insurance can be divided into single-peril and multiple-peril insurance. Single-peril insurance is generally provided by the private sector, while multiple-peril insurance is provided or heavily subsidized by the government. The scope of private traditional insurance markets is restricted because of the prevalence of systemic risk among producers. Moreover, covering all perils is complicated for private insurers because of the limited reinsurance possibilities and capital availability in domestic financial markets (Goodwin 2001).

Government crop insurance programs are often multiple-peril. Although the larger scope of multiple-peril insurance offers greater protection to producers, recognizes the variety of problems that can lead producers to incur losses, and has been the most widely used, such a system fosters risky behavior (moral hazard) among clients and provides no incentive for clients to diversify their risk management strategies. Further, the pool of clients is already one of higher risk since poor data availability makes it difficult to calculate the probability of loss for individual clients accurately, thus creating the traditional adverse selection problem (Goodwin 2001). Finally, in terms of efficiency, the U.S. experience has demonstrated that the premiums collected under multiple-peril crop insurance are insufficient for covering indemnity payments and administrative costs, presenting yet another drawback to this system (Mahul 2001).

B. Innovative Agricultural Insurance Instruments

In recent years, a variety of new mechanisms have surfaced that overcome many of the problems faced by the traditional agricultural insurance schemes. The recent innovations range from institutional and technological advances that reduce the cost of product delivery and verification of losses to a complete restructuring of risk analysis and insurance contracts. The restructuring of the risk analysis and insurance contracts is index-based. When combined with the different instruments offered by financial markets, it offers a radical change in the approach to agricultural

production financial risk management. The new instruments function on the basis of setting indemnity payments to be contingent on an objective index reaching some trigger level. The protection granted to clients is therefore based on the assumption that the index is correlated with production losses to a certain degree. The two main categories of index-based insurance products are area-yield and weather-based index products.

1. Weather-Based Index Instruments

Weather-based index insurance can be structured so that insurance contracts are written with individual clients under the agreement that indemnification will occur given a trigger event. Payouts are made if the index hits a pre-specified threshold level in a given time period. The event is measured by an index, which is determined by the correlation of historical weather events and crop yields, such that the probability distribution of the event can be estimated and the event measured. The index can be one of a variety of weather indicators, such as rainfall accumulation, temperature, humidity, wind speed, or days of sunshine, all of which are validated by an independent third party and are correlated with an individual's damages from the event. The index is used to determine the occurrence and magnitude of the event stipulated by the insurance contract. There is no on-farm verification of losses. Therefore, indemnification occurs for the insured at the onset of the indexed event, whether or not the insured suffered losses from the event for which insurance was purchased. Given the structure of the contract, weather-based index insurance allows individuals to mitigate against production risk through a method that is independent of individual production.

Alternative risk transfer mechanisms, available through international and domestic financial markets, consolidate the up-front improvements of weather-based index insurance. These instruments extend beyond the scope of insurance. They are parametric, just like weather-based index insurance; their payout is based upon a weather parameter or index reaching some pre-determined level. The index is assumed to be correlated with agricultural losses. Perhaps the most widely used form of these alternative risk transfer mechanisms are *catastrophe (CAT) bonds*, developed in the mid-1990s. CAT bonds are securities issued by insurers, via reinsurance companies or Special Purpose Reinsurance Vehicles (SPRV), to provide access to large amounts of capital given an event that incurs damages of catastrophic proportions.

Another instrument is *index-based weather derivatives*, such as temperature or rainfall-based options.² These can also be applied to agricultural production to hedge production risk. Certain characteristics distinguish them from weather-index insurance contracts. Notably, they do not respond to an insurable interest. Whereas insurance offers protection from high-risk, low probability events, derivatives tend to deal with high-probability, low-risk events. Derivatives also have the benefit of being based in financial markets where a larger number of participants do not necessarily have insurable interest. This allows for larger hedging capacity and liquidity, unlike insurance contracts, which are explicitly between the insurer and the insured.³ Temperature-based options have been used primarily by the energy sector on the Chicago

² *Options* are contracts between the option writer (the seller or principal) and the option holder, who purchases the contract, which grants the right to execute the deal stated in the contract. *Put options* involve the right to receive a payout if a certain price or index is attained. *Call options* grant the right to make a payout if a certain price or index is attained.

³ That is, unless the insurer hires an SPR to transfer risk through reinsurance in the case of catastrophic events.

Mercantile Exchange. These options are highly useful in hedging risk where a strong positive correlation exists between temperature, energy prices, and the income of the energy sector. Rainfall-indexed derivatives have been developed more recently, recognizing that weather derivatives need not be limited to temperature-based indices. The implementation of rainfall indices is more complicated than for temperature indices since there is greater variability within a given geographic area in obtaining rainfall measurements than for obtaining temperature readings (Moreno no date).

2. *Area-Yield Index Insurance*

Area-yield index insurance can be considered a medium step between traditional insurance and weather-based index insurance. Like weather-based index insurance, the insurance contract specifies indemnification if an objective aggregate index, such as crop or livestock yield, is lower than a specific threshold. Similar to traditional insurance, area-yield indexes are based on an aggregate output indicator. However, for area-yield insurance, the index is the average production yield within a pre-determined area, often at the county level. If average yields are below a pre-specified threshold yield, producers insured with such a contract may receive indemnity payments. Area-yield insurance, then, is less correlated with the individual producer than traditional insurance, but still maintains a degree of association, since average yields are based on an aggregate of individual producer yields (Chambers and Quiggin 2002).

If the region covered by area-yield insurance is sufficiently large, the output of any marginal producer cannot make a significant impact on aggregate yields (by the law of large numbers and because it would be harder for the group of producers to collude). Nonetheless, the region covered by an area-yield contract must only be large enough so that only those producers who face similar conditions and risks are in the specified region. Expanding the area of coverage beyond such defined natural (agro-ecologic) limit would bias the index such that it would not be representative of the risks borne by the producers who purchased the area-yield insurance. Similarly, setting the area coverage too narrowly would not properly eliminate or reduce the systemic risk against which indexed insurance intends to protect producers (Ramaswami and Roe 2004). However, if a region of coverage is properly defined, since the payout is not made on an individual basis, moral hazard is reduced or eliminated and an incentive is created for producers to improve their risk reduction and mitigation strategies to minimize their losses. This is because payouts are not based on individual performance but rather on the average yield. If average yields are below the threshold and an individual's yields are not, he or she still receives a payout, thus rewarding those producers who improved their risk management more than the average producer.

Weather-based index insurance (and derivatives) are much like single-peril insurance since the index by which indemnification occurs deals with a unique risk⁴. Payouts occur, therefore, based on factors that generate losses at the individual level. Area-yield index insurance is comparable to multiple-peril insurance, since aggregate yields can fluctuate for numerous reasons. The index assumes a correlated risk among the producers within a given region, but indemnification is not contingent on a specific event occurring. Payouts are based on the effects of one or more unidentified factors that reduce aggregate area yields. However, the potential for weather and

⁴ Some index insurance can also incorporate more than one weather risk, for example use the combination of temperature and rainfall to arrive at the risk of drought.

area-yield index products to expand the agricultural insurance market is superior to single- and multi-peril traditional instruments because of their capacity to minimize asymmetric information problems such as moral hazard.

III. BENEFITS AND CHALLENGES OF INDEX-BASED INSTRUMENTS

A review of the benefits and limitations of index-based insurance demonstrates that although this innovation faces challenges in developing countries, it has the potential to yield positive net benefits to both the suppliers and consumers of the insurance instruments.

A. Benefits

The overarching benefit that unifies all forms of index-based risk management tools is the reduction or near-elimination of moral hazard and adverse selection from the insurance market. Recall that a payout occurs with indexed insurance when an index moves positively or negatively beyond a pre-determined threshold, rather than being triggered by a specific loss in production. The method by which a payout occurs is based on an event whose occurrence is not tied to client behavior, since the payment is based on the intensity of a weather index rather than a weather event's explicit impact on yield (Mahul 2001). By eliminating the individual determination of indemnification, moral hazard is reduced or eliminated (Skees and others 2002).

The transparency and objectiveness of the index system further reduces moral hazard. The measurements of such indices are performed by independent entities (such as meteorological centers) exogenous to the insurance contract. If the system is tamper-proof, the occurrence of a weather event is independently verified and is not subject to manipulation. The greater level of transparency fosters confidence in the system and is likely to increase participation, on both the demand and supply side (Pollner 2000). Increased participation in the market generate opportunities for insurance holders to reduce their risk further by undertaking complementary risk management activities, such as self-insurance, which can have indirect welfare-enhancing effects (Ehrlich and Becker 1972). Payout schedules are based upon events independent of actual production. Thus the client has a clear incentive to minimize losses by improving risk reduction strategies so that if indemnification were to occur from a weather-related risk, the client could actually gain from indemnification, rather than merely cover losses. The benefits of improving risk management are two-fold. The producer benefits from increased output. The producer's income stream is improved from indemnity payouts as well as the additional income gained from improving production. This is particularly the case with area-yield index insurance.

Index-based insurance also reduces adverse selection in the market, which is reflected in the lower price of the contracts. Premiums are calculated according to three criteria: the transparency of the risk, administrative costs, and transaction costs. Under the indexed system, the costs associated with each component are lower. The risk component is based upon the probability of the trigger event occurring, not upon the probability of the insured experiencing losses (although these probabilities are correlated). Therefore, it is unnecessary to supervise and/or monitor each client. This lowers administrative costs. Further, transaction costs are lower since the channels by which a contract can be obtained, and by which indemnification is received, are more direct. The reduction in premiums makes the insurance accessible to a greater pool of clients, of different risk profiles.

More importantly, since individual-level data are not needed, the availability of individual data for calculating the premium is no longer an issue. The data needed to calculate premiums and

indemnities are for climatic events, which may be found in meteorological centers. Thus information asymmetries are nearly eliminated, generating a more efficient market.

The use of these innovative instruments has indirect benefits, as well. Since these products could insure against natural hazard events, they can ease the fiscal burden of providing assistance following natural disasters. In particular, when insurers reduce their risk exposure by obtaining reinsurance abroad, the government can reduce its role in providing disaster aid. This is particularly the case if a significant share of producers participate in the insurance and reinsurers take advantage of international capital, issuing such products as CAT bonds and transferring systemic risk abroad. This is a likely step for the agricultural insurance market, since taking on weather-based index securities is a way for investors to diversify their portfolios because weather indices are uncorrelated with the fluctuations in international capital markets. In turn, additional capital is brought into the agricultural insurance markets on a scale beyond which a government could provide under catastrophic insurance schemes.

From the producer standpoint, the indexed insurance instruments are beneficial since they offer protection in terms of income, output, and quality and are not mutually exclusive of other insurance products (see Box 4.1 and Appendix B). A producer has the option to combine indexed insurance with other risk management tools: even other insurance products that protect against individual crop yields (Piccioni 2002). Finally, from the perspective of financial markets, insurance companies, and financial institutions, being able to access such instruments in international (and domestic) financial markets is very attractive for portfolio diversification. Stock and bond markets are quite uncorrelated with climate fluctuations, especially in developing countries.

The equity component of indexed insurance also must be recognized. This kind of insurance is particularly useful in reaching out to insure the poorer segments of society, including those in remote rural areas. Its administrative and monitoring costs are low. It also creates the incentive for producers to pursue parallel risk reduction and mitigation strategies (Keipi and Tyson 2002). Furthermore, the attainment of insurance can serve as a vehicle for obtaining credit since formal lenders may recognize an insurance contract as (at least partial) collateral when other, traditional forms of collateral, such as a land title, are not held—as is common among poor, rural producers. In certain situations, lending institutions even require an insurance contract for an individual to receive a loan (Hogan 1983).

B. Challenges

There are two main limitations related to index-based insurance. The first one is the introduction of basis risk for the client. *Basis risk* arises when not all clients suffer the same extent of loss yet receive the same indemnification. Those who suffer the greatest losses are unlikely to receive coverage for the true extent of their losses. Basis risk can be temporal, spatial, or crop-specific, since at those levels, producers are affected differently from the same risk factors. *Temporal basis risk* indicates that production is influenced at different levels by climatic factors at different stages of growth. *Spatial basis risk* captures the geographic variability in factors affecting yield, even within the same region. *Crop-specific basis risk* reflects variations in factors such as opportune planting times, the length of the growing season, and the sensitivity to temperature and moisture across different crops, thus affecting production (Miranda and Vedenov 2001).

As with any risk, however, the possibility exists for producers to hedge against it. For basis risk, hedging hinges on two criteria: whether the correlation between the index and individual yields

is strong and the index is well-measured; and whether the efficiency gains from using indexed insurance are high enough to bring down deductibles to the point where basis risk does not impose a cost for clients. The cost of basis risk is thus truly significant only if undertaking the insurance does not reduce the insured's value at risk (VAR). *Value at risk* measures the overall vulnerability of a producer to exogenous environmental (market, man-made, or natural) events (Skees and Leiva 2004). It is measured as the difference between expected revenue and revenue under a loss situation. If value at risk is minimized, then basis risk is correspondingly reduced. Options for hedging basis risk lower VAR such that indexed insurance is justified and significant losses are not necessarily incurred.

Another option for controlling basis risk is for insurance to be purchased individually within a group of connected producers, with the ex ante arrangement for indemnity payments to be pooled and distributed equitably according to losses incurred, or some other pre-determined criteria (Skees and others 2002). Finally, insurers can attempt to reduce the spatial component of basis risk by setting premiums based on locality, recognizing that losses are not distributed equally geographically. Similar action can be taken to deal with the differences in losses over time, by varying the indemnification level based upon the point in the growing season in which a weather event occurs (Skees and Ekh-Amgalan 2002).

The second main challenge is that for index-based insurance to function, a number of preconditions must be met. Good historical meteorological data and infrastructure must be available. Weather stations must be tamper-proof to ensure the transparency and reliability of data readings. Clients must understand the concept and structure of such index-based instruments. Insurance providers must have the knowledge of the statistical dynamics of the index in order to undertake the risk analysis to design the instrument. Risk pooling and risk transferring mechanisms across regions or internationally should be available (in the form of aggregate risk pooling or reinsurance).

Most of these pre-conditions or problems are surmountable with the proper investments in data-gathering infrastructure, plant-growth modeling, planning, and structure of the insurance system, and an education campaign and technical assistance for the potential insured and insurers. However, the need for risk pooling and risk transfer mechanisms is somewhat of a challenge for individual countries, especially in Central America, since reinsurers depend on a minimum market size to penetrate with their services. This implies that the region must approach such agricultural reinsurance market *as* a region and not on an individual basis. If innovative financial instruments are to be used, a good institutional environment must be in place in which the government has a supervisory and regulatory body to oversee financial market soundness. The implementation of a sound institutional, legal, and regulatory framework can help overcome some of the challenges described (see Section V).

C. Implementation Channels

There are many implementation channels for the agricultural insurance products described. Potential clients can be targeted directly by insurance companies, by local financial intermediaries such as banks or microfinance institutions, or through local cooperatives that may purchase contracts collectively (Slangen 2002). The overall implementation of the system can occur at the federal or state level. Each channel has its advantages and disadvantages. The underlying determinant of which channel to utilize rests on which one is available and which one minimizes the administrative and transaction costs for a given situation. Providers in countries

with more developed and sophisticated financial structure range from energy companies, insurers, reinsurers, and hybrid companies (that offer insurance, reinsurance, and derivatives) to banks and brokers (Banks 2002). These all may apply in developing countries; however, given the nascent nature of the agricultural insurance industry, the scope may be limited in the near term.

Some opportunities for agricultural insurance delivery may arise from cooperation among rural producers in the same or neighboring communities. For example, cooperatives can be formed with the purpose of becoming mutual insurers by purchasing area-yield insurance and distributing indemnity payments appropriately, according to losses among the producers in the coop. Similarly, producers can act collectively to self-insure against losses and seek reinsurance from larger entities.

To reach rural producers, particularly small-scale farmers, collaboration is necessary with other entities already established in rural communities. Insurers can partner with financial service providers that function in rural areas and have greater knowledge about the client pool and the risks they face. Such financial service providers may be local banks or microfinance institutions (MFIs). MFIs are a particularly good channel, given the linkages between credit and insurance described above. Microfinance institutions can couple their operations of small loans for micro-business development with agricultural insurance products. They can even operate as explicit insurance delivery entities (Skees and others 2002). Non-governmental organizations can collaborate with MFIs already functioning in rural communities that have pre-established relationships, as well as greater knowledge of those communities than private external actors. Thus they may more effectively explain and possibly garner interest in the various mechanisms for hedging risk.

The regulatory agency (*superintendencia de seguros*) and the legal framework in which the agricultural insurance companies operate play a fundamental role in implementing such innovative instruments. Experience in other regions and most recently in Nicaragua has shown that it is important to have a regulatory body that is up-to-date with the innovations in this sector to better analyze the technical notes⁵ and proposals for introducing new insurance instruments in the market. Regulatory issues such as considering a weather-based index product, a financial derivative, or an insurance instrument are key questions that the regulator needs to address by having the knowledge of the mechanisms and structure of such instrument. As discussed in Section V, specific activities can be implemented in each country to bring training and knowledge to the regulatory bodies and public sector officials involved in the supervision of the sector.

Index-based insurance products and other innovative ideas have met with success in several countries. In Morocco, farmers have complemented their drought risk management techniques of water conservation, drought-resistant seeds, food storage, investments in livestock, and non-farm employment with rainfall indexed insurance (Skees and others 2001). Producers in India have purchased monsoon-index insurance to deal with flood risk. These contracts have also given the insured the option to establish a risk management account in which half the premium is

⁵ Technical notes refer to the technical documentation presented to the regulator about the details of the insurance instrument. This documentation must be reviewed before the instrument can be approved.

deposited into an interest-bearing account; these funds can be withdrawn if indemnity payouts provide insufficient coverage for losses. This arrangement reduces basis risk (Hess 2003).

To date, the implementation of innovative agricultural insurance products has been successful, but not widespread. The few examples of insurance products working in Malawi, India, Mexico, Morocco, and Mongolia indicate the feasibility of the contracts in developing countries and the possibility for overcoming the obstacles to indexed insurance. A key factor in the success of an innovative insurance product is that the product be tailored to the local context. If this is possible, through participation and transparent procedures, the products can garner local support, which is critical for the survival of these and any new projects.

IV. AGRICULTURAL INSURANCE IN MESOAMERICA

A. Mexico

1. Historical Perspective and Current Situation

Agricultural insurance in Mexico dates to 1942 and has evolved considerably since then, making Mexico a leader in the use of innovative agricultural insurance instruments. The early attempts in agricultural insurance were through mutualist arrangements and private insurance companies. In 1961, the Crop and Livestock Insurance Act was passed, formally establishing the State-run National Crop and Livestock Insurance Company (ANAGASA). ANAGASA began operations in 1963 and clients of State development banks, Banco Ejidal and Banco Agrícola (later merged to form Banco Nacional de Crédito Agrícola–BANRURAL), were obliged to purchase crop insurance policies. The policies were multiple-peril, premiums were subsidized, and the cultivated area insured was large. Unfortunately, losses for ANAGASA were staggeringly high due to lax monitoring, actuarially unsound pricing, and fraud (filing of false claims). At one point, indemnity payments represented 70 percent of BANRURAL's loan recoveries (BANRURAL has now become Financiera Rural). Eventually, the fiscal cost was deemed unacceptable and ANAGASA was closed in 1988 (Wenner and Arias 2003).

In 1991, a new government crop insurance company, AGROASEMEX, was formed to provide direct insurance to farmers; to reinsure local private insurance companies and mutual insurance funds (FONDOS); to serve as a technical adviser to the FONDOS; and to manage the federal premium subsidy program. AGROASEMEX was also given the task of developing the market through private intermediaries. Thus it has a key developmental role in the market, which allows the institution to invest public resources in innovative instruments that could serve as pilots for expansion of risk coverage. The risks covered in the Mexican agriculture insurance market are drought, excess moisture, frost, hail, fire, wind, plant infestations, livestock diseases, accidents, incapacity, and forced sacrifices. The products offered are for investments, expected yield, and greenhouses. Under this voluntary insurance program, the area insured has more than tripled (from 636,000 hectares to 1.9 million hectares) and livestock coverage has jumped from 576,000 heads to 9.7 million heads from 1991 to 2000. The area, however, was much less than the area covered by the predecessor, ANAGASA. However, AGROASEMEX's program is more cost-effective than ANAGASA's (Hernandez Trujillo 1997; Wenner and Arias 2003).

In 2001, AGROASEMEX made a transition to become solely a reinsurance company and undertook a first attempt at using weather derivatives and index insurance. The instrument introduced was a derivative (call option) for a series of 11 climate indexes to hedge the exposure of its assumed reinsurance portfolio from private insurers from low risk but high probability

weather events. Since then, AGROASEMEX has embraced the concept of indexed insurance. Two recent initiatives include the use of parametric instruments to insure states against droughts and the use of satellite imaging to measure rainfall accumulation for insurance against floods. Another interesting innovation is the development of weather-based index for insuring water availability in irrigation districts (Appendix B). This has the potential to change the way the Mexican insurance sector looks at index-based instruments, demonstrating that the government (at the state level) is not the only potential client of such contracts.

Of all the countries in Mesoamerica, Mexico has the most advanced indicators in terms of penetration of insurance in the agricultural sector (see Appendix C). Not only are the levels of premiums and hectares covered large, but the proportion of cultivated land is higher, and a wider range of risks and crops are covered. Furthermore, over the past decade the development of crop and livestock insurance has grown rapidly (see Figure 4.1), with the role of private insurance companies and of FONDOS increasing. The debate has increased in recent years with regard to the role that the FONDOS play in the agricultural insurance market, their growth, the competition with and between private insurance companies, and the functions that AGROASEMEX has as an administrator of the subsidy, as a market developer, and as a reinsurer to FONDOS and private companies.

FONDOS are self-insurance funds that have been operating in Mexico since 1988. In 2003, more than 240 FONDOS provided insurance against agricultural production risks (including hail, drought, frost, floods, diseases, and pests) to their members, accounting for half (50 percent) of the total insured agricultural area in Mexico. The total annual liability of the FONDOS was approximately US\$400 million in 2003. FONDOS are non-profit organizations constituted by the farmers as civil associations. There is no need to provide any capital endowment, except members' willingness to associate. FONDOS pool crop yield risks from farmers with similar risk profiles. The concept of insurance through mutuality-type organizations was developed based on a sound insurance market approach (including proper underwriting of risks based on technical principles, constitution, and investment of adequate financial reserves, loss adjustment procedures based on technical guidelines, and rates developed according to sound actuarial methodologies), while taking advantage of mutuality-type organizational principles and structure of incentives to control transaction costs.

The FONDOS can not sell insurance to their members unless they have a proper reinsurance treaty negotiated before the beginning of any specific agricultural cycle of production. Since these organizations do not have capital to guarantee their solvency, they must buy enough reinsurance to guarantee that members will receive the full amount of indemnity in the case of a peril. The regulation requires that any reinsurance contract negotiated by the FONDOS should be defined to absorb any indemnities after the financial reserves of the FONDOS have been exhausted. Thus the regulations implicitly request an unlimited stop loss reinsurance treaty. Historically, the State-owned reinsurance company AGROASMEX has offered this unlimited stop loss program to the FONDOS. However, a new law is in place that opens the market for private insurers and reinsurers to provide coverage for FONDOS in the form of reinsurance or co-insurance. In fact, this year we observed the first reinsurance contract from a FONDO to a private reinsurance company. This contract was between Fortschritt, a FONDO in the state of Chihuahua, and the leading private reinsurer in Mexico, for the Fall 05'-Winter06' period. The government also supports a training program through AGROASMEX and through ANFA (Asociación Nacional de Fondos de Aseguramiento) to enhance the operations of the FONDOS.

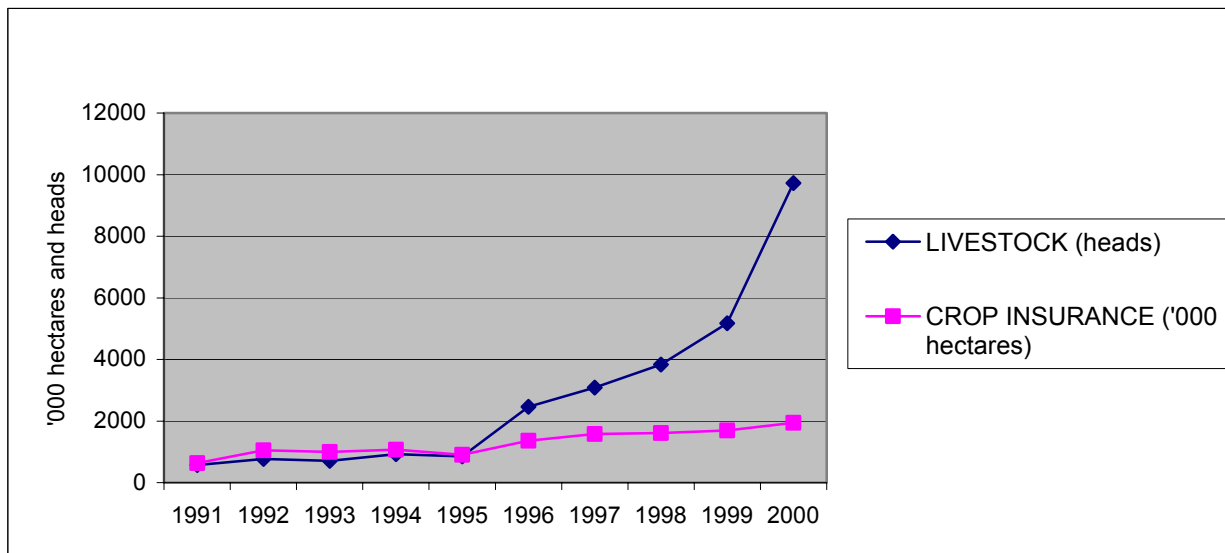
The training programs include technical aspects related to the underwriting and loss adjustment procedures, the development of new products, accounting, and legal aspects.

Since FONDOS do not exclude asset-rich farmers, the debate has centered on the crowding out effect that has resulted through government support to FONDOS and the equity aspects that such a program poses. However, the 2004 evaluation of the Agricultural Insurance Subsidy Program in Mexico shows that FONDOS work with a different client profile than the private insurance companies. An indicator of this difference is captured by the amount of land owned by the farmers insuring themselves through FONDOS versus through private companies. The average landholding for a farmer member of a FONDO is about one-third the size of a farmer that is insured through a private insurance company: 52 hectares, compared to 162 hectares.

FONDOS do not fall under the same regulations as private insurance companies, as they have different solvency criteria. This reduces costs for their members. FONDOS have performed well in the past decade. The Hazell ratio for the FONDOS has been 0.78 (including the government subsidy of 30 percent of the premium) and 1.08 (not including the subsidy) (Latin Risk 2005). This is a good performance by international standards for multi-peril agricultural insurance.

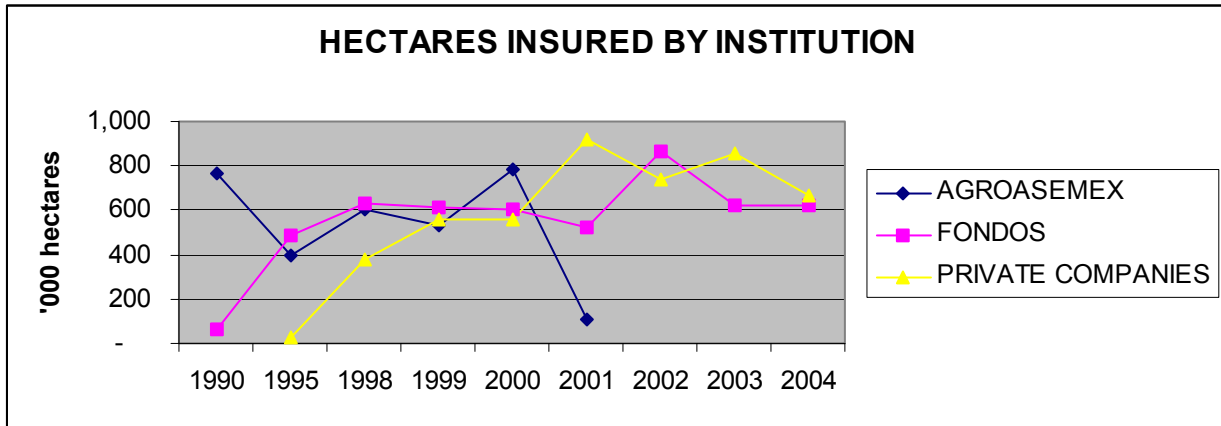
The private insurance market has been growing, especially in livestock insurance (see Figure 4.1) (although at least one private company has pulled out, following the Government of Mexico's recent elimination of the subsidy on the livestock insurance premium). FONDOS and the private sector have been growing the market in similar terms in terms of hectares covered.

Figure 4.1 Crop and Livestock Insurance in Mexico, 1991–2000

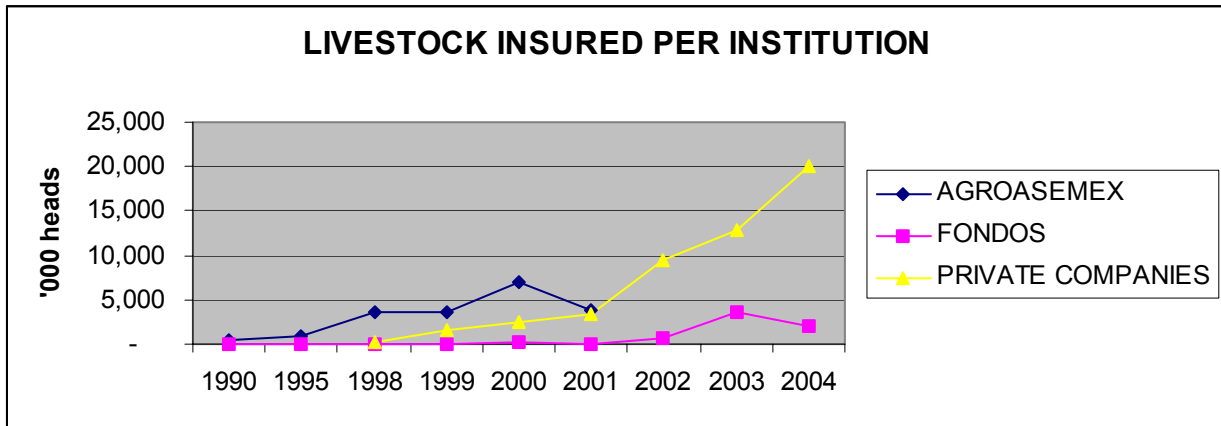


Source: AGROASEMEX (2003).

Figure 4.2 Hectares and Livestock Insured, by Institution, Mexico, 1990–2004
Panel A. Hectares Insured



Panel B. Livestock Insured

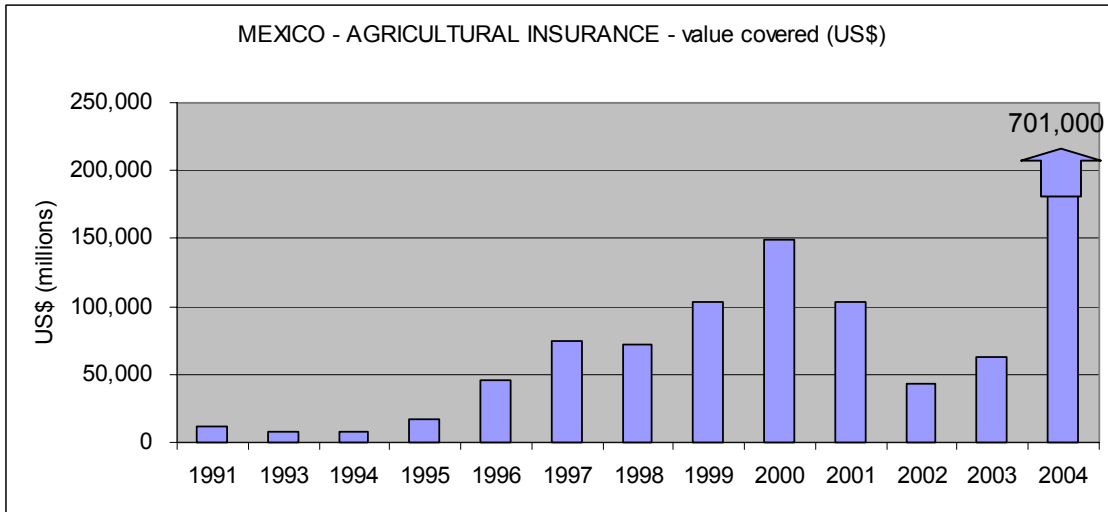


Source: AGROASEMEX (2004).

2. Market Trends and Perspective

Even though the Mexican agricultural insurance market has been growing in terms of hectares and overall coverage, the market is still relatively shallow compared to the penetration of other developed countries: only 9 percent of cultivated area (see Table 4.1). The pullout of AGROASEMEX from the agricultural insurance market in 2001 provoked a decline in coverage levels until recently (see Figure 4.3). However, in the past few years, the market, especially for livestock, has been growing exponentially.

Figure 4.3. Agriculture Insurance: Value Covered, Mexico, 1991–2004 (US\$)

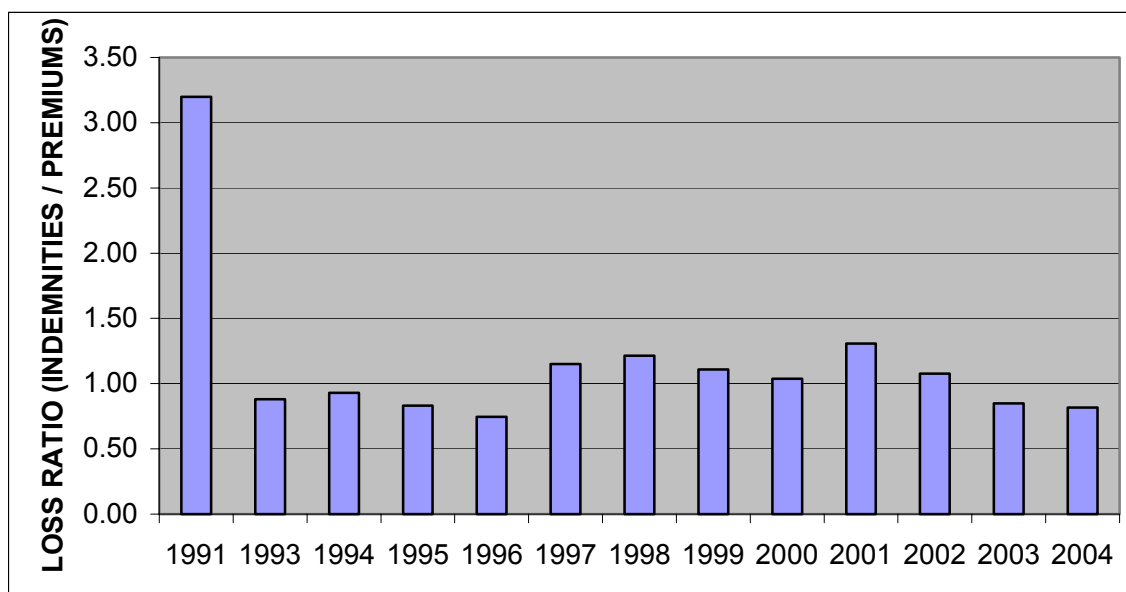


Source: Comisión Nacional de Seguros y Finanzas, México.

In addition to the steady but most recent growth of the agricultural insurance market, the loss ratios have shown some improvement.⁶ Loss ratios have always been above or very close to 100 percent (Figure 4.4). If administrative and operations costs are factored in, the Hazell ratio would be well above 1. How can a private insurance market operate under such financial conditions? The reason is that insurance companies are also obtaining returns from other financial products that have been placed using reserve funds, so the overall performance of the private insurance firm is not necessarily reflected only by the loss or Hazell ratio. The returns on financial products placed by insurance companies play a large role on the returns to the companies' activities in the sector. The market is showing an upward trend in terms of value, hectares, and livestock covered. The growth in livestock coverage has driven a large portion of the growth in Mexico's agricultural insurance sector.

⁶ These data do not include FONDOS.

Figure 4.4. Agricultural Insurance: Loss Ratio, Mexico, 1991–2004



Source: Comisión Nacional de Seguros y Finanzas, México.

AGROASEMEX, as a public development institution, has the instruments to play a pivotal role in deepening the insurance market in the agriculture sector, as well as the FONDOS. However, such deepening should be done keeping in mind the target population: those excluded from insurance coverage. Mexican public policy geared toward developing the agricultural insurance market should rely on the gains that its private sector has shown for the past decade in making insurance available to farmers, focusing on bringing additional and improved public goods and services to those companies and farmers that can expand coverage to untapped areas.

Table 4.1 Agricultural Insurance Coverage, Various Countries, 2000

	CULTIVATED AREA (million has)	INSURED AREA (million has)	Percent
United States	174.6	80.1	46 ^a
Canada	34.9	19.1	55
Spain	12.7	5.4	43
Japan	2.9	2.3	79
Argentina ^b	34.5	10.7	31
Mexico	21.9	1.9	9

^a The coverage ratio may extend to 70 to 75 percent if insurance for pastures is included.

^b 2004 data.

Source: AGROASEMEX (2003); Latin Risk (2005).

B. Central America

1. Current Situation

Agricultural insurance systems in Central America vary by country (see Appendix C), going from completely private, to mixed, to completely public. However, all these systems share the same characteristic; coverage is very low (not even 1.5 percent of the cultivated area). The crops with the lowest agricultural insurance penetration are staple crops. Export crops have the highest penetration, as expected (see Table 4.2).⁷ Most are fruits (bananas, plantains, melons) and reach 6 to 7 percent of total area cultivated in that crop in certain Central American countries. The exceptions are rice and cotton. Cotton has a 100 percent penetration rate in El Salvador because the government requires farmers to buy (subsidized) insurance in order to participate in the government-promoted program for cotton. Rice in Honduras faces a similar situation with credit and subsidies on interest rates of loans.

Table 4.2. Crops with the Highest Agricultural Insurance Penetration, Selected Central American Countries, 2002–04 (average)^a

Crop			
	Total cultivated area (has)	Insured area (has)	Penetration rate (percent)
Cotton (El Salvador) ^a	2,240	2,240.00	100.00
Rice (Honduras)	4,079	1,204.00	29.52
Cucumbers (Honduras)	1,130	256.90	22.73
Watermelon (Honduras)	683	101.64	14.87
Plantain (Guatemala)	6,800	494.60	7.27
Banana (Guatemala)	19,040	1,276.76	6.71
Banana (Honduras)	18,690	1,249.52	6.69
Cantaloupe (Guatemala)	5,880	389.40	6.62
Squash (Honduras)	300	16.46	5.49
Maize (Honduras)	322,850	9,800.43	3.04
Plantain (El Salvador)	2,000	49.00	2.45
Peanut (Nicaragua) ^a	20,918	440.30	2.10
Cantaloupe (Honduras)	6,349	85.40	1.35

Note: Shaded rows are export crops.

a. 2004 data, only, for El Salvador and Nicaragua.

Source: EEC (2005).

This low penetration, even for profitable crops such as fruits, reflects the very shallow and incipient agricultural insurance market in Central America. The future development of the market will depend on the institutional arrangements for such instruments. The discussion that follows places the countries into three groups: El Salvador, Guatemala, and Honduras in the first (completely private market); Panama and Nicaragua in the second (mixed, public-private); and Costa Rica in the third (completely public). Belize is not included because it does not have an

⁷ Crop-specific information on agricultural insurance was not available for Costa Rica or Panama.

agricultural insurance market.⁸ If an agricultural insurance market were to develop, Belize would fall in the first group, as its insurance market is completely private.

El Salvador, Guatemala, and Honduras have a very recent history in the commercialization of agricultural insurance products. Such products started to be offered in Guatemala in 2000 and expanded into Honduras in 2001 and El Salvador in 2004. These three countries have a relatively high number of insurance companies (not only agricultural insurance), with relatively high market penetration compared with the Central American countries in the other two groups (see Table 4.3).

Table 4.3 Insurance Systems in El Salvador, Guatemala, and Honduras, 2004

Country	Insurance companies	Premiums (US\$'000)	Profits (US\$'000)
El Salvador	14	339,252	24,338
Guatemala	18	309,254	19,232
Honduras	11	164,182	23,665
Total	43	812,688	67,235

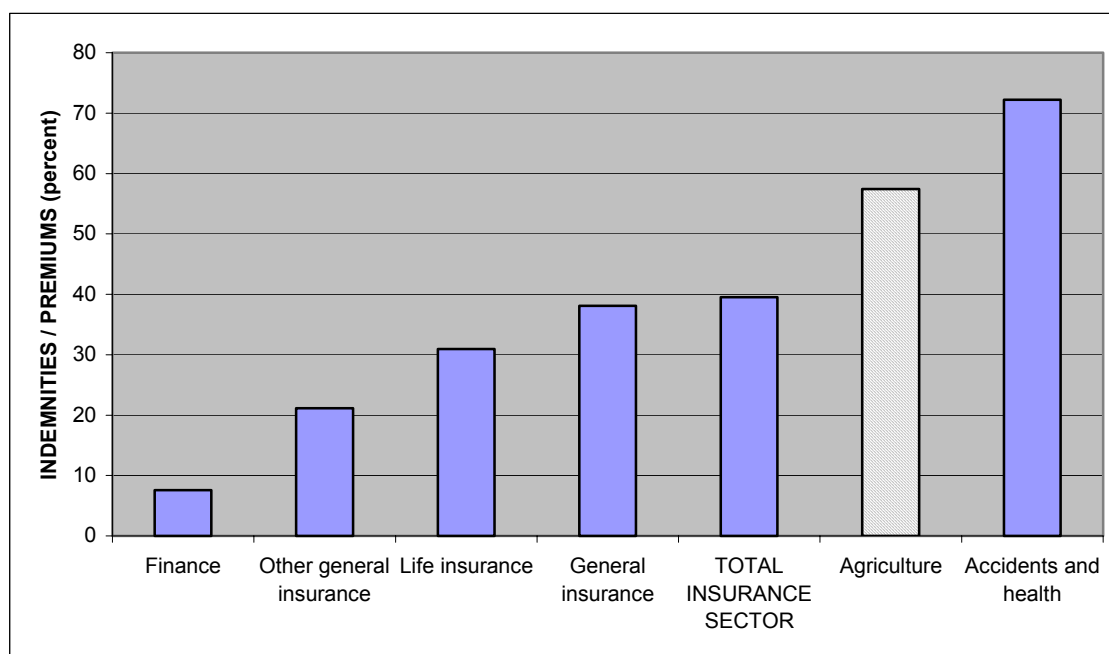
Source: Revista Moneda, 28/02/2005.

There is an inverse relationship between the size of the rural population and the development of the overall insurance market in the region. Financial services, such as insurance, tend to be concentrated in urban areas, and most of the insurance products offered in the region are for life, car, health, injuries, and theft—not agriculture. Thus El Salvador, with a relatively higher urban population, has a relatively larger financial (and insurance) market, even though its total population is half the size of Guatemala's. However, El Salvador's agricultural insurance market is the smallest of the three countries. Honduras, with the smallest overall insurance market, has the largest agricultural insurance market out of this group of three countries. So, even though Honduras ranks third of the three countries in terms of overall insurance premiums, it ranks first in amount of agricultural producers and hectares covered by agricultural insurance. Only six companies in El Salvador, Guatemala, and Honduras currently offer agricultural insurance (14 percent of the total number of insurance companies).

However, even among the insurance companies in Honduras that offer agricultural insurance products, the agricultural insurance premiums do not amount to even 2 percent of total premiums collected. Overall, the performance of agricultural insurance products in Honduras has not yielded great benefits to the companies. As the 2003 data in Figure 4.5 show, the loss ratio (indemnities over premiums) for agriculture insurance is higher than the average insurance sector, reaching 57 percent. For Guatemala, the loss ratio was 115 percent in 2001 and 64.5 percent in 2002 (CORECA 2003).

⁸ F&G Insurance used to offer insurance for banana plantations in Belize, but they have stopped. Various reinsurers have expressed interest in Belize; however, no product has been developed.

Figure 4.5 Indemnities over Premiums, Honduras, 2004



Source: CAHDA (2003).

Administrative costs for the industry in the region range between 28 and 30 percent of premiums collected, on average (EEC 2005). Administrative costs tend to be higher for agricultural insurance products, especially in the first years of operation. This places the Hazell ratio at close to 1 for Guatemala and Honduras, the limit of sustainability. For Honduras, as for the rest of the fully private insurance markets of Guatemala and El Salvador, this could reflect the fact that these programs are at the initial stages where the break-even point or the profitable stage has not been reached yet. It could also mean that some improvements in the framework in which these companies operate are needed for these products to become more attractive to the private sector. The agricultural insurance market is new and growing in these three countries. For it to accelerate its growth and reach into rural areas, especially to small-scale producers, specific public policies and programs are needed.

Nicaragua and Panama, the second set of countries, have a mixed (public-private) system. A private insurance sector co-exists with a public company that offers insurance services and that often competes with the private companies. In Nicaragua, this public company is INISER (Instituto Nicaragüense de Seguros y Reaseguro). In Panama, it is ISA (Instituto de Seguro Agropecuario). In Nicaragua, INISER co-exists with four other private insurance companies. However, it is the only company offering agricultural insurance. The only two crops covered so far are peanuts and rice. Agricultural insurance in Nicaragua started in 2004. INISER is looking at implementing new index-based instruments to expand its agricultural insurance market (see Box 4.1).

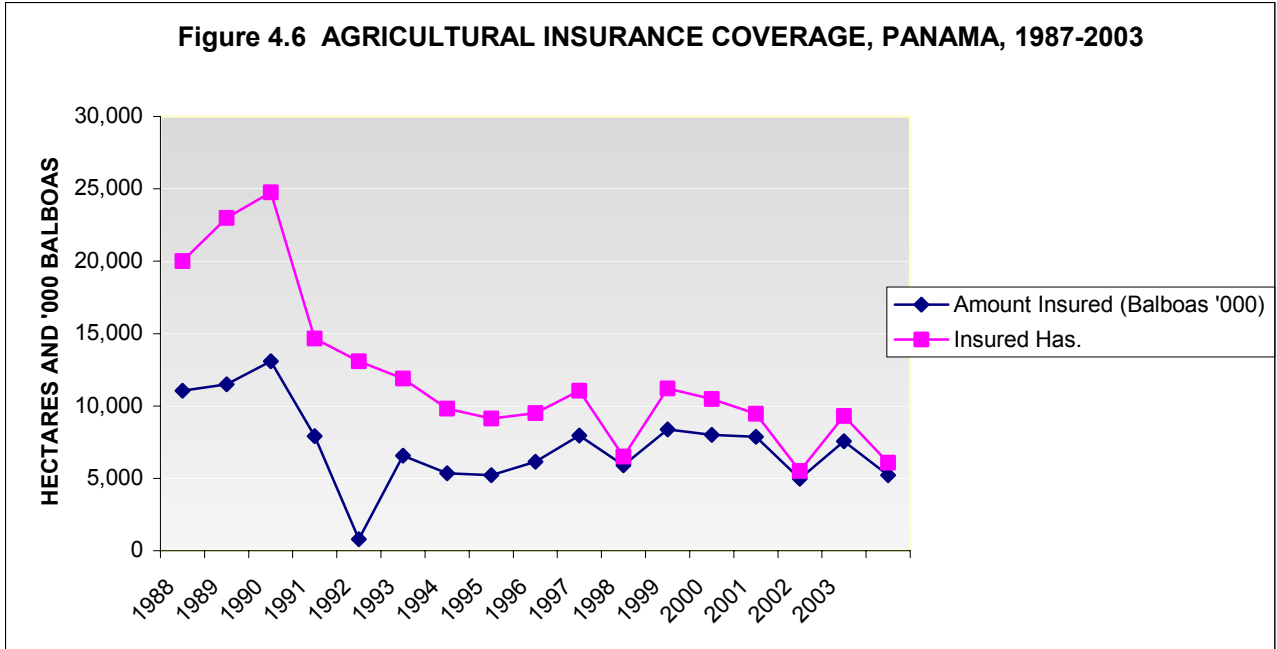
Box 4.1 Rainfall-Based Index Insurance in Nicaragua

With support from the World Bank, INISER (Instituto Nicaragüense de Seguros y Reaseguros) is implementing a pilot project in Nicaragua that offers index-based weather insurance to peanut producers in the regions of Leon, Tipitapa, and Chinandega. The insurance contracts indemnify peanut producers under three circumstances: drought (indicated by subnormal rainfalls), excess rainfall, and excess humidity.

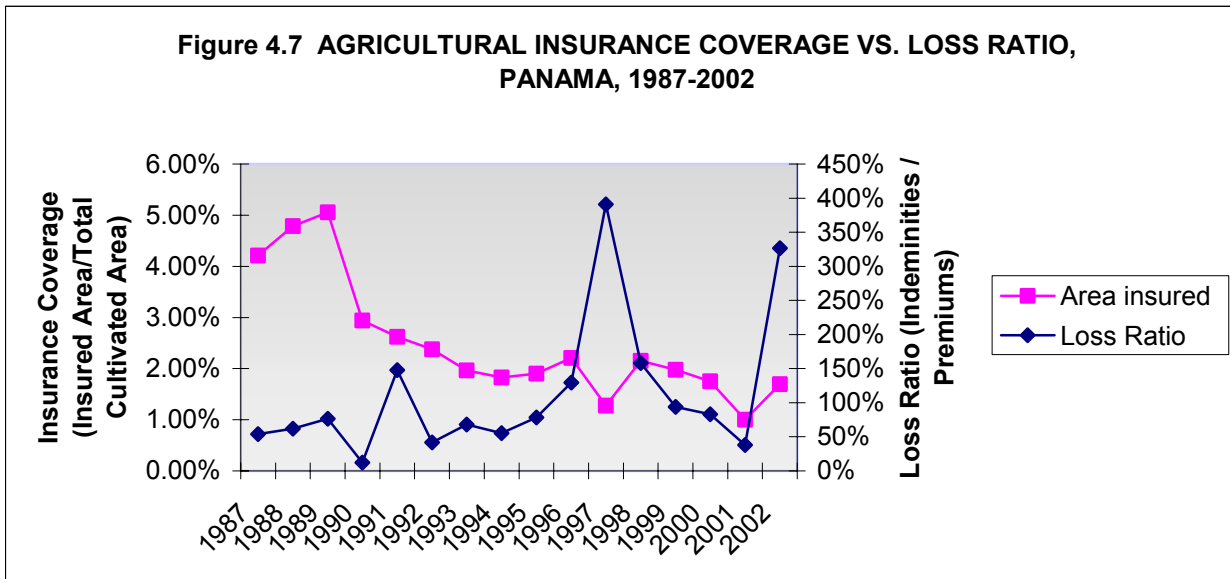
This new method addresses production risks unique to peanuts. Under traditional crop yield insurance, a producer is indemnified if production falls below a given *quantity*. Since peanuts are groundnuts, several days generally pass between the time the peanuts are picked and they are gathered. If the peanuts receive excess moisture in that period, the *quality* of the crop falls and the peanuts cannot be sold in market at top prices for quality nuts. The index-based weather insurance covers farmers for this risk in terms of its impact on the quality as well as quantity of the product.

Indexes that will reflect drought, humidity, and rainfall are being designed with the participation of various stakeholders, to make the contracts transparent and build confidence among the producers who are expected to seek insurance. The insurance contracts will be offered through INISER, a public insurance and reinsurance agency that holds about 40 percent of Nicaragua's insurance market. The substantial market share makes INISER a good agency through which to implement the pilot. Some obstacles to the success of the pilot are the projected demand for subsidies by producers, as well as the level of confidence the producers have in the institutions governing the insurance contracts.

In Panama, the situation between the public company (ISA) and the private sector is slightly different. Agricultural insurance has been offered since 1976. ISA has been offering multi-peril voluntary agricultural insurance to farmers in Panama for over 28 years. However (as seen in Figure 4.6), coverage has been steadily decreasing since the end of the 1980s and the area insured has never exceeded 5 percent of the total area cultivated. Furthermore, the loss ratio (insurance indemnities over premiums) has been increasing (see Figure 4.7), frequently surpassing the 100 percent mark. The average loss ratio since 1987 has been 96 percent, making the program financially unsound, considering that the Hazell ratio would surpass 1 by adding the administrative costs of providing insurance.



Source: ISA (Instituto de Seguro Agropecuario) (2004).



Source: ISA (Instituto de Seguro Agropecuario) (2004).

The fact that agricultural insurance penetration has been decreasing and that the ISA has become less financially sound over time has generated debate over the public policy toward agricultural production risk management, the future role of ISA, and the private companies that would like to penetrate the untapped market. Panama, like El Salvador, possesses a relatively developed financial market and a smaller rural-to-urban population ratio, making the potential benefits of agricultural insurance an attractive option for private financial institutions.

Costa Rica is in the third group since it is the only country with a full public monopoly over the insurance sector. The INS (Instituto Nacional de Seguros) has operated as the only insurance company in Costa Rica since 1970 and has been offering multi-peril crop policies. However, penetration does not exceed 1 percent of total cultivated area. Of the insured area, 90 percent is planted in rice and the remaining 10 percent is planted in plantains, tobacco, roots, cantaloupe, papaya, potatoes, beans, and maize. The predominance of insurance to rice producers shows the public policy focus to support rice producers. Premiums have not been enough to cover administrative costs and indemnities (the Hazell ratio exceeds 1). The INS covers this financial gap for agricultural insurance by cross-subsidizing it from the profits made through the rest of the insurance products it sells. This is done by an internal fund called the Agriculture Contingency Reserve (Reserva de Contingencias Agrícolas). Part of the overall INS profits go to support any shortfall in its agricultural insurance division.

2. Market Trends and Perspective

All Central American countries are increasingly moving toward trade liberalization. Panama is in negotiations with the United States, and the rest of Central America (except Belize) has recently signed a Free Trade Agreement with the United States (CAFTA). Trade liberalization will provide many opportunities for increasing the competitiveness of the region's agriculture sector, and thus increase demand for financial risk management instruments such as agricultural insurance. Such forces, coupled with the recent increase in the number and magnitude of natural disaster events in the region and the necessity of improving the competitiveness of the agriculture sector within a given time frame, are yet additional compelling reasons to support the supply and demand for agricultural insurance.

Not only is the agricultural insurance market of Central America shallow, but the crops covered are already export crops. This is good news, in that those crops that have potential to compete in international markets are already taking advantage of agricultural insurance. However, the crops that will be affected by trade liberalization (staple crops) have little or no coverage. Thus the challenge lies in increasing coverage to staple crop producers, who are mostly the rural poor. During the trade liberalization period, small-scale farmers will need financial mechanisms to adjust to new market conditions. Index-based insurance instruments could play an important role by complementing income support and financial resources of agriculture producer groups, NGOs, and MFIs, bringing financial services to rural areas.

In the particular case of Costa Rica, CAFTA⁹ will not only provide such opportunities and challenges for the agriculture sector, but will force the insurance market to open, providing a new and relatively more profitable market for private companies wanting to offer agricultural insurance.

V. A PUBLIC POLICY FRAMEWORK TO SUPPORT THE DEVELOPMENT OF THE AGRICULTURAL INSURANCE MARKET

Mesoamerican governments should consider supporting the development of the agricultural insurance market with great interest but also with great caution. The agricultural insurance market can prove very beneficial to deepening rural financial markets and increase the

⁹ Costa Rica's congress has not ratified the agreement. In the meantime, the sector remains closed.

competitiveness of the agriculture sector. However, inappropriate public policies—as the vast international experience demonstrates—could result in the opposite effect, making future natural catastrophes even worse (Barnett 1999) and enabling private agents (farmers and insurers) to capture public resources well beyond the initial start-up or market failure phase (Skees, Barnett, and Hartell 2005). In Mesoamerica and especially in Central America, where public resources are scarce, programs should follow a strict analysis of the social opportunity costs of such public investments and the effects that these may have in distorting agriculture production decisions and thus making the sector less competitive in the current trade liberalization environment.

The public policies required to develop the agricultural insurance market and explored in this section apply to both traditional agricultural insurance and new index-based insurance instruments. Indeed, an important factor in supporting the development of the market is not to discriminate between types of agricultural insurance instruments in the public policies and programs that support them, as all types of instruments are crucial for the deepening of rural financial markets.

The first step in providing public policy recommendations for the development of the agricultural insurance market in the region is determining why these markets are not already developed, especially in Central America. This discussion starts by noting that the very nature of crop yields—with highly skewed probability distributions with long tails—generates ambiguity and uncertainty for insurers and insured. This is worsened by the lack of infrastructure to collect and compile climatic and agricultural data and by the incomplete and poor quality historical data that exist in these countries to undertake reliable risk analysis (Skees, Barnett, and Hartell 2005). As a result of this ambiguity, farmers are less willing to pay the premiums being offered by the insurer. Accordingly, the penetration of such instruments is very shallow in the region, regardless of whether agricultural insurance markets are private, mixed, or public. However, the important difference among these systems is that private agricultural insurance system is financially sustainable, while the public system is not.

Public policies that relate to the development of the agricultural insurance market can be characterized into two large groups. The first is provision of the public goods and services needed to create an environment that will foster the development of the market, diminishing (if not eliminating) market failures and improving data access and reliability. The second group relates to the incentives that the government may provide directly to the private sector (insurance companies and/or farmers) to make the purchasing or selling of insurance more attractive. This second group of policies and programs has been where most of debate about agricultural insurance has centered. Indeed, it has often overshadowed the first group—which is what provides the necessary (and often sufficient) conditions for the sustainable development of the market.¹⁰

¹⁰ An interesting analysis would be to follow up on the current literature on the social rate of return of investments in private vs. public goods and look at the differential returns (in terms of market development) of resources allocated toward public vs. private goods that support the development of agricultural insurance.

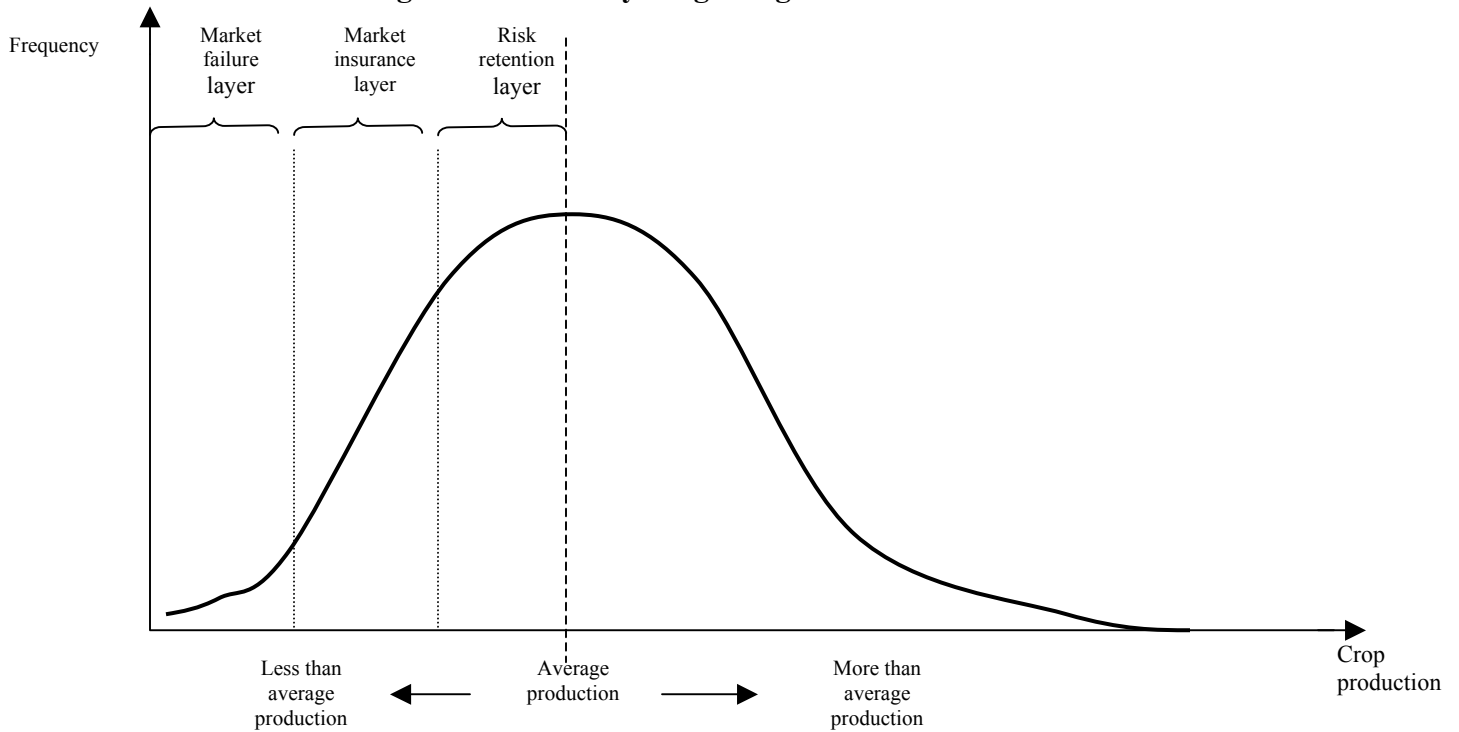
A. Public Goods and Services Needed to Support the Development of the Agricultural Insurance Market

Public policy responses to providing public goods and services for the development of the agricultural insurance market in Mesoamerica may be separated into four general areas: (i) managing and transferring the market failure risk layer (or catastrophic risk layer) of agricultural production; (ii) improving information systems (including the infrastructure to collect and compile data); (iii) improving the legal and regulatory framework; and (iv) harmonizing and pursuing a regional perspective for market development.

1. Disaster Aid Response and Management of the Market Failure Layer

Public policy intended to develop the agricultural insurance market must carefully layer the various risks and differentiate the policy response by the type of risk that needs to be addressed. The various risk layers are depicted in Figure 5.1, plotted against the probability distribution of agriculture production.

Figure 5.1 Risk Layering in Agricultural Production



Source: Authors' illustration, based on Hess and Syroka (2005).

Farmers have various alternatives for managing agricultural production financial risks when average production falls below the expected average. If the production shock is not large, farmers at the individual household level usually respond by borrowing from savings, moneylenders, family networks, or by smoothing consumption over time to the level that does not significantly affect welfare. These negative shocks fall under the “*risk retention layer*” shown in Figure 5.1, and refer to regular variation in production from year to year that do not call for the use of complex financial mechanisms.

The next risk layer is where financial instruments such as agricultural insurance can play a role. In the face of large negative production shocks, if agriculture insurance is not available, farmers turn to financial institutions for loans and other types of formal borrowing. If these do not exist (which is most often the case), farmers pursue asset-reducing strategies, which in turn tend to perpetuate poverty among low-income producers. On the other hand, when agricultural insurance is available, it is structured by following the layers shown in Figure 5.1. Insurers are not interested in offering coverage below or above the “*market insurance layer*” and farmers are not willing to buy it. Insurance contracts are written with a deductible (a defined amount above which the insurance will cover the additional costs of the losses). Amounts covered in the deductible fall into the “*risk retention level*.” Moreover, insurance comes with a maximum coverage amount, above which the insurance company will not provide indemnities. Insurers may exclude certain risks, including highly systemic shocks such as hurricanes or widespread flooding. These excluded risks, and risks above the maximum covered, fall into the “*market failure*” layer.

Much of the ambiguity that surrounds agricultural insurance is caused by low-frequency highly catastrophic events (catastrophes that occur at least once every 15 years). It is made worse by deficient or poor quality data. It is further exacerbated by natural disaster aid programs that are not explicit about the type of risks and coverage that they provide farmers. It is clear that in the third risk layer (market failure), the government has the role of pooling and transferring such risks. However, it is difficult to determine where the agricultural insurance risk layer ends and where the market failure risk layers begins. This difficulty can be traced to the lack of explicitness in natural disaster aid programs. Such problem can be seen not only in the emergency relief and coverage programs being offered by the governments of Mesoamerica, but also in programs of developed countries and by the financial instruments for natural disasters (loans) offered by international financial institutions to beneficiary countries. Even though it is not realistic to think that these natural disaster aid programs will change the way they function (many of the rules of operation are subject to political pressures of the moment), governments can take certain steps to reduce the ambiguity to farmers and insurers about when and how the government will intervene in case of low-frequency highly catastrophic systemic shocks (Box 5.1).

The first and foremost action that the government needs to take is to layer the disaster risk by exposure and frequency, identifying financial risk transferring mechanisms by layer and making natural disaster aid programs for rural areas as explicit as possible. Even though ex post adjustments to the rules of operation of such programs often happen and are likely in the future, a sincere effort needs to be made to reduce the ex post political interference in such aid programs, in order to reduce the variations of expected outcomes after the shock. Furthermore, the

Box 5.1 Steps to Improve Disaster Aid Programs to the Agriculture Sector and Rural Areas

1. Divide the disaster risks faced by agricultural producers into various risk layers according to frequency and exposure.
2. Identify current and alternative mechanisms for transferring aggregate financial risk by layer, as identified in Step 1.
3. Make rules about when, where, to whom, and what kinds of aid is to be offered by government and international donor-backed programs as explicit as possible in advance of any disasters, especially for rural areas.
4. Explore the introduction of disaster response products to complement and expand coverage of ex ante financial risk instruments by agricultural producers.

government can embark on devising specific natural disaster aid rules and programs for the agriculture sector that can focus on fostering the development of the agricultural insurance market. This can be done by targeting the market failure risk layer. Specific disaster response products can be developed that will provide specific coverage for farmers that correspond to triggers and characteristics of current and/or future agricultural insurance policies.

Such disaster response products (DRPs) (see Skees, Barnett, and Hartell 2005) could be administered directly by insurance companies or banks offering insurance and would be free for farmers. There are only a few examples of DRPs that are coupled with agriculture insurance instruments to farmers to expand the market. Mongolia, through a World Bank project, has implemented a scheme where an index-based (area-yield) insurance for livestock is offered to herders (see Mahul, Olivier, and Jerry Skees 2005). The risks are layered according to Figure 5.2 and the index is based on the livestock mortality rate at the county level. A stop-loss is defined in the insurance contract, beyond which a DRP covers the losses. Insurance companies cover losses when livestock mortality rates at the county level are between 7 and 30 percent. Beyond the 30 percent county-level mortality rate, the Government of Mongolia has structured a DRP by signing a contingent loan with the World Bank that effectively acts as reinsurance for such a catastrophic event. If livestock mortality rate exceeds 30 percent, the insurance companies stop paying the herders. The Government provides the additional coverage, through the World Bank contingent loan.

This DRP and related insurance instruments were structured because the Government of Mongolia found itself providing cash handouts and bailouts to herders each time a major climatic event (usually a combination of drought and low temperatures) killed large amounts of livestock. There was an urgent need to develop ex ante rules for providing such catastrophe assistance to herders and also providing incentives for the development of the agricultural insurance market and the sustainability and growth of access to credit and investments—and reversing the disincentives caused by inexplicit ex post disaster assistance.

Figure 5.2 Risk and Insurance Layering for Livestock Insurance and Reinsurance, Mongolia

Estimated frequency		Layer of risk
3 % of the time	Disaster response product (DRP)	Up to 100% mortality
15% of the time	Basic insurance product (Insurance companies)	Up to 30% mortality
83% of the time	Self-retention (Herders)	Up to 7% mortality

Source: Mahul and Skees 2005.

Such DRPs would not only provide structure in the public policy response to such catastrophic events, but would improve the efficiency of natural disaster aid programs that the government offers. Disaster response products for the agriculture sector could take different shapes and forms (such as CAT bonds, mentioned in Section II) and can be administered in many different ways. The governments of Mesoamerica should consider taking advantage of the potential of agricultural insurance in the region to design an improved rural financial coverage and response system to such systemic shocks.

2. *Public Information Systems*

As basic public goods and services, public information systems must be at the top of the public policy response list, not only for the development of the agricultural insurance market, but for the increased competitiveness of the region's agriculture sector. Access to good quality, timely, and historical information about agricultural risks and production is key to undertaking private and public responses to address the needs and opportunities of the agricultural and related sectors—particularly in light of increased competition from international markets for agricultural products (see Table 5.1 for a list of some of the information required).

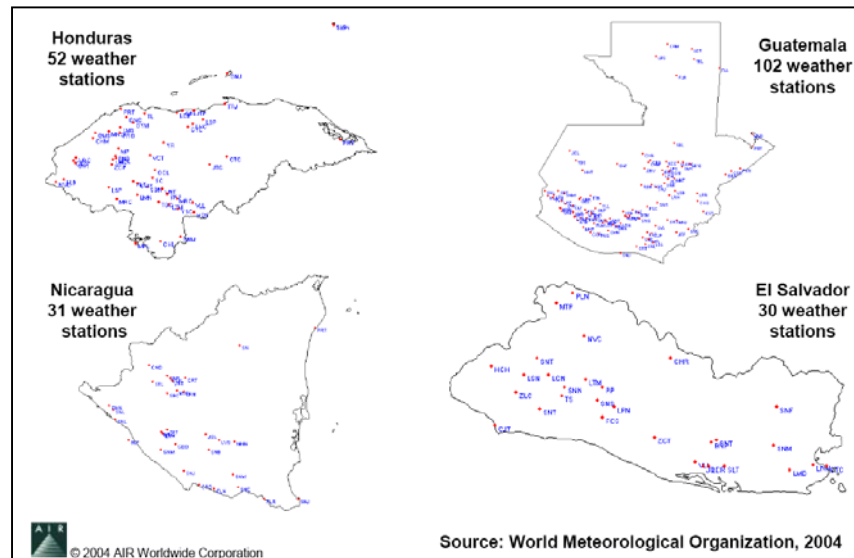
Table 5.1 Required Information for an Agroclimatic Risk Management Information System

Climatologic	
Parameter	Frequency
Air temperature	<ul style="list-style-type: none"> • Daily, minimum and maximum • Average (daily, weekly, monthly)
Soil temperature	<ul style="list-style-type: none"> • Daily, minimum and maximum • Average (daily, weekly, monthly)
Precipitation	<ul style="list-style-type: none"> • Accumulated daily, weekly, monthly
Evapotranspiration	<ul style="list-style-type: none"> • Accumulated daily, weekly, monthly
Relative humidity	<ul style="list-style-type: none"> • Daily, minimum and maximum • Average (daily, weekly, monthly)
Period of light	<ul style="list-style-type: none"> • Daily, monthly, weekly
Cloud coverage	<ul style="list-style-type: none"> • Daily, monthly, weekly
Agriculture	
Surface	<ul style="list-style-type: none"> • Per crop
Production	
Yields	
Cartografic	
Geo-political divisions	<ul style="list-style-type: none"> • Altimetry, planimetry
Hydrographic watersheds	<ul style="list-style-type: none"> • City, country
User access	
<i>Source:</i> EEC 2005	

Mesoamerica, especially Central America, lags behind in the area of information systems. There is a lack of infrastructure to collect and compile climatic and agricultural information. Meteorological stations certified by international standards are very scarce: there are only about

220 stations in Central America, compared to more than 9,000 in the United States (see Figure 5.3). Moreover, weather stations in Central America are usually near airports, reducing the data points available to analyze risks in remote rural areas. By contrast, coverage is much more complete in the United States. A map of U.S. weather stations would reveal almost no white spaces, unlike the map of Central American countries in Figure 5.3.

Figure 5.3 Weather Stations in Central America



There is a similar problem in terms of information on agricultural productivity, production costs, and general statistics on the sector. Agricultural censuses are conducted very rarely. General population surveys (household surveys) do not usually include information on agricultural production, although more household surveys, such as the Living Standards Measurement Study (LSMS), contain a section of questions on agriculture. Insurance companies and other financial institutions operating in rural areas must spend a substantial portion of their administrative costs to obtain information on agricultural production data such as climate, pests, and historic production yield. Such information is not only difficult to acquire but it is often not of sufficient quality or reliability, making it more difficult to bridge the problems of asymmetric information between insurers and insured.

Public information systems began appearing in the region in the early 1990s. Most of them were (and some still are) the result of international technical cooperation centered in the areas of agriculture, environment, energy, roads, and land surveying and administration (cadastre). The projects establishing such information systems were placed within various public structures, often duplicating efforts and information collection. Lack of funding from the central government after their establishment and institutional rivalries led some of them to disappear.

In recent years there has been a trend to re-implement such information systems, after certain natural phenomenon shocked the region—notably Hurricane Mitch (1998), earthquakes in El Salvador (2001), the adverse effects of El Niño, and the most recent flooding, land-slides, and volcanic eruptions in Central America (October 2005)—and underscored the need to store data

and make projections about such events. Various institutions in the region, such as CEPREDENAC and CRRH, are already collaborating with one another and with international organizations, such as World Meteorological Organization (WMO) and the U.S. National Oceanic and Atmospheric Administration (NOAA). At the national level, various centers coordinate and centralize information on natural disasters. Such centers can serve as a good basis for a national information platform. All the countries in Mesoamerica have initiatives that relate to such data coordination and centralization activities. Such initiatives aim to centralize and coordinate the data that relates to spatial variables, climate, hydrology, cartography, natural disasters, and other variables for various types of users.

Governments must support these initiatives, since they constitute key public goods and services. However this support should come not only in the form of financial resources but also through close coordination with agricultural insurance companies and other rural finance institutions that will be using such information. The objective could be to forge private-public partnerships where private financial institutions could pay for part of the services as a way to ensure that their information demands are met. The private insurance sector of the region views such a possibility with great interest, especially given the strict requirements from reinsurers (see Box 5.2 for some of the requirements listed by one reinsurer for structuring rainfall index insurance in developing countries).

Box 5.2 What is Needed to Make Rainfall Insurance for Agriculture Work?

Some market makers are keenly interested in offering rainfall index insurance in developing countries. For example, one reinsurer, PartnerRE New Solutions, presented the following list of items that are needed for them to consider offering such contracts:

- Historic weather data
- Prefer 30+ years of data, especially to cover extreme risk
- Limited missing values and out of range values
- Prefer less than 1 percent missing
- Data integrity
- Availability of a nearby station for a “buddy check”
- Consistency of observation techniques: manual vs. automated
- Limited changes of instrumentation/orientation/configuration
- Reliable settlement mechanism
- Integrity of recording procedure
- Little potential for measurement tampering

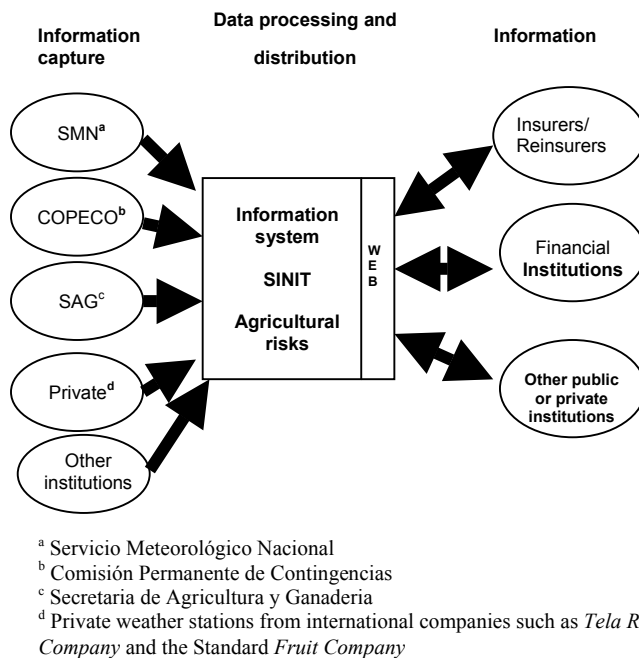
Source: Skees, Barnett, and Hartell (2005). Brian Tobben of PartnerRE New Solutions presented these items at the Annual Meeting of the International Task Force on Commodity Risk Management, jointly sponsored by the FAO and the World Bank at the FAO, 5–6 May, 2004, Rome.

Honduras is an interesting example of the initiatives that are being implemented across the region. A new institutional structure was created to obtain and consolidate the information for the administration and evaluation of climatic risks. Honduras passed a law (Ley de Ordenamiento Territorial) that declared SINIT (Sistema Nacional de Información Territorial) the official storage of all geographic, biophysical, socio-economic, and climatic information

collected by all public organizations. All public agencies that collect such information are obliged by law to transmit it to SINIT. SINIT has the obligation to make this information public and free of charge.¹¹ SINIT is working with the private insurance sector in Honduras so that the information they provide meets the requirements (in terms of quality, time-availability, and data desegregation) that risk analysts have to structure such insurance contracts. Figure 5.4 illustrates how these systems are being structured.

An information system like the one in Honduras works and is part of the reason why Honduras is relatively more advanced in the provision of agricultural insurance. Other countries have established, or are in the process of establishing, similar systems. The system in El Salvador is called SNET (Servicio Nacional de Estudios Territoriales), in Guatemala SNIG (Sistema Nacional de Información Geográfica), and in Nicaragua INETER (Instituto Nicaragüense de Estudios Territoriales). Mexico and the rest of the countries of Central America (Belize, Costa Rica, and Panama) do not yet have such centralized structures for providing this type of information. The governments of the region have a great opportunity to establish long-term relationships with the private sector (agricultural insurance companies and rural financial sector) to make such information systems sustainable and built according to demand.

Figure 5.4 Information System for the Provision of Agricultural Risk Information in Honduras (SINIT)



¹¹ The information made available by SINIT can be found at: www.sinit.hn.

3. *Legal and Regulatory Framework*

The third area where public policy is needed is in the regulatory and legal framework in which such insurance instruments operate. The laws and regulations governing agricultural insurance in Mesoamerica are not tailored for agricultural insurance products. The specific problems and constraints faced by agricultural insurance companies in the region include the following: Agricultural insurance instruments are considered “catastrophic” regardless of their actual risk exposure. This requires companies to have a higher level of reserves per policy issued. Agricultural insurance contracts are often three to six months long, yet regulations require them to maintain year-long reserves, often doubling the amount of reserves needed per policy issued. Also, supervisory agencies may be constrained or have difficulties approving new agricultural insurance instruments (especially those parametric in nature) due to gaps or inadequacies in current regulations. Foreign insurance companies (even those with operations in Mesoamerica) are often not allowed to sell agricultural insurance in the local market.

Box 5.2 Agricultural Insurance Pool (AIP), from Mahul 2005

The syndicated pooling arrangement facilitates, through a public-private partnership, the development of market-based agricultural insurance products. Their key objectives are:

1. Provide affordable and effective agricultural insurance coverage.
2. Ensure that farmers receive full indemnity payments that are due (no default risk).
3. Insulate the domestic insurance industry from catastrophic losses in this new line of business.
4. Act as a center of technical excellence to support small insurers.
5. Provide the insurance industry with incentives to collaborate on the integrity of the program.
6. Ensure efficient local retention by pooling non retainable risks.
7. Get optimal pricing from international reinsurers by providing a partly diversified portfolio.

Limit government fiscal exposure.

Public policy makers and regulators should work closely with the private sector to bring about laws and regulations that do not limit the development of and innovation in the area of agricultural insurance, while maintaining the control and protection necessary for the long-term sustainability of the industry. Public policy should not stop at an improved legal and regulatory framework; it should go on to provide training and awareness among regulators so that the officials who evaluate technical notes and cases are up to date with developments in the sector. Agricultural insurance is such a small portion of the overall insurance portfolio of the region that it is understandable that the knowledge of the technical details of such instruments, especially the new ones, is not current.

Insurance market in some countries of Mesoamerica, especially in Central America, is underdeveloped technically and financially. Therefore, a new line of business, such as agricultural insurance may expose the industry to unacceptable levels of risk, jeopardizing its overall financial viability. It could then be an option for governments and regulators to provide protection from financial contagion to the overall insurance industry from this new line of business. An Agricultural Insurance Pool (AIP) could act as such protection, providing risk aggregation and certainty to farmers about the financial sustainability of the system. The AIP model is based on strong public-private partnership between government, international donors, private insurers and re-insurers. In Turkey (Turkish Earthquake Insurance Pool) and in Mongolia (Mongolian Livestock Insurance Indemnity Pool) has worked as an effective model to offering standardized contracts for specific risks, fostering the development of new market-based

insurance products (See Box 5.2 and Mahul 2005 for more details). Mesoamerica should explore the design and implementation of such schemes within their insurance sectors.

4. *Regional Cooperation*

Finally, cutting across the three areas outlined above, governments in the region— especially in Central America—must maintain a regional perspective toward the development of public goods and services in the agricultural insurance sector. For the agricultural insurance market to develop, interested reinsurers must be willing to put capital at risk in the region. Wide variations from country to country in natural disaster aid programs, information systems, and regulatory and legal frameworks discourage reinsurers from offering their services in the region because of the high transaction costs required to enter a new market. Reinsurers need a minimum volume of premiums to cover those transaction costs. Given the small size of the countries of the region, reinsurers are more reluctant to penetrate one country than to penetrate the region as a whole. Having a harmonized regional information system, similar legal and regulatory frameworks, and similar approaches toward dealing with the market failure risk layer would go a long way toward providing the incentives reinsurers need to increase their business in the region. For example, in the case of information systems, CRRH (the Regional Committee on Water Resources) could play an important role, working in parallel at the domestic and regional level to integrate the various information systems. Such Regional Public Goods (RPGs) could have a large impact in the development of the agricultural insurance markets of the region.

B. *Market Interventions and Subsidies*

The issue of direct subsidies inevitably arises when dealing with policies, programs, and projects that require individuals to adjust their behavior, change the environment in which they operate, or pay for some service. Throughout the region, in countries with and without agricultural insurance systems, governments provide large direct subsidies to the agricultural sector through ex post disaster aid when natural catastrophes occur. In countries with agricultural insurance markets, such as France, Italy, Spain, and the United States, direct subsidies are often allocated to insurers and producers.

Government intervention through direct subsidies presents opportunities and challenges to the economic environment. The provision of subsidies can make insurance accessible to those who cannot afford it. In the case of disaster aid, it helps mitigate the negative physical and economic effects of natural events that are beyond an individual's control. Despite these benefits, allocating direct subsidies to the agricultural sector can produce less attractive side effects. Disaster aid in the form of subsidized insurance has been shown to foster relatively greater production in areas prone to natural disaster risks, and to introduce more producers than is efficient to the agricultural sector, creating political and economic deadweight losses (Innes 2003). Crop insurance subsidies in the United States were found to produce similar effects, in addition to driving down prices for crops and livestock (Young and others 1999).

Despite these problems, the provision of government assistance to these sectors is sometimes necessary. The key is the manner in which assistance is structured and distributed. However, the framework followed by countries like the United States cannot necessarily be applied in developing countries, such as those in Mesoamerica. The supports offered to producers and insurers in developed countries would be too costly for Mesoamerican countries, both because of fiscal constraints and because the contribution of the agricultural sector to GDP in Central America and Mexico is larger than for developed countries (Slangen 2002).

First and foremost, the structure of direct subsidies must be carefully planned to avoid inducing rent seeking (or to minimize it) and to ensure that risks are not completely transferred away from producers. If subsidies reduce the cost of insurance too much, the risk of magnifying moral hazard is introduced. Subsidies should not be so large that the insured do not feel the cost of the insurance contract, since this may foster production in higher risk areas and with higher risk crops. Risks must be internalized for the system to be efficient. Overall, as with any investment, the benefits must outweigh the costs of an intervention. Government intervention is justified when it is clear that a lack of intervention is more costly to society than the social costs of the subsidy itself (Skees, Barnett, and Hartell 2005).

The sustainability of a system of subsidies must also be taken into account, considering the source of financing of the subsidies and whether the subsidies are a transitory form of assistance or the foundation upon which the agricultural insurance market will function. The resources that finance subsidies must be carefully considered and defined. Subsidies financed from society's resources (tax resources) are unlikely to be an adequate source of financing, given the procyclical nature of tax revenue and the fact that tax revenue is often committed to numerous competing purposes and yearly (political) reviews. The establishment of inter-sectoral transfers could be more efficient.

Determining the temporary or permanent nature of a subsidy is important, given that the sustainability of an insurance program may rely on this factor. A temporary subsidy may be implemented to assist individuals in the transition to a new economic environment, such as CAFTA. In the case of insurance, this is not the case. It is unlikely for a premium subsidy to be temporary, since agricultural insurance is implemented to mitigate against uncontrollable effects of nature such as drought and floods, rather than man-made impacts. Given that a subsidy, once introduced to an insurance system, is extremely politically costly to remove, the importance of finding a proper financing mechanism for the subsidy is very important for sustainability.

Governments could use various types of direct subsidies and interventions to support the agricultural insurance sector, if socio-economic net benefits exist. These are grouped in three general areas in the discussion below. The first group is direct subsidies. The second and third are public interventions.

1. Direct Subsidies to Premiums

Premiums are subsidized in almost every developed country with an agricultural insurance program. In Mesoamerica, Mexico, El Salvador, and Guatemala have programs that directly subsidize agricultural insurance premiums. There is an implicit subsidy in the agricultural insurance offered by public companies in Costa Rica, Nicaragua, and Panama. For countries with relatively large farming populations, considering direct subsidies for premiums can prove fiscally impossible and unsustainable. Furthermore, experience overwhelmingly shows that the way in which these subsidies are implemented is counter-productive to its objectives, is regressive, does not reach the target population, and makes them harder to eliminate. Thus a great deal of caution needs to be taken into account when considering the option of a direct subsidy to agricultural insurance premiums.

Premiums have a risk component (expected losses) and a cost component (administrative and operating costs of offering insurance). Farmers need to pay at least for the risk component (coverage of the their expected losses) as a way to avoid large moral hazard problems. If subsidies cover the risk component of premiums, farmers will produce riskier crops in riskier

regions. This will increase potential negative environmental impacts and encourage activities that are counterproductive to the overall risk exposure reduction strategy that the public policies was designed to address in the first place (Skees, Barnett, and Hartell 2005).

Direct subsidies to cover the cost component of delivering agricultural insurance could be justified, in some cases. However, they are tricky to implement since they should be temporary until the transition to private market pricing is achieved—but they usually become permanent. Administration and operation costs are very similar on a per policy basis. The cost component of the subsidy does not vary much by the amount of coverage, meaning that if subsidies to cover administrative and operations costs are given on a per policy basis, this would have a progressive effect, since smaller farmers would tend to receive a larger subsidy in relation to the overall cost of the policy. However, the way agricultural insurance premium subsidies programs are handled, the subsidies are established as a percentage of the premium, meaning that as premiums (coverage) increases, so does the subsidy. This simplistic approach toward subsidizing agricultural insurance administration and operation costs produces excess rent seeking of public resources by the private sector and makes the subsidy grow more expensive, as an increase in coverage would increase the subsidy but not necessarily increase the administrative and operation costs.

2. Public Insurance/Reinsurance Companies

Public companies are usually established under the justification of market failure. In the agricultural insurance sector, market failure is not necessarily reflected by the lack of private insurers. For example, in Mexico, once the public insurance company (ANAGSA and later AGROASEMEX) left the insurance market, private companies stepped in and offered such instruments, expanding the market beyond historical coverage. It is virtually impossible to justify how a public provider of agricultural insurance could have any advantage over a private provider in terms of overcoming the same market failures. Information asymmetries will exist under public as well as under private insurance markets. Nevertheless, certain roles played by public institutions merit highlighting as potentially justified public interventions.

Mexico's AGROASEMEX is worth exploring in detail. Even though its reinsurance function does not provide any additional benefit to the reinsurance provided by private companies in terms of eliminating market failure, its market development function is important and in principle justified. Over the years, AGROASEMEX has helped develop innovative agricultural insurance instruments (mainly index-based) to reach small farmers excluded from the system. Such a market innovation function is important and one to which the private sector may not dedicate enough resources under private market conditions. For Central America, such a market development function could conceivably be justified as well: perhaps at a regional level and in coordination with the international private insurance and reinsurance sector. INISER in Nicaragua has also been undertaken such a market development function by implementing an index-based agricultural insurance policy (see Box 4.1).

AGROASEMEX also provides provide technical support (mostly free of charge) and reinsurance to the mutual insurance funds (FONDOS). Such support represents a high portion of the administrative costs of the FONDOS. Furthermore, FONDOS have been criticized for crowding out the private sector and for not reaching the intended population for which they were created. However, the concept of mutual insurance funds is an institutional arrangement to pool risks across farmers (not only low-income farmers), making basis risk less of a challenge for index-

based instruments. Also, in response to new regulations, FONDOS are beginning the search for reinsurance in private markets since they are not obliged anymore to reinsure themselves exclusively with AGROASEMEX. As a potentially viable institutional arrangement to deliver agricultural insurance to small-scale farmers, public support for FONDOS in Mesoamerica should be evaluated. However, the lessons from the Mexican experience with the FONDOS must be taken into account to ensure that efficiency is maintained without distorting existing and future private markets.

3. Mandatory versus Voluntary Insurance

One of the effects of asymmetric information in insurance is adverse selection. The adverse selection problem can be solved by reducing the asymmetry of information between insurer and insured. However, adverse selection has been put forward by policy makers as the reason to make insurance schemes mandatory. For example, many programs in Mesoamerica require the farmer to be insured as a condition for participation. A recently established program in Guatemala states that in order for banks to offer credit under the Guateinvierte guarantee program, the farmer receiving the loan must be insured. In Honduras, the Public Agricultural Development Bank (BANADESA) has a similar requirement.

Rigid requirements like these overlook the fact that farmers in Mesoamerica follow various types of strategies for on-farm production management activities. Some producers will not need or want to purchase agricultural insurance if their financial risk management strategy does not require it. This does not mean that the producer is more or less risky, but the financial risk management strategies available and adopted by each farmer vary significantly. Not all perils are insurable; production risk management strategies are more or less costly; and not all agricultural insurance products are tailored to farmers' needs (Skees, Barnett, and Hartell 2005). Thus requiring agricultural insurance from a farmer who does not need it will do little in terms of changing his or her risk profile. If anything, his or her financial risk management costs will rise unjustifiably.

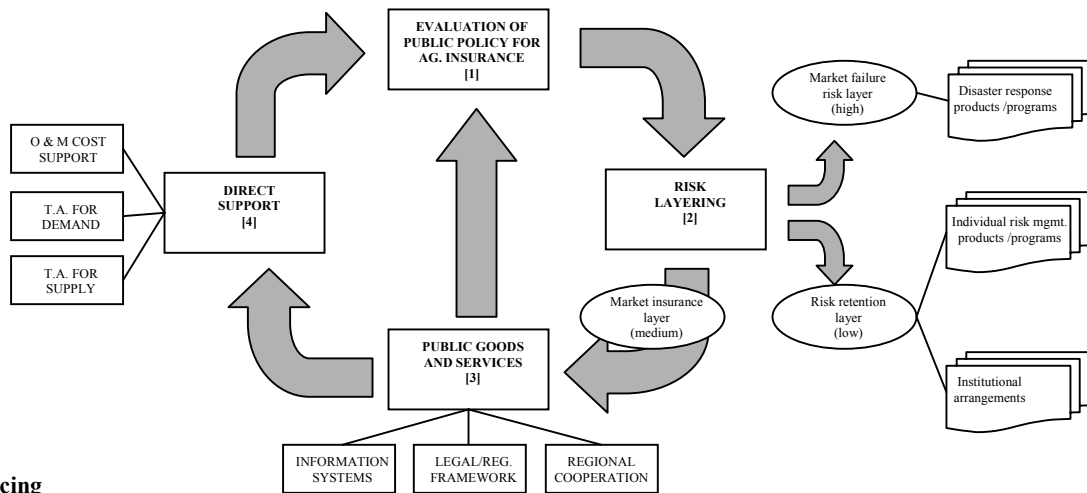
Public programs and interventions in the agriculture sector (especially those that involve credit and/or guarantee programs) should encourage the use of agricultural insurance. Banks are an efficient institutional mechanism to deliver agricultural insurance. However, this encouragement should be done by training credit officers in determining the financial risk profile of clients in the agriculture sector and incorporating insurance into such analysis, especially if an applicant lacks collateral. Many financial institutions that operate in rural areas do not consider agricultural insurance as a factor that reduces the risk profile of a farmer. For example, it would be logical to offer lower interest on a credit to a farmer who has agricultural insurance than on a credit to a farmer who does not (other things equal). This differentiation would go further in encouraging and making financial services to rural areas sustainable than making the purchasing of insurance one more requirement of program participation.

To expand demand for agricultural insurance, the government may undertake the role of educator in promoting awareness of risks and risk management among users. This is particularly important in light of a study of U.S. producers, which demonstrated significant differences between the intrinsic characteristics of those who purchased insurance and those who did not (Sherrick and others 2004). This study found that not all producers necessarily have the same level of knowledge to gauge and manage their risks adequately. The government can take on the responsibility of improving the overall knowledge base of agricultural producers.

C. A Public Policy Framework

Governments that would like to embark on public policies to support the development of the agricultural insurance market must do so with great caution. A socio-economic evaluation of public policies and programs must be undertaken before any decision is made in this area, since the social opportunity costs of public resources could be high, especially for fiscally strapped countries such as many in the region. Public policies must begin by addressing the existing market failures with interventions and/or programs that result in the highest social return to the investments. These are the necessary public goods and services for developing, expanding, and accelerating agricultural insurance coverage. Only when such public goods and services are being provided can public policy turn toward evaluating whether direct subsidies to the sector are justifiable. Figure 5.5 illustrates the proposed policy-sequencing framework in which to approach the support to the development of the agricultural insurance market.

Figure 5.5 Public Policy Sequencing Framework for Developing the Market for Agricultural Insurance



Sequencing

[1] EVALUATION OF PUBLIC POLICY FOR AGRICULTURAL INSURANCE: Policy makers evaluate the types of public support needed to develop the agricultural insurance market. The evaluation should begin by undertaking a socio-economic evaluation of the impacts of investing public resources in financial risk management instruments such as agricultural insurance and DRPs.

[2] RISK LAYERING: Policy makers identify the various risk layers involving agricultural production and address the higher and lower risk layers with specific support. They especially consider the need to clearly delineate the limits of public disaster aid (high risk layer). They also should carefully consider the low risk layer, as it involves support to institutional arrangements to allow for financial risk management by farmers, individuals, and households (savings, mutual funds, group credit).

[3] PUBLIC GOODS AND SERVICES: The third step looks at three key public goods and services that may be needed to address market failures and remove barriers that hinder on the development of the agricultural insurance market. These are improving the access and reliability of information systems; improving the legal and regulatory framework (including the possibility of setting-up and AIP); and, especially for Central America, undertaking a regional harmonization of the previous two public goods to support the transfer of risk abroad.

[4] DIRECT SUPPORT: If the necessary public goods and services are provided for and if the socio-economic analysis determines it is viable, direct support could be provided in the form of technical assistance (TA) to insurers and insured and support to the operations and maintenance cost component of premiums. This support should not be permanent, but only temporary until the transition to private market pricing is complete.

Source: Authors.

After conducting the evaluation of public policy for agricultural insurance [1], the second step [2] is layering the risk and structuring the support (public goods and services and/or subsidies) accordingly. At low levels of risk, individual risk management methods should be used and supported. These may include supporting microcredit and savings institutions in rural areas, but most importantly for Mesoamerica, effectively channeling remittances (see Terry and Wilson 2005). The literature on such low risk financial management among farmers, and its relationship to insurance instruments, is extensive (see Ehrlich and Becker 1972). These financial risk management methods have great potential to be completed by agricultural insurance to deliver a complete financial risk management package that can stop the poverty trap of low-income sectors of the rural economy.

At very high risk levels (low-frequency catastrophic risks) government support and intervention is desirable and required. Such assistance must avoid the gray area in which public disaster aid programs and policies intervene and most times overlap with the middle (or market insurance) risk layer. Such public action in the disaster aid domain could be in the form of making more explicit (and long-lasting) the ex ante rules of the program and/or developing disaster response products (DRPs) that would set some limits on agricultural insurance instruments being offered or being developed for the local market.

This middle risk layer is where the potential for agricultural insurance markets lies and where the debate over public policies and subsidies evolve. Therefore, once the risk layering and the different financial risk transferring mechanisms have been identified and the natural disaster aid programs for rural areas made explicit, the third step [3] is determining the necessary public goods and services for the development of the agricultural insurance market. Mesoamerica is in need of public policies and programs that support information systems, the regulatory and legal framework, and regional cooperation (see discussion above).

The shallowness of agricultural insurance markets is not enough justification for government intervention and direct support. Market failures do exist, but these could be diminished by the provision of public goods and services outlined above. However, there may be some cases where such direct support may prove to have net socio-economic benefits, and with fiscal resources available it could be justified. If such support were indeed justified, decision makers could move to the next step (4) to evaluate the direct interventions or subsidies needed.

In considering the various options for direct support, it is important to prevent the insurance system from becoming a social welfare program. This is especially germane since agricultural insurance has been likened to a system of producer supports, particularly when the insurance is provided by the public sector and is subsidized. The private sector must undoubtedly participate in the provision of agricultural insurance to foster competition, and market incentives must be offered to the insured to improve and diversify their risk management strategies. Furthermore, any of the types of direct support described below should not be permanent but only temporary, until the transition to private market pricing is achieved. Such incentives, once deemed viable, could be in the form of support to administrative and operations costs, technical assistance to expand demand, and technical assistance to expand supply (see discussion above).

VI. CONCLUSIONS

Mesoamerica is benefiting from a growing interest at the local, regional, and international level, and from the public and private sectors, in the development of the agricultural insurance market as a promising tool for economic development for rural areas. This interest is driven by a paradigm shift in the way agricultural insurance contracts are structured, eliminating the traditional barriers to reaching small-scale producers.

The recent innovations range from institutional and technological advances that reduce the cost of product delivery and verification of losses under traditional schemes to a complete restructuring of risk analysis and insurance contracts being offered. The restructuring of the risk analysis and insurance contracts is index-based. When combined with the different instruments offered by financial markets, it offers a radical change in the approach to agricultural production risk management—one that improves upon the drawbacks of traditional insurance. The index-based insurance instruments present some challenges, most of them surmountable.

To date, the implementation of innovative agricultural insurance products has been relatively successful, but not widespread. The few examples of insurance products working in India, Malawi, Mexico, Mongolia, and Morocco indicate the feasibility of the contracts and the possibility for overcoming the obstacles to indexed-insurance in developing countries. A key factor in the success of an innovative insurance product is tailoring the product to the local context. If this is possible, through participation and transparent procedures, the products can garner local support, which is critical for the survival of these and any new projects.

The public sector must focus on supporting innovative agricultural insurance instruments that have the potential to reach the rural poor, such as index-based products. This is especially the case in Central American countries, which may not be able to afford direct agricultural insurance subsidies for all producers. Mesoamerica, like other regions in Latin America, must prioritize investments that yield the highest social return. Within the debate of private vs. public goods, the highest return seems to lie with the investments in public goods (for a recent analysis, see Lopez 2004). Thus public policy intended to support the development of the agricultural insurance market must, with great caution, start by layering the risks and addressing the necessary public goods and services for buyers and sellers of such instruments to expand the market and innovate to accelerate expansion. Policy areas that top the list are:

- an adequate regulatory and legal framework
- a reliable and extensive public information system (including investments in new and rehabilitation of old infrastructure to collect and compile climatic and agricultural data)
- clear rules for catastrophic interventions (disaster aid) in rural areas, and
- regional integration (harmonization) of such public goods and services to make it more attractive for private insurance and re-insurance companies to enter the market.

If and only if the necessary public goods and services are being provided to their fullest potential should direct support (subsidies and/or technical assistance) to the sector be considered. It should always be kept in mind that such incentives for the supply and/or demand of insurance must be efficient and equitable, and should not distort production decisions by farmers. These effects could reduce the competitiveness of the agriculture sector, resulting in perverse incentives that

could undermine the medium- to long-term expansion of the market—and work against all the public policies efforts previously undertaken.

Mesoamerica's agricultural insurance markets are small but growing. Countries with publicly owned insurance companies should look at further opening the market to private firms, as the intervention of public companies has not solved the market failure problem within the sector. All countries should focus on providing the public goods and services needed to lift the barriers to market failure. They should take full advantage of the opportunities of index-based instruments to reach the small-scale farmer. At the same time, they should focus on all agricultural insurance products as a way of providing the sector with an array of financial risk management instruments to cope with production shocks. The Mesoamerican region is suffering from an increase in the number and magnitude of natural disasters and the agricultural sector is increasingly more integrated with international markets. To support the transition of small-scale producers toward higher value added crops and to increase the competitiveness over time of agro-exports, reducing their financial exposure to natural hazard risks, agricultural insurance needs to be at the forefront of financial instruments that can be supported and developed to help rural producers reach higher sustainable levels of welfare over time.

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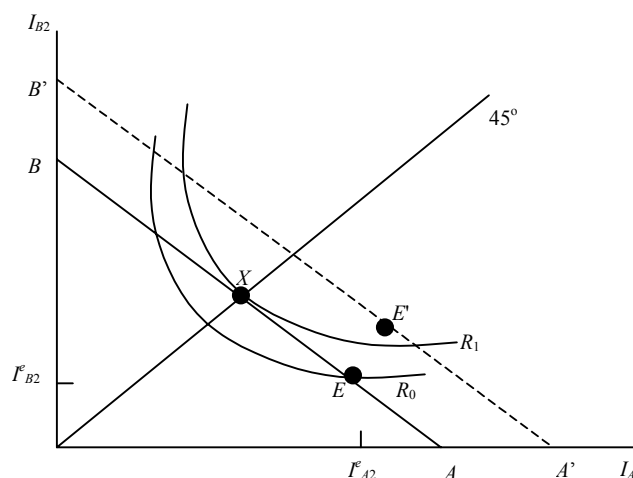
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Appendix A

THE WELFARE BENEFITS OF AGRICULTURAL INSURANCE: A THEORETICAL ANALYSIS

This study used a simple insurance model developed by Ehrlich and Becker (1972) that employs two states of nature. State *A* represents a favorable state of nature: that is, good harvest, high livestock survival, and so on. State *B* represents the unfavorable state of nature. State *A* occurs with probability p , and State *B* occurs with probability $(1-p)$. The price of insurance (or rate of exchange between states of nature) is denominated by π . When $\pi = p/(1-p)$, the insurance is actuarially fair.¹²

Figure A.1 A Simple Insurance Model



Source: Authors' calculations, based on Ehrlich and Becker (1972).

Figure A.1 represents period 2 of the income of a given economic agent (a farmer) in State *A* (I_{A2}) and State *B* (I_{B2}). If in period 2, States *A* or *B* were to occur, the individual farmer is expected to be faced with income I_{A2}^e or I_{B2}^e , respectively. The line *AB* is the insurance line that goes through point *E*, where both expected income from the two different state of nature meet. The insurance line has slope π . If it is actuarially fair, the point where it intersects the 45° ray (point *X*) is the expected value of the income endowment. The insurance line (*AB*) shows that if there is insurance available, it allows the individual to transfer income across states of nature to any point on the line. Furthermore, if individuals are assumed to be risk-averse, then indifference curves such as R_0 and R_1 can be drawn, showing that there are utility gains by being able to use insurance to redistribute income across states of nature.

¹² In this case, the price of insurance is measured in terms of income in State *A*.

The following mathematical model allows us to look at how an efficient bond market—which allows the individual to borrow or lend money at the same interest rate i —achieves a higher consumption endowment, shown by point E' in Figure A.1. It is assumed that an efficient bond market exists; that individuals are risk-averse¹³ and time impatient; and that the portion of an individual's wealth in period 1 (W^e_1) that is not consumed is invested for producing income in period 2.

The utility maximization problem of the farmer is:

$$\max U = pU(I_1, I_{A2}) + (1-p) U(I_1, I_{B2}) \quad (\text{A.1})$$

$$\text{s.t.} \quad I^e_2 = P(W^e_1, I^e_1) + (1+i) (I^e_1 - I_1) \quad (\text{A.2})$$

$$I^e_B = I_B + \pi [I_A + (I^e_A/I^e)], \quad (\text{A.3})$$

where $U(\cdot)$ is the utility function with diminishing utility of income: $U' > 0$, $U'' < 0$. $P(\cdot)$ is the intertemporal investment possibilities function. The first constraint represents the investment possibilities (eq. A.2). The second constraint represents the income distribution possibilities of the insurance (eq. A.3).¹⁴ The first order conditions of this system yield the following equalities:

$$U_1 = -\gamma(1+i) \quad (\text{A.4})$$

$$pU_{A2} = -\lambda\pi \quad (\text{A.5})$$

$$(1-p)U_{B2} = -\gamma \quad (\text{A.6})$$

$$P' = 1+i \quad (\text{A.7})$$

$$\gamma = \lambda(\beta + \pi\alpha), \quad (\text{A.8})$$

where γ and λ are the Lagrange multipliers, $\beta = I^e_{B2}/I^e_2$, and $\alpha = I^e_{A2}/I^e_2$.

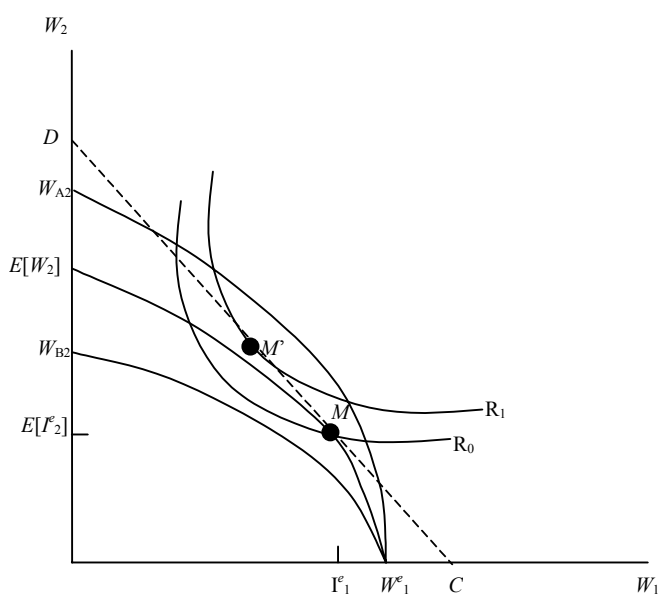
¹³ Risk preferences will dictate the use of insurance to smooth out the income stream (eq. A.5 and A.6). If an individual is risk neutral, his or her indifference curves will be parallel to the actuarially fair insurance line, meaning that his/her utility function of his/her risk depends only on the expected value and is linear on income. The individual would be indifferent between point E and X in Figure A.1.

¹⁴ To be consistent with the previous model by Ehrlich and Becker, eq. A.3 can be rewritten as:

$$I_{B2} = \beta I^e_2 + \pi (\alpha I_2 - I_{A2}).$$

Figure A.2 presents the production transformation curves representing the various levels of investments under the two states of nature ($W^e_1W_{A2}$ and $W^e_1W_{B2}$) and an average curve ($W^e_1E[W_2]$). From the first order conditions above, the optimal level of investment is determined at the point of tangency between the financial market line (DC) given by eq. A.7, and the production transformation curves. Given the way the indifference curves have been drawn, the best strategy for the farmer is to rearrange his consumption, saving in period 1 in order to reach a higher indifference curve (R_1) at point M' . This point M' yields a higher expected income endowment in period 2 for both states of nature, thus yielding point E' in Figure A.1.¹⁵

Figure A.2 Investment Levels by State of Nature

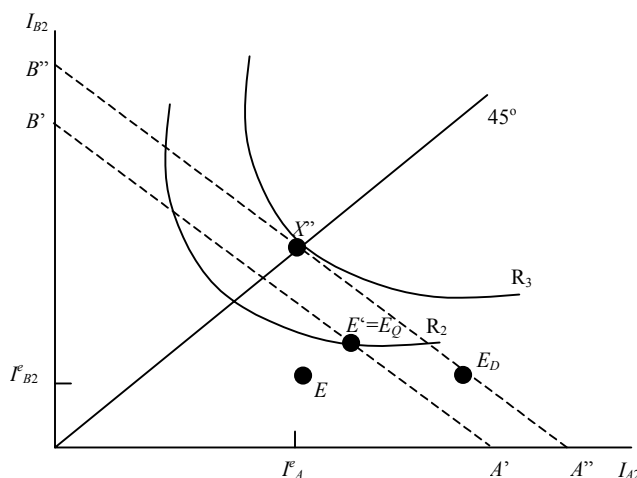


Source: Authors' calculations, based on Ehrlich and Becker (1972).

¹⁵ It is only in this example that the consumption rearrangement by the farmer yields savings in period 1. It could very well be that due to the high expected income endowment in period 2 and the shape of the indifference curve (as a function of time preferences) the farmer borrows in the first period, thus reducing expected income in period 2.

In Figure A.3, the individual is presented with the option of self-financing for production in period 2 or supplementing his or her own resources with credit targeted to results of State A .¹⁶ The credit available will substantially increase the income endowment in State A but it will leave State B unchanged. Self-finance will have a small positive impact in improving State A but will at least somewhat improve the income endowment in State B . To build upon Figure A.1, Figure A.3 starts with an individual in period 1 with an income endowment of I_{A1}^e . He or she can choose to self-finance period 2 production or to supplement his or her own resources with credit for innovative production technology.

Figure A.3. Self-financing versus Credit



Source: Authors' calculations, based on Ehrlich and Becker (1972).

Start from point E' , which is equal to point E_Q , representing period 2 income under self-financing. $A''B''$ is the actuarially fair insurance line. R_2 and R_3 are the indifference curves for a risk-averse individual. As mentioned, E_Q will yield a small improvement in the income endowment of State A and it will also improve that of State B . E_D , representing period 2 income when maximum credit for technological innovation is used, produces a larger increase in the income endowment of State A but leaves State B unchanged.

¹⁶ This can be viewed as a credit for investments in new technology.

This clearly shows that for risk-averse individuals (represented by the indifference curves), in the absence of insurance instruments, self-finance yields a lower expected income but a higher utility than incurring maximum debt from such credit programs, because of the high risk undertaken in heavy borrowing (point E_D is below the R_2 curve). Having access to insurance,¹⁷ the individual can exchange income across states of nature until reaching the highest level of utility possible (curve R_3). In this case, this is also at the point of expected value of the income endowment in period 2 (point X''). This lack of insurance may also be part of the explanation of why financial (credit) markets have not been successful in the rural/agricultural sector and why farmers prefer to self-finance investments in production rather than borrow from production technology credit lines.

¹⁷ For the sake of simplicity, the actuarially fair insurance has no deductible or coinsurance.

APPENDIX B
INDEXED INSURANCE IN IRRIGATION DISTRICTS IN MEXICO

Mexico has a long history of agricultural insurance (see Table B.1). One of the latest innovative instruments being evaluated is the implementation of index insurance contracts coupled to water rights for irrigation districts in Mexico.

The National Water Authority (CNA), with input from each district, makes decisions on water allocation for the producers in a district, after it has received crop portfolio and cost information from the Water User Associations (AURs) in the district. The CNA allocates district-level volumetric water rights to the Sociedad de Responsabilidad Limitada (SRL), which in turn distributes the water rights to the users in the various modules within a district. The actual receipt of water is tied to payments of a water quota fee to the CNA at the user, irrigation module, and SRL level.¹⁸ The purchase and allocation of water rights occurs in advance: before the agricultural year for which the rights apply.

Table B.1. A Chronology of Agricultural Insurance in Mexico

Period	Description
1926–1931	The agricultural credit laws that mandate the establishment of provision funds in the agricultural cooperatives and associations are promulgated.
1939	The establishment of unions between associations for the administration of reserve funds are authorized
1942	First insurance operations in Comarca Lagunera through a mutual fund. Significant influence from Spain
1952	Establishment of the Agricultural Insurance Studies Office. The first subsidy program is launched. It was applicable only when the consortium of insurance firms had an operational deficit for its insurance operations.
1955	Establishment of the first mutualist insurance associations
1956	Establishment of the Federation of Mutualist Agricultural Insurance Association
1961	Promulgation of the Agricultural Insurance Law
1963	Mandatory agricultural insurance when taking a credit. Establishment of the National Agricultural Insurance Company (ANAGSA)
1971	Introduction of the farmer life insurance
1976	Liquidation of the mutual insurance associations. ANAGSA becomes a monopoly of the agricultural insurance market of Mexico
1978	The establishment of FONDOS is authorized
1981	The 1961 law is abolished and replaced by the Agricultural and Farmer Life Insurance Law
1989	Agricultural Insurance must obey the General Law on Mutualists Insurance Associations and Institutions and the Law of the Insurance Contract. The operations of FONDOS begin. ANAGSA is liquidated.
1990	AGROASEMEX, a para-statal entity is established. A 20 percent subsidy on premiums is established for agricultural insurance policies contracted with AGROASEMEX.
1991	The subsidy to insurance policies by the FONDOS is extended.
1992	The General Rules for the Constitutions, Operation and Administration of FONDOS are promulgated. The subsidy to agricultural insurance premiums is increased to 30 percent.
1993 and 1994	Private insurance companies re-enter the agricultural insurance market of Mexico
1994	The subsidy to premiums is extended to private companies
1995	The 30 percent premium subsidy is extended to livestock insurance underwritten by AGROASEMEX, private firms and FONDOS
1996	The National Rural Insurance System (SNAMR) is created. The SNAMR coordinates and supports the institutions involved in agricultural insurance in Mexico, AGROASEMEX, FONDOS and private companies.
1997	The condition of being reinsured with AGROASEMEX in order to obtain the subsidy is eliminated
2000	Publication of the changes to the General Rules for the Constitutions, Operation and Administration of FONDOS
2001	AGROASEMEX moves out of direct insurance and operates only as a reinsurer
2003	The subsidy program is assigned to SAGARPA and it names AGROASEMEX as the operator of the program

Source: Sistema Nacional de Aseguramiento al Medio Rural (SNAMR).

¹⁸ The quota is determined by the operations and maintenance budget divided by the volume of water to be used for irrigation in the agricultural year.

In periods of drought, the system is imperfect since the total volume allocated by those rights is rarely delivered. The scarcity of water has generated a water rights market in which rights are bought and sold among producers (both land owners and tenants) temporarily and permanently. In practice, only the most efficient producers can produce under the condition of water scarcity. In periods of scarcity, certain producers temporarily cease production since it is more profitable to sell the water rights than produce crops that yield low income,¹⁹ even though these crops are often those that require less water to produce.

Under a rainfall index insurance contract, producers could complement their production decisions with indemnity payments in periods of drought, when rainfall levels are subnormal. By compensating producers when water is scarce, less efficient producers are more likely to sell their water rights to producers who can use the water more efficiently. Such insurance would likely improve the efficiency of the water markets by expanding the exchange of water rights among producers so that each has the potential to obtain an optimal solution in terms of water rights, crop production, and farm earnings.

AGROASEMEX has expressed interest in applying the approach to dam inflows in the Rio Mayo district in the State of Sonora. The Rio Mayo district has one dam, one SRL, 11,600 users²⁰, and 16 modules that are the primary users of the dam's water supply. Virtually all (97 percent) of the water is used for agricultural purposes. Indemnity payments would be paid out when the inflows to the dam are below a given trigger level: 700 million cubic meters (mcm), for example.

The Rio Mayo district is an ideal scenario for the design of this kind of insurance: not only because of the simple organization of the district, but also because there has been an interesting transition in crop production patterns. In 1991, an SRL was formed in the Rio Mayo to represent the users in the 16 modules and to assume water allocation responsibility to the modules from the CNA; the CNA retained responsibility only over the decision to release dam water.²¹ Water release from the dam is based on historical inflows, expected inflow, current storage, and the module's proposed seasonal crop portfolio. The onset of drought in the late 1990s led CNA to pursue a very conservative annual water release decision. This produced varying degrees of uncertainty about water, production, and income among the Rio Mayo water users. These uncertainties are magnified by the poor efficiency of the system. Of the water authorized for release from the dam, only about half (55.34 percent) actually reaches the producers because of efficiency losses through the course of the irrigation system.²² The limited efficiency of the

¹⁹ A limiting factor on how many producers stop production is the influence of the PROCAMPO subsidy, a direct subsidy paid to farmers in Mexico on a per hectare basis, since it is tied to current and previous years of production.

²⁰ The producers are of all farm sizes and include *ejidos* (small agricultural producers who have been allocated common land in the last agrarian reform) and three FONDOS.

²¹ The Comité Hidráulico, a committee with representatives from CNA, SRL, the AURs, and SAGARPA, the Ministry of Agriculture, reviews the CNA's decision; however, the final decision is made by CNA.

²² Some 10 percent is lost from the dam to Tésia, where distribution authority is passed from CNA to SRL. From Tésia to the modules, 16.7 percent is lost, and from each module entry point to the individual users, 27 percent of the water is lost.

system is further complicated by the fact that the irrigation system was designed to serve 70,000 ha, yet the titled land within the irrigated sector is 96,000 ha.

The uncertainty of the CNA's decision about water release set off a trend in crop portfolios. Production in the Summer-Spring (SS) season nearly ceased, since the crops available for production in that season require more water, yet yield fewer earnings. Production is concentrated in the Fall-Winter (FW) season. This pattern is reflected in the production plan the modules prepare for CNA annually in order to receive water. This, in turn, has placed downward pressure on the CNA's water release decision, since producers do not replace forgone SS production with an equivalent increase in FW production. Though this has a positive influence on dam storage, it is limiting improvements in farmers' livelihoods, since only enough water for FW production is released. Allocations beyond that volume must be petitioned by April 1 of the year.

Rio Mayo producers, however, recognize that though they do not plan production for SS, certain crops that are considered FW, such as sweet maize, chilies, beans, and some kinds of potato, must be planted before the FW cycle begins on October 1. These crops must be planted as early as August, but if water is scarce, the possibility that farmers may produce those crops diminishes. However, this production decision is also contingent on the profitability of the crops, given variable prices. If prices are lower than average, selling the water rights is more profitable.

The implementation of an insurance product to indemnify against low water inflows to the Rio May dam would reduce producers' uncertainty about water availability, production, and livelihood. An indexed insurance product based on inflows to the dam would best insure the water users if implemented at an aggregate level, such as by module or through the SRL, the two entities below the CNA that distribute water to the users but do not make the final water release decision. Figure B.1 illustrates an institutional arrangement for delivering the insurance product through the SRL. Users would pay a premium to their module's AUR (Asociación de Usuarios de Riego), which would pay the aggregate premium to the SRL, which would then pay the insurer the total premium. Indemnity payments would be made in inverse order: from insurer to SRL to AUR to the individual users. Indemnities would be allocated according to a pre-specified risk level. Contracts could be for a growing season (FW or SS), or for up to two years.²³ It would not be obligatory to produce in a given year. However, the intent would be to insure water users who intend to produce in a given year.

²³ In a presentation of the insurance model to Rio Mayo stakeholders, some producers expressed interest in longer contracts, such as for ten years. However, the management of contracts of such length is complicated. Thus shorter terms are preferable.

Potential Benefits

Indexed insurance presents multiple benefits to the irrigated sector in Rio Mayo. The risk of lost income because of drought would be transferred from producers to the insurance company, since the insurer has the commitment to indemnify in drought situations. Because the insurance would be purchased collectively, the risks would be pooled (at the module or district level). Thus there would be less variability in the risk profile of the individuals insured and the group as a whole. This would prevent the premium from being too expensive. The water rights market would likely become more competitive, since producers would have an option to sell their water rights in drought years without losing income. This would also improve producer efficiency. Moral hazard would be reduced or eliminated, since the only monitoring necessary would occur at the dam level in verifying the accuracy of inflows to the dam. Adverse selection would also be absent from these contracts, since the risk of low inflows to the dam is uniform for the district, making all insured water users homogeneous in the eyes of the insurer.

An additional benefit would be greater access to credit for the producers. Currently, the *Fideicomisos Instituidos en Relación con la Agricultura* (FIRA) is reluctant to extend credit to producers in the SS cycle, given the lack of production during that period, which translates into a lack of income and a reduced ability to repay debt. The extension of credit in the FW cycle does not suffer from this constraint and FIRA currently lends to producers for investments that improve FW production. The introduction of the indexed insurance is of interest to FIRA, and possibly other banks, since it would directly compensate for low inflows to the dam—which, given recent trends and discounting price effects,²⁴ is the main factor influencing the lack of production in the SS cycle and a major factor in the earnings variability of debtors, creating potential obstacles to the repayment of debt. Ultimately, the risk incurred by banks when lending to agricultural producers would be reduced.

Increased access to credit could create an opportunity for improving the efficiency of the irrigation system through new investments in infrastructure. The Rio Mayo is undertaking an investment to improve the lining of one of the two principal canals extending from the dam. Although this investment will increase the land area the system is able to serve, according to the CNA and SRL, it falls short of what is necessary to make up for the losses incurred in the system. The water users, modules, and/or SRL could use the indexed insurance contracts as collateral for credit to undertake a range of investments at different levels of the irrigation system that could build capacity and improve service.

Challenges

Any insurance product that bases the contract on an index that does not have a linear correlation with losses is likely to introduce basis risk. In the Rio Mayo district, index-based insurance undoubtedly would present some basis risk, given that indemnities would not be paid out based on individual losses from a drought. However, since the water received by producers is a function of several factors, one of which is inflows (historical and expected) to the dam, the negative effect of low inflows on individual production can be offset by the CNA's release decision. This can be adequate for seasonal production if, for example, the previous year received above-normal inflows. In other words, management rules can serve as a form of

²⁴ Producers also stated that prices are an additional factor that has limited their SS production.

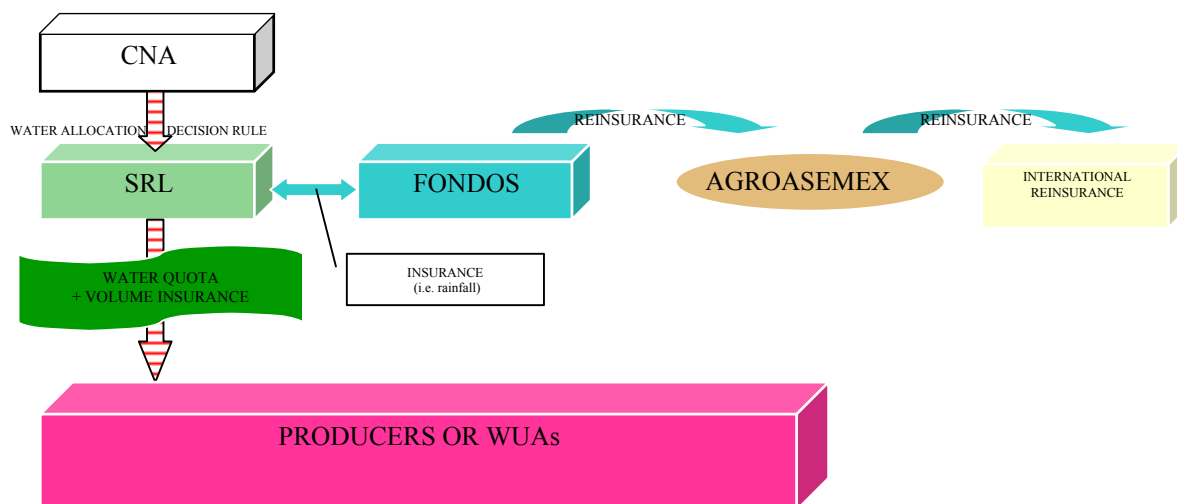
insurance. Further, the water rights market can diffuse the negative effects of low inflows on production, since water rights can be transferred between producers. Overall, basis risk would be present, but because of these factors, it may not present a high risk for the water users. Overall, for such an insurance product to be enacted successfully in Rio Mayo, the administrative and organizational capacity of the modules must be consolidated, as must the confidence in the potential insurance companies and the CNA to be consistent in its release rules. Without adequate organization within the module and a degree of trust, an indexed insurance system could be unsustainable. However, in Rio Mayo, the existence of FONDOS, collective *ejidos*, and the presence of a functioning water market demonstrates a level of organization that appears appropriate to undertake a collective insurance scheme.

An interesting direction that indexed insurance for dam inflows could take is the development of formalized futures markets for water rights. In the Rio Mayo, the cost of water rights when traded ranges from MXN1,500 to MXN3,000 per hectare; the range is defined by fluctuations in supply and demand and the date at which the rights are purchased. Therefore, individuals who choose to purchase additional water rights must pay more when water is scarcer. To plan for a full crop season in a drought period, producers generally will purchase water rights by October 1 of any given year. However, producers often buy the rights much earlier to guarantee access to water. Purchasers of water rights incur a degree of risk when undertaking this transaction. If substantial rain falls following the purchase of the water rights (which is quite likely if a producer purchases the rights during the rainy SS cycle for the following year, anticipating a dry season), the producer will have paid more than the value of the water rights. And if it rains to the point where water rights are unnecessary to obtain water, the investment in water rights becomes a complete loss to the producer.²⁵

This situation presents a scenario in which call options for the purchase of water rights would introduce greater efficiency to the system and reduce the risk and losses for those engaging in water rights transactions. A producer could pay a premium to an insurer for the option to purchase water rights at a given price by a certain date. If the cost of the water rights is greater than the producer's willingness to pay, then producer can forgo the purchase of the water rights, incurring only the loss of a premium. However, if the water rights are priced at or below the amount specified in the insurance contract, the producer can purchase the water rights and forgo additional expenses. This concept has not yet been developed for Rio Mayo, but the successful implementation of an indexed insurance system based on dam inflows could open this opportunity to the water users in the Rio Mayo.

²⁵ For example, the Rio Mayo entered the 2004-05 planting season with low dam storage levels. From November 2004 through February 2005, substantial rain fell out of season, pushing down the price of water rights. If the SS cycle receives normal quantities of rain, water restrictions would be deemed unnecessary, as would be the purchase of water rights.

Figure B.1 Possible Institutional Arrangement for Delivering Index-Based Insurance for Water Availability in Irrigation Districts



Note: The striped arrows represent water allocations plus water rights. The solid arrows represents the insurance and reinsurance contracts.

Source: Wenner and Arias (2003).

A PROFILE OF THE AGRICULTURAL INSURANCE MARKET IN MESOAMERICA

TABLE C.1 THE AGRICULTURAL INSURANCE MARKET IN MESOAMERICA

Estimates 2004	HONDURAS	GUATEMALA	NICARAGUA	EL SALVADOR	COSTA RICA	PANAMA	MEXICO
Agricultural insurance companies (number)	3	2	1	2	1	1	6
Volume of premiums (US\$)	679,216	298,080	--	--	--	276,496	21,000,000
Hectares insured	12,000	3,755	927	2,289	---	6,076	1,900,000
Hectares insured (% of cultivated area)	1.39	0.27	0.09	0.34	< 1	1.11	9
Indemnities paid (US\$)	390,245	192,510	--	---	---	217,263	10,920,000
Risks covered (number)	4	4	4	4	1	2	7
Risks covered	Livestock insurance; agricultural insurance: production guarantee, investment insurance, plant insurance (multi-peril)	Livestock insurance; agricultural insurance: production guarantee, investment insurance, plant insurance (multi-peril)	Livestock insurance; agricultural insurance: production guarantee, investment insurance, plant insurance (multi-peril)	Livestock insurance; agricultural insurance: production guarantee, investment insurance, plant insurance (multi-peril)	Multi-peril agricultural Insurance	Multi-peril agricultural Insurance; livestock insurance	Livestock insurance; agricultural insurance: production guarantee, investment insurance, climate based, plant insurance (multi-peril)
Crops covered (number)	13	11	2	2	10	12	52
Crops covered	Rice, cucumber, watermelon, banana, maize, cantaloupe, pepper, palm oil, sorghum, beans, sugar cane	Plantain, banana, cantaloupe, broccoli, rice, potatoes, sorghum, coffee, beans, onions	Peanuts, rice	Cotton, plantain	Rice, plantain, tobacco, root vegetables, cantaloupe, papaya, potatoes, beans, corn	Rice, maize, sorghum, potatoes, beans, yam, tomatoes, cantaloupe, watermelon, squash	See list below (Table C.2)

Estimates 2004	HONDURAS	GUATEMALA	NICARAGUA	EL SALVADOR	COSTA RICA	PANAMA	MEXICO
Information systems available	SIM (Sistema Meteorológico Nacional); COPECO (Comisión Permanente de Contingencias); SINIT (Sistema Nacional de Información Territorial); MAG (Ministerio de Agricultura)	INSIVUMEH (Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología); IGN (Instituto Geográfico Nacional); MAGA (Ministerio de Agricultura, Ganadería y Alimentación)	INETER (Instituto Nicaragüense de Estudios Territoriales); MAGFOR (Ministerio Agropecuario y Forestal)	SNET (Servicio Nacional de Estudios Territoriales); MAG (Ministerio de Agricultura y Ganadería)	IMN (Instituto Meteorológico Nacional); MAG (Ministerio de Agricultura y Ganadería)	ETESA (Empresa de Transmisión Eléctrica); MIDA (Ministerio de Desarrollo Agropecuario)	AGROASEMEX; CAN (Comisión Nacional del Agua); SAGARPA (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación)
Type of agricultural insurance market	Private	Private	Private/Public	Private	Public	Public/Private	Private/Public
Subsidies	No national policy.	National policy of subsidizing agricultural insurance premiums through GUATEINVIERTE (fund to finance rural projects).	INISER, public insurance company, currently offers agricultural insurance. No national subsidy program.	No national policy.	INS, the only public insurance company, currently offers agricultural insurance.	ISA, the public insurance company, currently offers agricultural insurance. No national subsidy program.	AGROASEMEX, as a reinsurer, is supported by public funds and administers the subsidy to insurance premiums of the private sector.

-- Not available.

Source: EEC (2005) and authors.

Table C.2 CROPS COVERED BY AGRICULTURAL INSURANCE IN MEXICO

Agave
Alfalfa sprouts
Ancho peppers
Apple
Barley
Beans
Broccoli
Cacao
Cantaloupe
Cartamo
Cauliflower
Cedar
Cempazuchiti
Chayote
Chili
Chili, jalapeno
Citrus
Copra
Cotton
Cucumber
Garlic
Grapes
Guava
Janamango
Kikapu
Maize
Maize, sweet
Maize, wild
Maguey
Mango
Nogal
Nuts
Oat grain
Peaches
Peanut
Plantain
Potato
Pumpkin
Rice
Sesame seeds
Sorghum
Soy
Spinach
Strawberry
Sugar cane
Tamarind
Tobacco
Tomato
Tomato, green
Watermelon
Wheat
Zacate

Source: EEC (2005) and authors.