India is a large country with 15 agro climatic zones with diverse seasons, crops and farming systems. For a majority of the people in India, agriculture is the main source of livelihood. Agriculture is also most vulnerable to climate change because it is inherently sensitive to climate variability. Climate changes has an impact on Indian agriculture in various direct and indirect ways besides affecting the lives and livelihood of millions of Indians.

India has been traditionally vulnerable to natural disaster on account of its unique geo-climate conditions. Floods, droughts, cyclones, earthquakes, and landslides have been recurrent phenomena. About 60% of the landmass is prone to earthquake of various intensities; over 40 million hectares is prone to floods; about 8 % of total area is prone to cyclones and 68% of the area are susceptible to drought. In the decade 1990-2000, an average of about 4344 people lost their lives; about 30 million people were affected by disaster every year. The loss in terms of private, community and public assets has been astronomical. At the global level, there has been considerable concern over natural disaster. Even as substantial scientific and material progress is made, the loss of life and property due to disaster has not decreased. In fact, human toll and economic losses have mounted. It was in this background that the UN general assembly in 1989 declared 1990-2000 as the International decade of natural disaster reduction with the objective to reduce loss of lives and property and restrict socioeconomic damage through concerted international action. The Government of India has adopted mitigation and prevention as essential components of their development strategies.¹

The Tenth Five Year Plan documents have a detailed chapter on Disaster Management. The plan emphasizes the fact that development cannot be sustainable without mitigation being built into development process. Each State is supposed to prepare a plan and/or/scheme for disaster mitigation in accordance with the approach

outlined in the plan. In brief, mitigation is being institutionalized into development planning. The Finance Commission makes recommendation with regard to devolution of funds between Central Government and State Government as also outlays for relief and rehabilitation. The Government of India has issued guidelines that where there is a self of projects, projects addressing mitigation with be given priority. It has also been mandated that each project in a hazard prone area will have disaster prevention/mitigation as a term of reference and the project documents have to reflect as to how project addresses that term of reference.

India is one of the world’s most vulnerable countries to climate change. About half of India’s population is dependent upon agriculture or other climate sensitive sectors, and according to the World Bank, about 76 percent of the population lives on less than $2 a day. The 2010 United Nations Human Development Report (HRD, 2010) found that poverty levels in eight Indian states are as acute as those in the 26 poorest countries in Africa. These eight Indian states are home to about 421 million people in poverty, 11 million more people in poverty than in the 26 poorest African countries combined. India is vulnerable to sea level rise and extreme weather events, and increasingly face threats to human health, water availability, and food security. Additionally, about 12 percent (40 million hectares) of India is flood prone, while 16 percent (51 million hectares) is drought prone thus India is also vulnerable to potential climate change - induced shifts in precipitation patterns. Agriculture is extremely vulnerable to climate change. Indian agriculture faces the dual challenge of feeding a billion people in a changing climatic and economic scenario. Also, it is the main source of livelihood for almost 60% of the country’s

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6 Central Water Resources (CWR), 2011, India: Country paper on Water Security, Available at: http://www.indiaenvironmentportal.org.in

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total population. The impact of climate change on agriculture will be severely felt in India. It has been projected that under the scenario of a 2.5°C to 4.9°C temperature rise, rice yields will drop by 32%-40% and wheat yields by 41%-52%. This would cause GDP fall by 1.8%-3.4%. Agricultural productivity is sensitive in two broad classes of climate-induced effects (a) direct effects from changes in temperature, precipitation, or carbon dioxide concentrations and (b) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases. The impact assessment can be made with three major factors i.e. Environmental, Biophysical and Socio-economic factors.

Climate change is not only a major global environmental problem, but also it is an issue of great concern to a developing country like India. As stated by the Intergovernmental Panel on Climate Change (IPCC), climate change is “Unequivocal”. The IPCC projected a global average temperature rise of 4.2°C under the BAU (Business-As-Usual) emissions scenario (A1B) towards the end of the 21st century, while new studies project a warming of more than 6°C under the current BAU emissions scenario over the same period.

Climate change affects the balance of natural eco-systems (i.e. forests, river basins, sea level) and socio-economic systems (i.e. agriculture, fisheries, irrigation and power projects). The lack of resources, technology and finances in developing countries such as India have limited capacity to develop and adopt strategies to reduce their vulnerability in climate change. It is widely accepted that the poorest are disproportionately vulnerable to climate change and the least able to adapt.

**Indian Agriculture: Scenario, Impacts and Vulnerability Assessment**

The food-grain production in India has increased spectacularly due to the Green Revolution from 50 Mt in 1951 to 212 Mt in 2002 and the mean cereal productivity

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7 Government of India, Department of Agriculture & Cooperation, 2011.
has increased from 500 kg per ha to almost 1800 kg per ha. The share of agricultural products in exports is also substantial with 15% of export earnings. Agricultural growth also has a direct impact on poverty eradication and is an important factor in employment generation. Wheat accounts for one-third of the total food-grain production, while rice forms 43% of the total and is cultivated in 43 million hectares, which is about 30% of the net cultivated area.\textsuperscript{12}

Agriculture in developing countries must undergo a significant transformation in order to meet the related challenges of achieving food security and responding to climate change. Projections based on population growth and food consumption patterns indicate that agricultural production will need to increase by at least 70 percent to meet demands by 2050. Most estimates also indicate that climate change is likely to reduce agricultural productivity, production stability and incomes in some areas that already have high levels of food insecurity. Developing climate-smart\textsuperscript{13} agriculture is thus crucial to achieving future food security and climate change goals. Climate change is expected to exacerbate the existing challenges faced by agriculture. Food security and climate change are closely linked in the agriculture sector and that key opportunities exist to transform the sector towards climate-smart systems that address both.

Estimates show that the world population will grow from the current 6.7 billion to 9 billion by 2050 with most of the increase occurring in South Asia and sub-Saharan Africa. Taking into account the changes in the composition and level of consumption associated with growing household incomes, FAO estimates that feeding the world population will require a 70 percent increase in total agricultural production.\textsuperscript{14} At the same time, climate change threatens production stability and productivity. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is


\textsuperscript{13} Definition of climate-smart agriculture: agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals.

\textsuperscript{14} Bruinsma, J., “The Resource Outlook to 2050”, in Expert Meeting on “How to Feed the World in 2050” (FAO, Rome), 2009.
expected to reduce productivity to even lower levels and make production lower.\(^\text{15}\) Long term changes in the patterns of temperature and precipitation, that are part of climate change, are expected to shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, prices, incomes and ultimately, livelihoods and lives. Preserving and enhancing food security requires agricultural production systems to change in the direction of higher productivity and also, essentially, lower output variability in the face of climate risk and risks of an agro-ecological and socio-economic nature. In order to stabilize output and income, production systems must become more resilient, i.e. more capable of performing well in the face of disruptive events. More productive and resilient agriculture requires transformations in the management of natural resources (e.g. land, water, soil nutrients, and genetic resources) and higher efficiency in the use of these resources and inputs for production.\(^\text{16}\) Transitioning to such systems could also generate significant mitigation benefits by increasing carbon sinks, as well as reducing emissions per unit of agricultural product.

Climate change is now largely accepted as a real, pressing and truly global problem. The main arguments concern how much climate change there will be, what impacts will ensue and how best to adapt to them, or better, mitigate the causes. There remain many objections to both the quality of the science behind global warming and the nature of cause and effect, but politicians are increasingly aware that the risks of climate change are so great that ignoring or delaying in addressing them would be far more costly than not doing so.\(^\text{17}\) The small chance that the science is wrong is not worth taking. The wrangling over costs of adaptation and mitigation at the Copenhagen summit in 2009 is ample evidence of the acceptance of the climate change problem by a broad community.

Scientific evidence for global warming is now considered irrevocable. It is witnessed by unprecedented rates of increase in atmospheric and sea temperatures,


\(^{16}\) These estimates refer to a specific baseline scenario which excludes, among other elements, the effects of climate change on production. For more details see FAO (2006).

and is correlated to rapid increases in atmospheric carbon dioxide. Corroboration for these warming trends is found in the dramatic loss of glaciers in the world’s high mountains, and in the rise of sea levels. It has recently been estimated that developing countries will bear 70–80 percent of the costs of climate change damage. At the same time, current estimates of total cost of climate ‘insurance’ through mitigation activity to stabilize temperature rise to 2 °C at an atmospheric carbon dioxide content of 450 parts per million (PPM) would be less than 1 percent of predicted global gross domestic product (GDP) in 2100, which is in any terms ‘affordable’. Further assessment of adaptation costs by sector have also been made, notably.  

Climate Change and Natural Disasters in Jammu and Kashmir State

Jammu and Kashmir is having a long history of Natural disasters; the state has witnessed many natural disasters especially in the 19th and early 20th centuries. Owing to its peculiar topography, rugged terrain, extreme weather conditions and above all an underdeveloped economy especially a poor road and communication network, the state has suffered a lot on account of both life and property in the past. In addition to disasters like earthquakes, floods, fires, drought, avalanches and landslides, the state has witnessed many disasters in the shape of epidemics, plague, cholera and famines in the 19th and early 20th centuries which have taken a heavy toll of human as well as animal population in addition to damage to houses, public infrastructure and crops. Although much information is not available on the occurrence of past disasters in the state yet there are a few fragmented references where a mention of the different events has been made. Since the state has suffered heavily on account of natural disasters and still the vulnerabilities are increasing, there have been many initiatives taken up at various levels from time to time to coup up with situations. However, the need to have clear cut policy on disaster

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management was felt badly especially after the National Disaster Management Act, 2005.

Owing to a unique geo-political and geographical setting, the state of Jammu & Kashmir has witnessed a multitude of disasters. Ranging from the local incidents of fires up to catastrophic earthquakes, the State has always paid heavily in terms of loss of life and property. However, in the absence of a reliable record and information, most of the events are either partially reported or exaggerated or sometimes not recorded at all. Within a period of one year (2004-2005), the Indian subcontinent was struck by the two major devastating hazards (Tsunami, Dec’04 and Kashmir earthquake’2005). The earthquake of October 8’2005 devastated Kashmir and northern Pakistan and killed more than 87000 people and injured about 1 lakh. The Kashmir earthquake is claimed to be the most adverse disaster of the century with an adverse impact more than the Tsunami of Dec’04, which affected 52 countries directly or indirectly along the course of Indian Ocean. Prior to 2005 earthquake, J&K was hit by snowstorm in February 2005 which destroyed many country-side villages in south Kashmir and inflicted huge loss of human life, livestock and property. The Himalayan states are prone to these natural hazards and similar other hazards like floods, avalanches, landslides etc. the Natural disasters do not respect the national boundaries.

In recent years, natural disasters, particularly climate-related ones, have increased both in frequency and magnitude. Scientists the world over have agreed that human-induced climate change is exacerbating this impact. Findings show that economic losses from disasters are rising dramatically – almost nine-fold in real terms from the decade of the 1960s to the 1990s, and insured losses more than 15-fold. Of these, losses due to extreme precipitation events, floods and storms increased most. The IPCC also concluded that at least part of the increase in economic losses is due to changes in climatic conditions. Another factor behind this increase in losses is viewed to be increasing concentration of people and capital in vulnerable areas. The poor and the marginalized of the developing countries are the worst victims to these

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22 Munich Re Group Annual Report (Germany: Munich Re, Central Division, Corporate Communications), 2003.
disasters. On the other hand, they have the least capacity to adapt. For some low-income countries, losses due to climate disasters account for several percentage points of their GDP. Per capita loss in relation to GDP is at least 20 times higher in developing countries than in the industrial world. Agriculture sector is likely to be affected most due to extreme weather events like cyclone, flood or drought. So, the farmers are hit hardest.

What is Risk?

Risk can be defined as the combination of the probability of an event and its consequences. In all types of undertaking, there is the potential for events and consequences that constitute opportunities for benefit (upside) or threats to success (downside). Risk Management is increasingly recognized as being concerned with both positive and negative aspects of risk. Therefore, this standard considers risk from both perspectives. In the safety field, it is generally recognized that consequences are only negative, and therefore, the management of safety risk is focused on prevention and mitigation of harm.

Risk is the possibility of adversity or loss, and refers to “uncertainty that matters.” Consequently, risk management involves choosing among alternatives to reduce the effects of risk. It typically requires the evaluation of tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other variables. Understanding risk is a starting point to help producers make good management choices in situations where adversity and loss are the possibilities.

Risk is uncertainty that affects an individual’s welfare, and is often associated with adversity and loss. Risk is uncertainty that “matters,” and may involve the probability of losing money, possible harm to human health, repercussions that affect resources (irrigation, credit), and other types of events that affect a person’s welfare. Uncertainty (a situation in which a person does not know for sure what will

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happen) is necessary for risk to occur, but uncertainty need not lead to a risky situation.

Risk management is a rapidly developing discipline and there are many and varied views and descriptions of what risk management involves, how it should be conducted and what it is for. Some form of standard is needed to ensure that there is an agreed:

- Terminology related to the words used
- Process by which risk management can be carried out
- Organization structure for risk management
- Objective for risk management

Importantly, the standard recognizes that risk has both an upside and a downside.

Risk management is not just something for corporations or public organizations, but it is for any activity whether short term or long term. The benefits and opportunities should be viewed not just in the context of the activity itself but in relation to the many and varied stakeholders who can be affected.

**Risks in Agriculture**

Weather plays a fundamental role in crop disasters. Thanks to the development of insurance and financial markets, it is now possible to transfer significant portions of weather risks off the farm. A new generation of financial products, known as weather derivatives and weather insurance, enable farmers to make risk management decisions about their operations that are affected by specific weather events, thereby providing them with greater income stability. Agricultural production is inherently a risky business, and farmers face a variety of weather, pest, disease, input supply and market related risks. Given an uncertain income each year, farmers must worry about their ability to repay debt, to meet overhead costs (e.g. land rents and taxes) and, in many cases, their ability to meet essential living costs for their families. These same risks are also of concern to agricultural lending institutions. Confronted with risky borrowers, lenders must seek to reduce the possibility of poor loan recovery rates in unfavorable years, even if this means only modest levels of lending to agriculture.
In India, agricultural risks are exacerbated by a variety of factors, ranging from climate variability and change, frequent natural disasters, uncertainties in yields and prices, weak rural infrastructure, imperfect markets and lack of financial services including limited span and design of risk mitigation instruments such as credit and insurance. These factors not only endanger the farmers’ livelihood and incomes but also undermine the viability of the agriculture sector and its potential to become a part of the solution to the problem of endemic poverty of the farmers and the agricultural labour. The criticality of agriculture in the rural transformation and the national economy, seen along with its structural characteristics, require substantial governmental and financial sector interventions not only to ensure household food and nutritional security of the farming community but also to generate savings and investments in this grossly underfunded sector. The poor penetration and development of various risk management tools in the country also represent the huge opportunities for the emerging agricultural insurance and commodity markets to pull the producer from out of the poverty trap by insulating him from income loss shocks and by ensuring that a fair share of the price goes to the producer. The prevalence of risk in agriculture is not new and farmers, rural institutions and lenders have, over generations, developed ways of reducing and coping with risk. Although the virtues of these traditional risk management mechanisms are widely recognized yet they also have their limitations. They can be costly in terms of the income opportunities that farmers forego (e.g. crop diversification is typically less profitable than specialization). They can discourage investments and technological changes that, while risky, enhance long-term productivity growth. And they have limited capacity to spread covariate risks like droughts that affect most farmers in a region at the same time. In theory, these limitations would not exist if capital and insurance markets were perfect, but the reality for many risky agricultural regions in developing countries is quite the opposite; relevant capital and insurance markets are poorly developed and they are weakly linked across regions and with urban areas.27

The challenge of developing effective and efficient risk-transfer markets for crop losses caused by natural hazards has eluded private and public sectors in countries around the world. In developed countries, the agricultural policy debate has been how and to what extent government should intervene in assisting market development. Now, it seems the debate has been largely resolved—governments have assumed significant obligation to farmers suffering from catastrophic production loss, resulting in the development and delivery of highly subsidized crop insurance products and significant retention of risk by government.  

The risks confronted by grain and cotton farmers are of particular interest, given the changing role of the Government after passage of the 1996 Farm Act. With the shift towards less government intervention in the post-1996 Farm Act environment, a more sophisticated understanding of risk and risk management is important to help producers make better decisions in risky situations and to assist policymakers in assessing the effectiveness of different types of risk protection tools. In response, this report provides a rigorous, yet accessible, description of risk and risk management tools and strategies at the farm level. Risk is uncertainty that affects an individual’s welfare, and is often associated with adversity and loss. There are many sources of risk in agriculture, ranging from price and yield risk to the personal risks associated with injury or poor health. In dealing with risky situations, risk management involves choosing among alternatives to reduce the effects of the various types of risk. It typically requires the evaluation of tradeoffs between changes in risk, changes in expected returns, entrepreneurial freedom, and other variables. Several surveys have been conducted asking about the types of risk most important to farmers. These surveys reach similar conclusions.

A 1996 USDA survey, for example, indicates that producers are most concerned about changes in government laws and regulations (institutional risk), decreases in crop yields or livestock output (production risk), and uncertainty in commodity prices (price risk). In general, producers of major field crops tend to be more concerned about price and yield risk, while livestock and specialty crop growers are relatively more concerned about changes in laws and regulations. While concerns about risk vary across types of producers, other factors are also important in determining the risk inherent in a producer’s situation. Yield risk, for example, varies regionally, and depends on soil type, climate, the use of irrigation, and other variables. Yield risk tends to be low in California, where irrigation is widespread, and higher in dry land producing areas in the Great Plains. In contrast to yield risk, price risk for a given commodity tends not to vary geographically, and depends on such factors as commodity stock levels and export demand. Farmers have many options in managing agricultural risks. They can adjust the enterprise mix (diversify) or the financial structure of the farm (the mix of debt and equity capital). In addition, farmers have access to many tools such as insurance and hedging that can help
reduce their farm-level risks. Off-farm earnings are a major source of income for many farmers that can help stabilize farm household income. Indeed, most producers combine the use of many different strategies and tools. Because farmers vary in their attitudes toward risk, risk management cannot be viewed within a “one size fits all” approach. That is, it is not wise to say that “All Midwestern corn farmers should hedge 50 percent of their crop in futures,” or that “No farmer should plan to obtain more than two thirds of his or her income from a single commodity.” Different farmers confront different situations, and their preferences towards risk and their risk-return tradeoffs have a major effect on decision making in each given situation. A large, industrialized operation, for example, may hire marketing expertise to directly use hedging and options, while a smaller farmer may prefer forward contract with other parties, better able to hedge directly. Although farmers in similar situations can differ greatly in their response to risk, yet surveys provide an overall view of producer choices.29

The results of a 1996 survey, conducted shortly after passage of the 1996 Farm Act, indicate that operators in the largest gross income categories (more than $250,000 annually) are more likely to use virtually all risk management strategies than small-scale operators. Keeping cash on hand for emergencies and good buys was the number one strategy for every size farm, for every commodity specialty, and in every region. Evaluating the effectiveness of different strategies and tools requires an understanding of the risk-return tradeoffs of individual producers. Several major points can be made, however, that generally apply to risk management. Most of the tools discussed in this report tend to reduce intra-year income uncertainty, but may have only small or negligible effects on multi-year uncertainties. In addition, some strategies such as the combined use of insurance and forward pricing tend to complement each other in reducing risks. In short, understanding risk in farming is important for several reasons. First, most producers are averse to risk when faced with risky outcomes. Someone who is risk averse is willing to accept a lower

average return for lower uncertainty, with the tradeoff depending on the person’s level of risk aversion. Thus, strategies cannot be evaluated solely in terms of average or expected return, but also must consider risk. Second, understanding risk helps farmers and others develop strategies for mitigating the possibility of adverse events, and aids in circumventing extreme outcomes, such as bankruptcy.30

The enterprise of agriculture is subject to a great many uncertainties. Yet, more people in India earn their livelihood from this sector, than from all other economic sectors put together. In rural India, households that depend on income from agriculture (either self-employed or as agricultural labour), accounted for nearly 70% of the population (estimates from Survey of Consumption Expenditures, National Sample Survey, 1999/00). Seventy five percent of all rural poor are in households that are dependent on agriculture, in one way or other. Households that were self-employed in agriculture, account for 28% of all rural poor, while households that were primarily dependent on agriculture as labour, account for 47% of all rural poor.

Types of Risks in Agriculture

Three major types of natural phenomena contribute to yield risks in agriculture: hydro-meteorological, geological, and biological. Hydro-meteorological risks include excessive rain, floods, droughts, high winds, tornados, hurricanes, hail, frost, abrupt temperature changes, heat waves, blizzards, prolonged cold spells, avalanches, landslides, high waves, storm surges. Geological risks include earthquakes, volcanic eruptions, and tsunamis. Biological risks include diseases and insect infestations. Each of these risks can then be categorized as either catastrophic or non-catastrophic, depending on frequency, scale, intensity, and duration. Catastrophic risk refers to natural disasters (earthquakes, hurricanes, volcanic eruptions, tsunamis, tidal waves, storm surges, etc.) that inflict large-scale damage over an extended area but are infrequent, low probability events. Non-catastrophic climatic risks (droughts, floods, landslides, mudslides, hail storms, freezes, heat waves, etc) affect localized areas (one or two provinces) or sometimes only a few farms. They tend to be more frequent, last longer, but cause less total economic

30 Ibid.
damage. Biological risks such as insect infestations and disease epidemics tend to be localized but in some instances, if the disease is highly communicable, livestock may have to be slaughtered over a very wide swath surrounding the original outbreak point as a containment measure. Thus, an outbreak of brucellosis, a bacterial infection that affects ruminants, on one farm is a non-catastrophic risk whereas an outbreak of mad cow disease would be a catastrophe for the entire cattle industry in a particular country.

**Sources of Risk in Farming**

The agricultural sector is exposed to a variety of risks which occur with high frequency. These include climate and weather risks, natural catastrophes, pests and diseases, which cause highly variable production outcomes. Production risks are exacerbated by price risks, credit risks, technological risks and institutional risks. Risk management in agriculture ranges from informal mechanisms like avoidance of highly risky crops, diversification across crops and across income sources to formal mechanisms like agriculture insurance, minimum support price system and futures markets.

Some risks are unique to agriculture, such as the risk of bad weather significantly reducing yields within a given year. Other risks, such as the price risk or institutional risks, discussed below, while common to all businesses, reflect an added economic cost to the producer. If the farmer’s benefit-cost tradeoff favours mitigation, then he or she will attempt to lower the possibility of adverse effects. These risks include the following:  

**Production or yield risk** occurs because agriculture is affected by many uncontrollable events that are often related to weather, including excessive or insufficient rainfall, extreme temperatures, hail, insects, and diseases. Technology plays a key role in production risk in farming. The rapid introduction of new crop varieties and production techniques often offers the potential for improved efficiency, but may at times yield poor results, particularly in the short term. In contrast, the threat of obsolescence exists with certain practices (for example, using...
machinery for which parts are no longer available), which creates another, and different, kind of risk.

**Price or market risk** reflects risks associated with changes in the price of output or of inputs that may occur after the commitment to production has begun. In agriculture, production generally is a lengthy process. Livestock production, for example, typically requires ongoing investments in feed and equipment that may not produce returns for several months or years. Because markets are generally complex and involve both domestic and international considerations, producer returns may be dramatically affected by events in far-removed regions of the world.

**Institutional risk** results from changes in policies and regulations that affect agriculture. This type of risk is generally manifested as unanticipated production constraints or price changes for inputs or for output. For example, changes in government rules regarding the use of pesticides (for crops) or drugs (for livestock) may alter the cost of production or a foreign country’s decision to limit imports of a certain crop may reduce that crop’s price. Other institutional risks may arise from changes in policies affecting the disposal of animal manure, restrictions in conservation practices or land use, or changes in income tax policy or credit policy.

Farmers are also subject to the **human or personal risks** that are common to all business operators. Disruptive changes may result from such events as death, divorce, injury, or the poor health of a principal in the firm. In addition, the changing objectives of individuals involved in the farming enterprise may have significant effects on the long run performance of the operation. Asset risk is also common to all businesses and involves theft, fire, or other loss or damage to equipment, buildings, and livestock. A type of risk that appears to be of growing importance is contracting risk, which involves opportunistic behaviour and the reliability of contracting partners.

**Financial risk** differs from the business risks previously described in that it results from the way the firm’s capital is obtained and repaid. A farmer may be subject to fluctuations in interest rates on borrowed capital, or face cash flow difficulties if there are insufficient funds to repay creditors. The use of borrowed funds means that a share of the returns from the business must be allocated to meeting debt payments.
Even when a farm is 100-percent owner financed, the operator’s capital is still exposed to the probability of losing equity or net worth.

**Agricultural Risk and Risk Management**

Agricultural producers are susceptible to a variety of risks. Among these are variations in market prices for agricultural commodities and production inputs. The focus here is on crop yield or output risk, rather than price risk. This discussion is also applicable to situations where the productivity of pasture and grazing land is at risk. Many of the non-weather perils that impact yields including insect infestation, biotic and abiotic infection, and even congestion caused by poorly controlled weedy plant species can be addressed via improved management practices. However, agriculture’s greatest risk exposure is to adverse weather events. There are many examples, including drought stress, sudden freezing temperatures, hail and wind damage, insufficient snow cover, and excess moisture. In some cases, the weather event itself may not be directly damaging but contributes to the growth and spread of other harmful agents like molds.

For any business, including agriculture, the purpose of risk management is to reduce the variance of expected financial returns given the uncertainties encountered in a stochastic production and demand environment. Risk management seeks to smooth income over time by taking specific actions to protect against downside risk, which in exchange, often requires giving up some upside earnings potential. Risk-averse agents are willing to make this exchange because there is greater utility in predictable, steady income.

Farmers use a variety of strategies to address the financial consequences of risk. In general, these strategies can be categorized into risk mitigation, risk transfer, and management of retained risk. Risk mitigation refers to actions that reduce either or both the probability of a loss occurring and the severity resulting from a loss event. Common strategies include irrigation; integrated pest management systems; the adoption of risk-reducing technologies, such as pesticides or improved seed varieties, and diversification across commodities (including mixing crop and

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livestock activities) or regions; and engagement in off-farm enterprises. Risk transfer shifts a portion of a producer’s risk exposure, at some cost, to another entity, willing and more able to diversify the risk. In developed countries, farmers often have access to risk-transfer mechanisms, such as futures market contracts, to manage output price risk. Various crop insurance schemes are often available to help manage yield risk. Vertical integration and forward contracting are also strategies that can change the distribution of risk, usually price risk, between contracting parties. In the developing world, the availability of risk transfer mechanisms is much more limited and informal. Even if they utilize available risk mitigation and/or risk-transfer mechanisms, farmers still retain some degree of risk exposure and must use additional strategies for coping with the financial implications of loss events. Typically, these are mechanisms for smoothing inter-temporal consumption across low- and high-income periods, such as private savings or maintaining credit reserves with formal lending institutions. While these mechanisms may work well for low magnitude losses, even if they are frequent, they often prove to be inadequate for retained risk that is rare but severe. Retained weather risk is always present either in whole or in part, and is wholly retained in situations where existing crop-yield insurance is either not purchased or unavailable by location or crop. Even in cases where crop-yield insurance is utilized, the loss deductible is retained. While this discussion casts risk management strategies as complimentary, there may also be instances when risk mitigation and coping mechanisms for retained risk substitute for risk transfer, as seen in the U.S. crop insurance experience. There are likely several explanations, but risk mitigation and risk coping strategies may potentially be overwhelmed by catastrophic loss events in the absence of risk transfer. Building systems, whereby insurance transfers highly correlated and catastrophic losses out of the community, and banking and non-banking systems facilitate savings and borrowing to assist in coping with more frequent and less severe events, is at the core of designing effective institutions for agricultural output risk.

Traditional agricultural risk assessment tends to focus on specific risks faced by different groups, for example climate risk affecting farmers’ crop production and

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yields or the risk of disease in livestock, or the impact of price risk on commodity traders, rather than adopting an integrated approach to studying different sources of risk throughout the agricultural supply chain. In recent years, the Agricultural Risk Management Team (ARMT) of the Agriculture and Rural Development (ARD) Department of the World Bank has developed a more holistic approach to analyzing and quantifying risk in the agriculture supply chain leading on to risk transfer solutions where appropriate. This approach is referred to as Rapid Agricultural Supply Chain Risk Assessment (RapAgRisk). Table 3.1 presents a classification of the main sources of risk facing agricultural supply chains along with examples of the risk events that can lead to losses for farmers, input suppliers and output traders and other players in the chain. Weather related risks including extreme weather events will not only impact adversely on the farmers’ crop production and yields and the quality of the yield, but this in turn will affect the farmers’ demand for inputs and other support services and their ability to repay loans and will also have an impact on buyers and processors upstream in the supply chain. Extreme natural or weather events, wherever they occur, may cause major disruptions in transport, communications and energy supplies affecting both upstream and downstream participants in the supply chain as well as the farmers. The RapAgRisk approach highlights the transmission of risk responses and the effects on each participant in the supply chain and their interdependency. Agricultural crop insurance is a restricted instrument in that it only addresses production and yield loss because of weather, natural and (occasionally) biological risks. Crop insurance provides limited coverage for growing crop from the time of sowing or crop emergency through to completion of harvest. It does not, however, usually address downstream sources of risk including post-harvest storage losses, or market price risk.\footnote{The US Federal Crop Insurance Programme (FCIP) is a rare example of a programme where both yield and price loss can be insured for specific commodities such as maize, wheat and soybeans.}

**Farmer strategies to manage risk in agriculture**

Farmers all over the world use a range of strategies to manage risk in agriculture and it is useful to categorize these strategies as “informal” (farm-household or community-based) and “formal” (market-based or publicly provided) risk.
<table>
<thead>
<tr>
<th>Type of Risk</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather related risks</td>
<td>Periodic deficit and/or excess rainfall or temperature, hail storms, strong winds.</td>
</tr>
<tr>
<td>Natural disasters (including extreme weather events)</td>
<td>Major floods and droughts, hurricanes, cyclones, typhoons, earthquakes, volcanic activity.</td>
</tr>
<tr>
<td>Biological and environmental risks</td>
<td>Crop and livestock pests and diseases, contamination related to poor sanitation, human contamination and illnesses, contamination affecting food safety, contamination and degradation of natural resources and environment, contamination and degradation of production processes and processing.</td>
</tr>
<tr>
<td>Market related risks</td>
<td>Changes in supply and/or demand that impact domestic and/or international prices of inputs and/or outputs, changes in market demands for quantity and/or quality attributes, changes in food safety requirements, changes in market demands for timing of product delivery, changes in enterprise/supply chain reputation and dependability.</td>
</tr>
<tr>
<td>Logistical and infrastructural risks</td>
<td>Changes in transport, communication, energy costs, degraded and/or undependable transport, communication, energy infrastructure, physical destruction, conflicts, labour disputes affecting transport, communications, energy infrastructure and services.</td>
</tr>
<tr>
<td>Management and operational risks</td>
<td>Poor management decisions in asset allocation and livelihood/enterprise selection, poor decision-making in use of inputs, poor quality control, forecast and planning errors, breakdowns in farm or firm equipment, use of outdated seeds, not prepared to change product, process, markets, inability to adapt to changes in cash and labour flows, etc.</td>
</tr>
<tr>
<td>Policy and institutional risks</td>
<td>Changing and/or uncertain monetary, fiscal and tax policies, changing and/or uncertain financial (credit, savings, insurance) policies, changing and/or uncertain regulatory and legal policies, and enforcement, changing and/or uncertain trade and market policies, changing and/or uncertain land policies and tenure system, governance related uncertainty (e.g. Corruption), weak institutional capacity to implement regulatory mandates.</td>
</tr>
<tr>
<td>Political risks</td>
<td>Security-related risks and uncertainty (e.g. threats to property and/or life) associated with politico-social instability within a country or in neighboring countries, interruption of trade because of disputes with other countries, nationalization/confiscation of assets, especially for foreign investors.</td>
</tr>
</tbody>
</table>

Source: Jaffee, Siegel and Andrews, 2008
management strategies. Table 3.2 presents a classification of risk management strategies using this categorization into informal and formal strategies and then this is further divided into ex-ante (before the event) prevention and mitigation actions and ex-post (after the event) risk coping or risk minimizing actions.\textsuperscript{36}

### Table 3.2

<table>
<thead>
<tr>
<th>Informal and Formal Risk Management Strategies in Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal risk management strategies</td>
</tr>
<tr>
<td><strong>Farm household (mitigating risk)</strong></td>
</tr>
<tr>
<td>Ex-ante</td>
</tr>
<tr>
<td>Savings, Buffer stocks, Enterprise diversification, Low risk, low return cropping patterns, Production techniques.</td>
</tr>
<tr>
<td>Ex-post</td>
</tr>
<tr>
<td>Sale of assets, Reallocation of labour, Reduced consumption, Borrowing from relatives</td>
</tr>
<tr>
<td>Community-level (sharing risk)</td>
</tr>
<tr>
<td><strong>Ex-ante</strong></td>
</tr>
<tr>
<td>Food crop sharing, Common property resource management, Social reciprocity, Rotating savings/credit.</td>
</tr>
<tr>
<td><strong>Ex-post</strong></td>
</tr>
<tr>
<td>Sale of assets, Transfers from mutual support networks.</td>
</tr>
<tr>
<td>Formal risk management measures</td>
</tr>
<tr>
<td><strong>Market-based (share/transfer risk)</strong></td>
</tr>
<tr>
<td>Ex-ante</td>
</tr>
<tr>
<td>Contract marketing, Financial hedging tools (options)</td>
</tr>
<tr>
<td>Traditional agricultural insurance Price guarantees or stabilization funds</td>
</tr>
<tr>
<td>Weather index insurance (WII), Contingent funds for disaster relief</td>
</tr>
<tr>
<td><strong>Ex-post</strong></td>
</tr>
<tr>
<td>Savings, Credit</td>
</tr>
<tr>
<td>Publicly-provided (transfer-absorb risk)</td>
</tr>
<tr>
<td>Ex-ante</td>
</tr>
<tr>
<td>Pest/disease management, Physical crop/food stocks, Price guarantees or stabilization funds, Input subsidies, Public agricultural insurance.</td>
</tr>
<tr>
<td><strong>Ex-post</strong></td>
</tr>
<tr>
<td>Disaster assistance, Social funds</td>
</tr>
<tr>
<td>Cash transfers, Waiver (cancellation) of crop loans</td>
</tr>
</tbody>
</table>

Source: Jaffee, Siegel and Andrews, 2008

In many countries in Asia and the Pacific region, informal risk management strategies predominate in rural and farming households, especially in those countries where there is no market-based or public sector agricultural insurance. It was not within the scope of this current study of agricultural insurance provision in Asia and the Pacific region to report on the different types of risk management strategies adopted at farm and community levels. In general terms, agriculture in the region is small-scale and intensive with a high proportion of irrigated cropping in the winter

dry season and mono-crop cultivation of paddy rice throughout much of South Asia in the monsoon summer season. The livelihoods of many of the poorest households in the region are supplemented through sharecropping and/or off-farm employment and income that act as a buffer in the event of major catastrophic events (typhoons, floods or tsunamis). In parts of South Asia, semi-commercial and commercial farmers have invested heavily in private tube-well irrigation as an ex-ante measure to reduce the risk of drought in the winter dry season. For larger semi-commercial farmers, savings and credit are important mechanisms of coping with major risks. Remittances from abroad are also very important in some Asian countries such as Bangladesh, Nepal, Thailand, Indonesia and the Philippines.

Traditional or informal risk management arrangements cannot provide protection against high severity, low frequency covariate risks in Asia and the Pacific region such as typhoons, floods, tsunamis and droughts. In times of severe loss, small and marginal farmers who own few assets and who do not have savings or access to consumption credit, may be forced to sell their productive assets (e.g. livestock). Repeated asset losses and income shocks can conspire to keep poor households trapped in poverty and may even lead to the sale of farms and forced migration. Farmers may also adopt risk avoiding strategies such as the adoption of local varieties that are often more resistant to drought or diseases, but which do not have the potential to generate high yields and surplus production for sale. They also purchase low levels of chemical inputs (fertilizer and plant protection chemicals). These strategies are less reliant on the use of credit to purchase high yielding technology and, therefore, less risky in the event of major crop loss. They do, however, carry a high opportunity cost in terms of forgone income and this is especially important in Asia and the Pacific region where land is the limiting factor and where farm incomes can be increased only through productivity gains. Formal market-based risk management strategies in Asia the Pacific region include savings and credit and in many Asian countries private commercial (and public sector) crop and/or livestock insurance. Agricultural insurance is, however, not available in any of the Pacific Island countries. In South and Southeast Asia, about 50 percent of countries have private commercial (and or public) agricultural insurance systems.

37 Ibid.
including the large mature agricultural insurance markets in Australia, Japan and New Zealand and the rapidly growing public-private partnership (PPP) models in China and the Republic of Korea. In contrast, none of the mainly smaller Pacific Island nations currently have any formal agricultural insurance markets. Other market-based financial instruments such as warehouse financing and price hedging are not well established in the developing countries of the region. A high proportion of rural households in Asia and the Pacific region are dependent on publicly provided ex-post disaster relief assistance. In response to the very high exposure to loss associated with typhoons and associated flooding and tsunamis, most countries in the region have well developed natural disaster risk management programmes that combine preventative measures with well established post-disaster response programmes involving relief, recovery and reconstruction operations. Farmers in these countries typically receive post-disaster compensation in the form of replacement - poultry and small livestock and free seeds and fertilizers - to enable them to replant their crops.

Several countries in Asia, and in the Pacific region also, have a long history of public sector crop and/ or livestock insurance, e.g. Democratic People’s Republic of Korea, India and the Philippines. These public-sector programmes have targeted small and marginal farmers and have been heavily subsidized.

Other forms of state-sponsored agricultural risk management in Asia include investment in public irrigation infrastructure, agricultural research into new high yielding crop varieties, major investment in national agricultural training and extension systems and in state sponsored lending to farmers that is often linked to compulsory crop insurance (e.g. India and the Philippines).

**Risk Management Strategies:**

To design appropriate risk management policies, it is useful to understand strategies and mechanisms used by producers to deal with risk, and for the purpose of this discussion to distinguish between informal and formal risk management mechanisms and between ex-ante and ex-post strategies. As highlighted in the 2000/2001 World Development Report (World Bank, 2001), informal strategies are identified as “arrangements that involve individuals or households or such groups as
communities or villages,” while formal arrangements are “market-based activities and publicly provided mechanisms.” The ex antes or ex post classification focuses on the point in time in which the reaction to risk takes place: prior to the occurrence of the potential harming event (ex-ante) or after the event has occurred (ex-post).

Table 3.3

<table>
<thead>
<tr>
<th>Informal Mechanisms</th>
<th>Formal Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoiding exposure to risk</td>
<td>Market based</td>
</tr>
<tr>
<td>Crop diversification and inter-cropping</td>
<td>Publicly provided</td>
</tr>
<tr>
<td>Plot diversification</td>
<td>Agricultural extension</td>
</tr>
<tr>
<td>Mixed farming</td>
<td>Supply of quality seeds, inputs, etc</td>
</tr>
<tr>
<td>Diversification of income source</td>
<td>Pest management systems</td>
</tr>
<tr>
<td>Buffer stock accumulation of crops or liquid assets</td>
<td>Infrastructures (roads, dams, irrigation systems)</td>
</tr>
<tr>
<td>Adoption of advanced cropping techniques (fertilization, irrigation, resistant varieties)</td>
<td></td>
</tr>
<tr>
<td>Crop sharing</td>
<td>□ Contract marketing</td>
</tr>
<tr>
<td>□ Crop sharing</td>
<td>□ Futures contracts</td>
</tr>
<tr>
<td>□ Sharing of agricultural equipment, irrigation sources, etc</td>
<td>□ Insurance</td>
</tr>
<tr>
<td>Informal risk pool</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex-Ante Strategies</th>
<th>Ex-Post Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing risk with others</td>
<td>Coping with shocks</td>
</tr>
<tr>
<td>Crop sharing</td>
<td>□ Financial support (calamity relief, food for-work, etc)</td>
</tr>
<tr>
<td>□ Sharing of agricultural equipment, irrigation sources, etc</td>
<td>□ Rescheduling loans</td>
</tr>
<tr>
<td>□ Informal risk pool</td>
<td>□ Agricultural insurance</td>
</tr>
<tr>
<td></td>
<td>□ Relaxations in grain procurement procedures</td>
</tr>
<tr>
<td></td>
<td>□ Supply of fodder</td>
</tr>
<tr>
<td></td>
<td>□ Cash transfer</td>
</tr>
</tbody>
</table>

Among the ex-ante reactions, it can also be useful to highlight the differences between on-farm strategies and risk-sharing strategies. Table 4.3 summarizes these classifications.

**Informal mechanisms:**

Ex-ante informal strategies are characterized by diversification of income sources and choice of agricultural production strategy. One strategy producers can employ is simply to avoid risk. In many cases, extreme poverty makes people very risk averse, often avoiding activities that entail risk but that could also bring larger income gains. This inability to manage risk and accumulate and retain wealth is sometimes referred to as the “poverty trap”.

Once farmers have decided to engage in farming activities, the production strategy selected is an important means of mitigating the risk of crop failure. Traditional cropping systems in many places rely on crop diversification and mixed farming. Crop diversification and inter-cropping systems are means to reduce the risk of crop failure due to adverse weather events, crop pest or insect attacks. Studies present evidence that households whose consumption levels are close to subsistence (and, therefore, highly vulnerable to income shocks) devote a larger share of land to safer, traditional varieties of rice and other cereals than to riskier, high-yielding varieties. Studies also present evidence that near-subsistence households spatially diversify their plots to reduce the impact of weather shocks that vary by location.

Apart from altering agricultural production strategies, households also smooth income by diversifying income sources and thus minimizing the effect of a negative shock to any one (source) of them. According to the study conducted by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), most rural households in villages of semi-arid India surveyed generate income from at least two different sources; typically crop income and some livestock or dairy income. Off-farm seasonal labour, trade and sale of handicrafts are also common income sources. The importance of income source diversification as part of risk management is emphasized by many studies, finding that households with more farm profit volatility are more likely to have a household member engaged in steady wage employment. Buffer stock accumulation of crops or liquid assets, and the use
of credit present obvious means for households to smooth consumption. Studies also show that currency and crop inventories function as buffers or precautionary savings.

Crop-sharing arrangements in land renting and labour hiring can also provide an effective way of sharing risks between individuals, thus reducing producer risk exposure. Other risk-sharing mechanisms, such as community-level risk pooling, occur in specific communities or extended households where members of the group transfer resources among themselves in order to rebalance marginal utilities. These kinds of arrangements are effective for counterbalancing consequences of events that affect some members of the community, but do not work well in cases of covariate income shocks.

Ex-post informal income-smoothing mechanisms are typically the sale of assets, such as land or livestock, or reallocation of labour resources to off-farm labour activities, deferred/low key family functions, reduced consumption patterns and migration. It is reported in studies that southern Indian farmers are able to quickly shift from 100 per cent on-farm labor activities to largely off-farm activities if the monsoon rains are expected to be poor.

Studies in India and elsewhere, reported considerable efficiency losses associated with risk mitigation, typically due to lack of specialization. In other words, farmers trade-off income variability with profitability. The need to smooth consumption not only against idiosyncratic shocks, but also against correlated shocks comes at a serious cost in terms of production efficiency and reduced profits, thus lowering the overall level of consumption of the household. A major consideration for innovation would be to shift correlated risk from rural households. An obvious solution is for rural households to engage in risk sharing with households or institutions from areas largely uncorrelated with the local risk conditions. Examples of such extra-regional risk sharing systems are found in the literature, for example, through credit and transfers with distant relatives; through migration and marriages; or through ethnic networks. Although there is some degree of risk sharing and thus of insurance against weather, none of the systems is so widespread that it covers all households, nor are the systems even close to providing a fully efficient insurance mechanism.
Most households are, therefore, still left with no insurance against correlated risks, the main source of which is weather.

**Formal mechanisms:**

Formal risk management mechanisms can be classified as publicly provided or market based (Flow Chart 3.1). Government action plays an important role in agricultural risk management both ex-ante and ex-post. Ex-ante education and services provided by agricultural extension help familiarize producers with the consequences of risk and help them adopt strategies to deal with risk.

Source: IRM, 2000
Supply of quality agricultural inputs is another institutional strategy. Governments also reduce the impacts of risk by developing relevant infrastructure and by adopting social schemes and cash transfers for relief after shocks have occurred. Production and market risks probably have the largest impact on agricultural producers. Various market-based risk management solutions have been developed in order to address these sources of risk.

Risk management is a central part of any organization’s strategic management. It is the process whereby organizations methodically address the risks attaching to their activities with the goal of achieving sustained benefit within each activity and across the portfolio of all activities. The focus of good risk management is the identification and treatment of these risks. Its objective is to add maximum sustainable value to all the activities of the organization.

**Managing Agriculture Risk in Poor Countries**

Many farmers and food consumers in poor countries are far more vulnerable to risks than their counterparts in rich countries. Where living standards are low, anyhow, families have a limited capacity to buffer income declines, and where poverty prevails, any further drop in purchasing power may result in destitution and misery. The share of family income spent on food is considerably larger among poor people than among rich, and a rise in food prices can have a dramatic impact on overall purchasing power in a poor country while it has only marginal implications in industrialized economies. Moreover, basic agricultural raw materials typically account for a significantly larger share of retail food expenditure in a poor society than among rich families who spend more on high-value products, processing, distribution and other non-agricultural elements in the food chain. As a result, price fluctuations on agricultural commodity markets affect food prices more in developing countries. At the same time, market instruments to manage risk tend to be less available or completely missing in poor countries. In particular, financial markets may not function well and make it much more difficult than in rich countries to borrow money that could help to tide over a bad year. Futures markets may not exist, or access to them may be extremely difficult, in particular for small producers or farmers living in remote areas. Production insurance is often not
available. Social safety nets are likely to provide less protection in times of crisis than those in developed countries. In other words, managing risks effectively in agriculture and the food economy is more important but also more difficult in poor than in rich countries. For a long time, governments of many developing countries had a strong tendency to engage in heavy-handed management of their agricultural markets, at both the border and domestically: keeping prices reasonably stable (and often also low, in the interest of urban food consumers) was one central aim of their market policies. Over time, these policies were reformed in many parts of the world, and policies became considerably more market-neutral. Policies have begun to focus more on managing risks rather than markets. However, when it came to responding to the extreme food price spikes during the 2006-2008 period, governments of many developing countries have intervened heavily in their agricultural and food markets, through various forms of domestic and across border measures, with the aim of calming down prices. There are good reasons, though, to question the effectiveness and efficiency of such market interventions. Moreover, efforts at controlling domestic prices in the face of international market volatility tend to aggravate the latter, much as when developed countries try to isolate their markets from international price fluctuations. In particular, export taxes and restrictions imposed by major exporters during the 2006-08 episodes have inflated the price spikes. Regarding producer risks in agriculture more generally, there are various approaches that governments of poor countries can use to strengthening risk management. Fundamentally, the tools available to them are the same as those used in richer countries, though they have, of course, to be adjusted to the economic, social, structural and natural conditions in the countries concerned. As a matter of fact, all sorts of instruments to manage risks in agriculture have been used in developing countries for a long time, and many governments and international

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donors, including multilateral institutions such as the World Bank and FAO, make efforts to assist farmers in their endeavours to manage risks. For example, FAO aims at supporting governments in developing risk-related policies, among others, by issuing related policy briefs. 42 A number of innovative developments can help to facilitate agricultural risk management in developing countries. For example, micro-insurance schemes can provide crop or livestock insurance to small producers. Weather index insurance can help to overcome the potentially large transaction costs involved in identifying crop losses on individual small farms, and at the same time guard against moral hazard. 43 Guidelines on disaster risk management, such as those put together by FAO, can help to improve preparedness and rapid response in dealing with natural hazards. 44 When it comes to dealing with price volatility on agricultural markets, arguably the most severe issue in poorer countries is the threat to food security resulting from food price spikes. Rising food prices have a positive impact on farmers in developing countries and provide incentives to invest in agriculture and expand production. Through their impact on employment creation in agriculture and rural regions, they may in the longer run even have positive implications for net food consumers, i.e. those families that consume more food than they produce. 45 However, the most immediate and often dramatic impact of spiking food prices is the extra poverty and malnutrition that they generate among low-income food consumers, including those in agriculture that produce less food than they need for their families. In the short run, that poverty impact of high food prices dominates. Recent World Bank research on the 2010-11 surge in food prices has shown that the adverse welfare impact on net food buyers outweighs the benefits to donors, including multilateral institutions such as the World Bank and FAO, make efforts to assist farmers in their endeavours to manage risks. For example, FAO aims at supporting governments in developing risk-related policies, among others, by issuing related policy briefs. 42 A number of innovative developments can help to facilitate agricultural risk management in developing countries. For example, micro-insurance schemes can provide crop or livestock insurance to small producers. Weather index insurance can help to overcome the potentially large transaction costs involved in identifying crop losses on individual small farms, and at the same time guard against moral hazard. 43 Guidelines on disaster risk management, such as those put together by FAO, can help to improve preparedness and rapid response in dealing with natural hazards. 44 When it comes to dealing with price volatility on agricultural markets, arguably the most severe issue in poorer countries is the threat to food security resulting from food price spikes. Rising food prices have a positive impact on farmers in developing countries and provide incentives to invest in agriculture and expand production. Through their impact on employment creation in agriculture and rural regions, they may in the longer run even have positive implications for net food consumers, i.e. those families that consume more food than they produce. 45 However, the most immediate and often dramatic impact of spiking food prices is the extra poverty and malnutrition that they generate among low-income food consumers, including those in agriculture that produce less food than they need for their families. In the short run, that poverty impact of high food prices dominates. Recent World Bank research on the 2010-11 surge in food prices has shown that the adverse welfare impact on net food buyers outweighs the benefits to

Dealing with these grave consequences of food price spikes is a major challenge for developing country governments. Among the many policy responses observed in recent years, the most promising approach with the least negative longer-term implications is the targeted use of social safety nets to assist those families whose livelihood is threatened by rising food prices. Indeed, several developing countries made use of their safety net regimes in recent episodes of spiking food prices. Probably, one of the most important lessons is that well designed safety net regimes need to be put in place in quiet times, for them to be available and fully functioning when a food crisis hits. Another lesson to be drawn from recent experiences with responding to exploding food prices is that many developing countries have difficulties mustering the requisite budgetary resources in crisis times. The international community can, and should, do more to help poor countries establish the necessary safety net regimes, and to finance their operations in episodes of surging food prices. Limited emergency food reserves, at both the national and international levels, can also help to make targeted food assistance available to the most vulnerable families. Finally, there are options for helping developing country governments to hedge prices of their food imports, and to protect them against counterparty risk in international trade contracts.

Risk Management Policy for Small Holders

In India, agricultural risks are exacerbated by a variety of factors, ranging from weather variability, frequent natural disasters, uncertainties in yields and prices, weak rural infrastructure, imperfect markets and inadequate and sub-optimal

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49 Ibid.
financial services including the limited span and design of risk mitigation instruments such as credit and insurance. These factors not only endanger the livelihood and incomes of small farmers but also undermine the viability of the agriculture sector and its potential to become a part of the solution to the problem of endemic poverty of farmers and agricultural labour. The critical nature of agriculture with respect to rural transformation and the national economy, considered alongside its inherent structural characteristics, requires substantial governmental and financial sector interventions in order to not only ensure the food and nutritional security of households in the farming community but also generate savings and investments in this grossly under-funded sector. The poor infiltration and development of various risk management tools in India also represents huge opportunities for the emerging agricultural insurance and commodity markets in terms of pulling producers out of the poverty trap by insulating them from income shocks and ensuring that a fair share of the price goes to the producer.

Farmers use a variety of formal and informal techniques to manage and mitigate risk, ranging from the use of drought resistant crop varieties to reduced consumption and sale of assets. The Government is also implementing a large number of schemes to provide succor to farmers facing adversity. As it is currently operating, the Comprehensive Agriculture risk management framework can be presented in three main categories:

Figure 3.3
Comprehensive Agriculture Risk Management Framework
The first covers direct initiatives on the part of the Government, such as agricultural credit, input subsidies and calamity relief.

The second covers indirect initiatives on the part of the Government to mitigate production risks through insurance mechanisms covering crops, weather and livestock and including micro insurance.

Thirdly, Government and market-based approaches to mitigate price or income risks, which includes minimum support prices, farm income insurance, a price stabilization fund, commodity markets, contract farming, etc.

**Insuring Agricultural Risk**

Insurance is a commonly used risk-transfer mechanism. Throughout the developed world, and in many developing countries, insurance is available to protect against the financial implications of events such as automobile collision, theft, and property damage caused by fire, wind, and other perils. Personal liability risk is also commonly transferred, as is the risk of illness or injury. When purchasing these insurance policies, individuals choose to accept a relatively small, consistent stream of losses (the insurance premiums) rather than face the risk of a large loss that is unlikely but possible. Production risk transfer in agriculture using insurance is much less common, however.

**Insurability Conditions**

Not all risks can be insured: Uninsurable risks violate one or more of five necessary conditions identified in the insurance literature. In particular, agricultural risks are unlikely to sufficiently meet these conditions:

Determinable and measurable loss: it must be possible to determine clearly when a loss has occurred and its magnitude; if not, settlements of claims will frequently require costly litigation. This dramatically increases the cost of providing insurance.

*Accidental and unintentional loss*

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Indemnities should be paid only when a loss has occurred due to a random event over which the insured has little or no control. If insureds can engage in hidden actions (including, but not limited to, fraud) that increase the probability of loss and/or its magnitude, indemnities will be higher than anticipated. Insurers often call this the “moral hazard” problem. Insurers can attempt to address this problem through increased monitoring of policyholders’ behavior, but this can be very expensive. Deductibles and co-payments can also be used to reduce the incentive for moral hazard.

Calculable expected frequency and magnitude of loss

To develop a premium rate, the insurer must be able to estimate accurately both the expected frequency and expected severity of loss. Of course, insurers understand that these estimates are likely to be imperfect. For that reason, insurers often load premium rates to account for uncertainty in estimating these factors. If the uncertainty is minimal, the load will be rather small. However, if the uncertainty is large, the load can be so high that the insurance is unaffordable. Potential insureds can be accurately classified into roughly homogeneous pools. Insurers typically do not develop premium rates on an individual basis. It would be very expensive to calculate the expected frequency and magnitude of loss for each individual insurance applicant. Instead, insurers attempt to classify applicants into risk pools and develop a premium rate for everyone in that pool.

Large number of independent exposure units

Insurers invest in a portfolio of insurance policies. The variance in returns on the insurer’s portfolio can be reduced by diversifying over a large number of insurance policies if the indemnities paid on those policies are independent or, at least, not highly positively correlated. If indemnities paid on the insurance policies are highly positively correlated, the variance in net returns from the portfolio will be quite large. Insurers seek to manage this portfolio risk by purchasing reinsurance and/or maintaining financial reserves. Note, however, that each of these risk management strategies comes at a cost. Insurers must pay a premium for reinsurance, and financial reserves must be maintained in a liquid state in case they are needed to pay indemnities. These funds would likely earn a higher rate of return if they were
invested for longer periods of time. Despite laying out such clear-cut conditions of insurability, many insurance products are available for risks that deviate somewhat from these ideal conditions. However, these deviations must be recognized and addressed when insurance products are being designed. Failure to do so may jeopardize the long term viability of the product. Risks characterized by extreme violations of these ideal insurability conditions are likely not insurable.

**Correlated Risk**

When considering the potential functionality of any risk-transfer instrument, a major consideration is the degree of correlation in financial losses caused by the risk, and building a diversified portfolio of insureds. Aggregating uncorrelated risks into a single insurance pool reduces the variance of loss. In other words, when considering a pool of uncorrelated loss events, the mean of the individual variances is always greater than the variance around the mean loss of the pool. This result follows from the statistical property known as the “law of large numbers.” Society benefits from insurance markets that pool uncorrelated risks, since the risk faced by the pool is less than the pre-aggregated sum of individual risks.\(^5\)

Agricultural production losses tend to be characterized by some degree of positive spatial correlation. This is especially the case when considering losses due to weather events since weather patterns are generally similar over large geographic areas. Thus, the degree of positive correlation is often inversely related to the size of the region under consideration: relatively small (large) countries are likely characterized by more (less) positively correlated agricultural losses. Positive spatial correlation of losses limits the risk reduction that can be obtained by pooling risks from different geographical areas. This increases the variance in indemnities paid by insurers. As a result, it also increases the cost of maintaining adequate reserves or reinsurance to fund potentially large indemnities caused by systemic loss events. In general, when losses are more positively correlated, insurance is less efficient as a risk-transfer mechanism. Other risk-transfer markets are better suited to highly positively correlated risks. For example, well-developed futures exchange markets

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exist to transfer risks associated with commodity prices, interest rates, and exchange rates and in each case, the underlying price generally moves together. In recent years, various capital market instruments have been developed for transferring highly correlated weather risks or risks associated with natural disasters.54

In general, agricultural production losses are typically neither uncorrelated nor highly positively correlated. They are what have been referred to as “in-between” risks.55 This implies that, if used exclusively, neither insurance nor capital market instruments are well suited for transferring agricultural production risks. However, a careful blending of these instruments can foster further development of agricultural risk-transfer opportunities, and weather index insurance contracts lend themselves to facilitating that blending.

**Implications for Agricultural Risk Transfer**

Given the insurability conditions and also some understanding of the current systems that producers use to manage risk,56 there are a number of implications for anyone considering developing risk-transfer products for natural disasters in agriculture:

► Relative risk varies by crop and region and these differences must be reflected in the price of the risk-transfer instruments.

► Individuals have many choices for managing risk; development must occur with an awareness of current risk management systems.

► Risk management comes at a cost.

► Not all risks are insurable.

► Not everyone wants (or needs) insurance.

► With insurance, one size does not fit all.

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Adverse selection and moral hazard are impediments to managing risk and more information is needed to control and mitigate these problems.

One must have sufficient data to calculate premium rates. Uncertainty about the frequency and/or magnitude of the risk being insured leads to higher premium rates via premium loads for the ambiguity of risk and builds catastrophe loads more quickly.

Multiple-year risks are almost impossible to insure without significant experience; therefore new product development should focus on single-year risks.

**Insurance as an Adaptation to Climate Variability in Agriculture**

Insurance is the largest global industry, with total revenue of $3.2 trillion US. It is also one of the most vulnerable to the effects of climate change. Penetration rates in developed countries are 100 times larger ($2700 US per capita) than in developing countries ($25 per capita). The growth potential of the industry is, therefore, great, but there are risks involved, especially for insurance policies offering coverage against damage caused by natural catastrophes. The industry is aware of the main challenges that climate change poses for its healthy growth and expansion. It is also a leading sector in the fight against climate change and a leading voice in requesting that security levels for construction, infrastructure and human settlements be upgraded and that exposure be reduced. Standard actuarial techniques, insurance contracting and risk transfer and pooling will not be sufficient to avoid significant losses if the insurance industry is to keep expanding and offering protection against natural catastrophes. Although it is relatively small, the agricultural insurance sector is also expanding in many countries. With almost no exceptions, growth in insured capital and coverage expansion has been coupled with intense public participation in the form of premium subsidies, public reinsurance, tax rebates,

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59 Ibid.
60 The International Conference of Agricultural Insurance held in Madrid in March 2010 provided a venue for officials from many countries to report the most recent trends (papers can be found at http://enesa.mapa.es/)
direct insurance participation, and market regulatory frameworks. Many policy issues associated with the role of public agencies in agricultural insurance have been discussed in the literature for decades.

Many of the challenges that threaten the survival of insurance companies also affect agricultural insurance branches and companies. To the extent that agriculture will be profoundly transformed by climate change, the insurance sector will have to adapt to new risk profiles while at the same time constantly innovating and seeking to offer new policies.

Role and scope of agricultural insurance

There are a number of key potential benefits from managing weather risk through agricultural risk transfer and insurance either at the individual farmer level (micro level insurance) or at a government-level (macro level) including:

- protecting rural livelihoods and smoothing incomes during major events, thereby reducing the potential for farmers to fall into the poverty trap;
- protecting the productive capacity of rural enterprises and farm households;
- protecting financial institutions against weather-related loan defaults; and
- financing disaster relief and encouraging structured social safety net policies.

Crop insurance enables farmers to remain creditworthy even in years of major crop loss and to avoid falling into the poverty trap. Individual farmer-traditional or index-crop and livestock insurance can play an important role in protecting farmers’ consumption and productive assets in years of major production losses, thereby

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65 Skees, J.R., & Murphy, A., ENSO Business Interruption Index Insurance for Catastrophe Flooding in Piura, Peru (Lexington, Kentucky: Global AgRisk), 2009.
enabling them to avoid falling into the poverty trap. More importantly, it may enable them to pursue riskier, but potentially much more profitable, farming activities which usually centre on the use of credit to purchase new production enhancing technology.

Agricultural insurance has the potential to play an important role in leveraging small farmers’ access to rural finance. The introduction of weather index insurance in India has shown that financial institutions are often willing to use a crop insurance policy as a substitute for traditional collateral requirements and that they are more willing to lend to these farmers because their loan is protected against climatic risk and production shortfall induced default. Experience shows that bundling agricultural insurance with rural credit provision and input supplies could offer major advantages. The bundling of crop insurance with credit and input supplies has shown to provide a win-win situation for farmers, lending institutions and insurers alike. The farmer gains access to seasonal crop credit, lending institutions are more willing to lend to small farmers because their loans are protected by crop insurance and the insurer benefits from: (a) reduced anti-selection, which in turn reduces the need for pre-inspections; (b) the reduced costs of marketing crop insurance; and (c) the insurance uptake and spread of risk is much better than would normally be achieved under a purely voluntary programme.

Agricultural insurance can also be used as a meso level instrument to protect rural bank lending (loan portfolio or business interruption protection). From the bank’s perspective, farmers who have crop insurance protection are less likely to default on their loans in the event of major weather induced crop failure. It also means that, in the event of a major regional flood or drought, the bank’s loan portfolio is protected against loss, enabling the bank to remain solvent and to reschedule farmers’ loans and to continue lending. Claiming on a crop insurance policy and rescheduling loans

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are generally much more acceptable to a bank than having to resort to the courts to recover their debts. At the national level, there also appears to be an important role for linking disaster risk management with an ex-ante macro level weather-index insurance policy.

**Climate Change and Agricultural Insurance**

There is much debate about the role of agricultural crop insurance and especially weather index insurance as a climate change adaptation tool. IRI (2009) lists three ways in which index insurance may contribute to climate change adaptation strategies in developing countries. *First*, index-insurance may help as a risk transfer mechanism within a comprehensive adaptation strategy involving, for example, more drought resistant crop varieties, micro irrigation, rainwater harvesting and improved soil conservation practices such as zero tillage and direct seeding: crop-index insurance would cover the unmanageable or catastrophe risk exposure. *Second*, index-insurance can contribute to adaptation through building more resilient livelihoods by increasing farmers’ access to credit and thereby enabling them to invest in more resistant crop production systems, technology and inputs. *Third*, crop insurance might be used as a mechanism to incentivize farmers facing climate change to adopt risk reducing strategies; for example, by insisting that drought resistant varieties must be used if the crop is to be deemed insurable. In this case, it is worth noting that all crop and livestock insurance policies make cover conditional on the farmer adopting in full, the recommended technical and husbandry practices for that crop/class of livestock. Climate change poses specific challenges for the design and rating of traditional and index-based crop insurance products. Most of the climate change predictive modeling work suggests that, over the twenty-first century, the trend in global warming will lead to significant increases in average temperatures of between three to five degrees in much of Africa and Asia. Climate change may lead to some risks and locations being uninsurable in future. This applies particularly to perils such as river flood and tidal surge leading to flooding in coastal regions. The rise in sea levels associated with global warming and melting of glaciers:

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the ice-caps, may therefore, be particularly detrimental to the future provision of crop and livestock insurance in Asia.

Limitations of agricultural insurance

Agricultural insurance is not a panacea and cannot replace sound risk management. Agricultural insurance has many limitations: it does not prevent the loss of the insured crop or tree or animal or other farm assets. It is not always the most appropriate option to manage risks, in terms of cost-effectiveness or affordability. For example, in some parts of Europe and Argentina that experience very high hail exposures, commercial fruit and flower farmers find it more cost-effective to invest in hail netting to prevent damage to their crops, rather than to claim on their crop hail insurance policies, which in any case are not designed to cover the full value of their lost revenue.

Similar comments apply to frost where, under certain conditions, it is more cost-effective to use frost prevention measures (e.g. sprinkler irrigation, fire-pots, wind-fans, smoke-generators) rather than to purchase frost insurance. Too often, agricultural insurance is perceived by policy-makers as a means of providing a safety net for farmers or even increasing their revenues. Agricultural insurance cannot solve problems of low farm income and poverty by itself. Although it can sometimes help channel additional social benefits to targeted farmers yet, it should not be considered an instrument that can provide poor farmers with higher revenues.70

Agricultural insurance on its own is not a solution. Agricultural insurance can contribute towards stabilization of agricultural production and farm incomes in times of major production loss and also to the modernization of agriculture through its ability to leverage access to credit thereby enabling farmers to purchase production-enhancing technology. However, agricultural insurance cannot be effective if it is provided in isolation. It should be promoted only when other essential agricultural services, including training and extension, the timely availability of inputs (seeds,  

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70 Mahul, O., Stutly, C. J., Government Support to Agriculture Insurance: Challenges and Options for Developing Countries, op.cit.
fertilizers, and pesticides) and efficient marketing channels for agricultural outputs, are in place.  

Often agricultural insurance is misunderstood as a silver bullet for risk management and climate adaptation. However, as Warner et al (2009) point out, (agricultural) insurance will fail to reduce risk and to advance adaptation unless it is implemented along with risk management and disaster risk reduction measures. With climate change, agricultural insurance tools will be challenged to cover increasingly frequent and intense events. Furthermore, traditional insurance may not be the appropriate tool for longer term foreseeable risks such as sea-level rise and desertification. In such cases, other measures including basic investments in risk reduction make more sense.

Traditional crop insurance cannot provide solutions for subsistence farmers. There is much evidence today that traditional individual farmer multiple peril crop insurance does not work for small and marginal farmers and usually ends up being heavily subsidized by governments. Individual farmer crop insurance is a tool that is most effective when the farmer produces a crop for sale and where he or she invests in purchased inputs and services often; using formal credit in such cases, the farmer faces a financial risk in the event of crop failure, and risk transfer through purchasing crop insurance is often justified. For small subsistence farmers producing food crops for on-farm family consumption, crop insurance is a luxury few of them can afford, hence governments’ intervention to make crop insurance more affordable through premium subsidies.

Types of Agricultural Insurance

Crop insurance is used mainly to cover harvest losses due to weather events. It includes single-risk insurance, combined insurance and yield insurance (multiple-peril crop insurance, (MPCI), in the US, according to the nature and number of the covered hazards. Table 3.4 shows the main types of insurance and their associated risks.

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71 Ibid.
Table 3.4
Insured Risks

<table>
<thead>
<tr>
<th>Insurance</th>
<th>Covered risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single risk (named peril)</td>
<td>Hail (hail + fire)</td>
</tr>
<tr>
<td>Combined risk - Different for different types of insured crops</td>
<td>Hail, frost; Hail, frost, flood; Hail, frost, storm, flood.</td>
</tr>
<tr>
<td>Yield insurance / MPCI</td>
<td>All climatic risks, Hail, fire, frost, storm, flood, drought, (plant diseases and pests usually not covered in Europe)</td>
</tr>
</tbody>
</table>

Single risk insurance (especially hail insurance) has a long history and is well developed in Europe and North America. Insurance policies developed to protect against the risk of frost or against a limited number of meteorological events can be referred to as combined risk insurance or pluri-risk insurance. Usually, private companies provide coverage only against hail and fire or against a limited number of risks, including floods or excessive rain. As government involvement in insurance increases, more comprehensive coverage against all climatic risks may be provided by insurance.73

Index-insurance products have been developed in recent years that have no negligible potential as means of adjusting to climate change. Index-contracts are more like financial derivatives or options than like insurance contracts.74 However, under certain conditions, they can be considered insurance: “The weather derivative can be brokered as an insurance contract or as an over-the-counter traded option”.75 Weather derivatives or weather options are managed by the private sector, so there is limited information available about them. Instead, there are tens of experiences already documented with various types of weather or index insurance.76

73 Mahul, O. and Stutley, C.J., Government Support to Agricultural Insurance. Challenges and Options for Developing Countries, op. cit.
Some authors argue that future insurance contracts should grow as variants of index-insurance to avoid the administrative costs and welfare losses associated with moral hazard and adverse selection.\textsuperscript{77} In fact, the main advantages of weather insurance over traditional crop insurance are that they avoid moral hazard and adverse selection problems, thus allowing for higher levels of coverage. It is easy to sell them through banks or through any other financial organization; they are transparent and affordable and entail very low administrative costs. However, an insured event may not always reflect the production losses that individual farmers experience, so they are more appropriate for very homogeneous areas and for reinsurance. Index-insurance pricing is a complex issue: traditional methods of pricing financial derivatives have been used, but insurance or actuarial methods may be more appropriate. At the same time, the possible impact of climate change is difficult to assess. There are many types of index insurance. We can distinguish two main groups:\textsuperscript{78}

- Area yield and revenue insurance (the index is an area’s average yield or income);
- Indirect index insurance, which is exogenous and yield tailored. These forms of insurance can be based on one or several indicators:
  - Meteorological indicators (the indices measure variables such as rainfall or temperature);
  - Agro-meteorological indicators (the indices measure indicators including the agronomic parameters of the crop such as soil moisture or leaf area index);
  - Satellite imagery indicators (using vegetation indices computed from satellite images).

Within the indirect index category, we can find examples of exogenous index insurance and of yield tailored insurance. The exogenous indexes either involve a fixed payment per unitary index decrease (for example, a payment of 1€ per 1 mm of rainfall shortfall) or are proportional (a 50% decrease in rainfall will trigger compensation in the amount of 50% of the insured capital). The yield-tailored

\textsuperscript{77} Ibid.
examples are more complex, and yield is adjusted by estimating a model that either combines several indicators or uses only one.

Index insurance products have actually been implemented as pilot programs all around the world. Index insurance can help manage catastrophic and highly covariate risks such as hurricanes, floods and severe (possibly back-to-back) droughts - serving clients, such as public or NGO relief agencies - that need to respond urgently in case of catastrophes. It can also be useful for financial agencies providing credit, rural households and input suppliers in areas subject to specific and easily measurable climatic hazards.\(^7^9\)

Livestock is subject to sanitary risks that can change with climate conditions (as changes in temperature and humidity can affect disease propagation), and livestock production is also dependent on forage and pasture availability, which is in turn subject to climatic hazards. Thus, climate change can affect livestock risk on two different fronts.

Livestock insurance has long existed in many countries for accidents and for non-contagious diseases. Epidemics and diseases that can directly affect human health are usually regulated by governments and covered by ad-hoc aid, so there is not as much of a need for insurance to cover this type of animal disease.\(^8^0\)

**Why Should Governments Support Agricultural Insurance?**

Market and regulatory impediments are often invoked to justify public intervention in the provision of agricultural insurance. Governments should identify and address these impediments, described briefly below, to help farmers complement their risk management activities with potentially cost-effective financial tools such as insurance.

**Systemic Risk**

One of the central arguments for government intervention in the provision, administration, and oversight of agricultural insurance programs involves the

\(^7^9\) Hazell, P., J. Anderson, N. Balzer, A. Alstrup Clemmenson, U. Hess & F. Rispoli, *The Potential For Scale And Sustainability In Weather Index Insurance For Agriculture And Rural Livelihoods*, op. cit.

presence of systemic risk (that is, risk that affects a large number of economic units, such as farmers and herdsmen, simultaneously).

The systemic component of agricultural risks can generate major losses in the portfolio of agricultural insurers. Estimated probable maximum losses for major events, such as those occurring once every hundred years, may exceed average expected losses by many times and seriously affect the financial solvency of insurance companies. Public intervention would be justified because no private reinsurer or pool of reinsurers has the capacity to cover such a large liability when the risks, even though small, may be difficult to diversify.

**Informational Asymmetries**

The two critical informational problems that any insurance program faces are adverse selection and moral hazard. They are intimately tied to the difficulties associated with measuring risks and monitoring farmer behaviour. It may be very difficult for private entities to measure risks, collect relevant data, monitor producer behaviour, and establish and enforce underwriting guidelines. These difficulties can result in high, sometimes prohibitive, transaction costs that preclude the development of private insurance markets.

Governments have a major role to play in reducing informational asymmetry. The development and maintenance of agricultural and weather databases as public goods can help insurers properly design and price agricultural insurance contracts, thus reducing adverse selection. Public extension services assisting and supervising farmers in the management of their production risks before and after the occurrence of a loss can help reduce moral hazard.

**Post disaster Assistance Programs**

Governments tend to alleviate the effects of crop failures or other disasters by providing post disaster direct compensation as a relief measure. This poses a “Samaritan’s dilemma,” whereby post disaster aid discourages programs such as insurance, which provide more efficient financial solutions and reduce the magnitude of losses from future events.
Limited Access to International Reinsurance Markets

Access to the international reinsurance market is often limited in developing countries, particularly for specialized lines of business such as agricultural insurance. In recent years, agricultural reinsurers and brokers have shown increasing interest in developing their business in low- and middle-income countries, particularly in large countries such as China and India. Smaller countries with far fewer business opportunities may have more difficulty attracting these international companies. Reinsurers report that reinsurance capacity is available for crop and livestock programs that are properly designed and have rates that generate sufficient premium volume to cover expected losses, operating costs, and cost of capital (including profit).

Agricultural Risk Market Infrastructure

An important supply-side impediment to the provision of agricultural insurance in developing countries is the lack of infrastructure support for agricultural insurance. Government could create these public goods, such as agricultural and weather databases and crop risk models, providing domestic agricultural insurers with reliable data and quantitative tools to better assess their catastrophe risk exposure and thus design actuarially sound agricultural insurance products.

Low Risk Awareness

Farmers tend to be very aware of their production risks. They may exhibit “cognitive failure”, however, in that they may underestimate the likelihood or severity of catastrophic events. Stakeholder consultations in India and Mongolia reveal that farmers and herders recall the occurrence of major past events but tend to underestimate their severity. Governments may play an important role in providing farmer awareness and education programs and in supporting the marketing and promotion programs of the private commercial insurance sector.

Lack of Insurance Culture

A commonly cited reason for the low demand for agricultural insurance in developing countries is the limited understanding of its benefits. Insurance is often perceived as a nonviable investment, because premiums are collected every year but
indemnities are paid much less frequently. The general population views insurance, particularly agricultural insurance, which, by definition, pays only when infrequent events occur coverage as a privilege of the rich.

Regulatory Impediments

The regulatory frameworks governing insurance markets in many low- and middle-income countries tend to be underdeveloped. As a result, regulatory overlay can in some cases inhibit increased penetration of insurance, including agricultural insurance. Innovative agricultural insurance products, such as index-based crop insurance or parametric (weather-based) crop insurance, require an enabling regulatory framework.

How Should Governments Support Agricultural Insurance?

Where it is offered, public support to agricultural insurance is part of the government’s overall agricultural policy, which may seek to correct market and regulatory inefficiencies and be part of broader objectives. Each agricultural insurance program is unique and requires tailor-made solutions. That said, several key features emerge that governments may want to consider when designing and implementing agricultural insurance. Agricultural insurance is part of a comprehensive agricultural risk management framework. It can contribute to the modernization of agriculture. However, it cannot operate in isolation. It should be promoted only when basic agricultural services such as timely availability of inputs, extension services, and efficient marketing channels for agricultural outputs are in place. Agricultural insurance programs need to be customized to beneficiaries. The emerging commercial agricultural sector needs more standardized insurance products offered through cooperatives or rural finance institutions, such as credit-linked agricultural insurance. The traditional farming sector may not be geared towards commercial insurance; governments may, therefore, need to consider alternative support mechanisms, in the form of social safety-net schemes, for example.

Agricultural insurance is a complex line of business that requires highly technical expertise, both in development and operational phases. Private insurance markets have proved to be efficient, without public intervention, for dealing with
nonsystemic risk and large farmers, but purely commercial insurance may not be viable for systemic risks or smaller farmers. The primary role of governments should be to address market and regulatory imperfections in order to encourage participation by the private insurance and reinsurance industry. In competitive markets, insurance premiums should be risk-based and differentiated, thus reflecting the underlying risk exposure. Actuarially-sound rates draw attention to the agricultural production risk exposure of individuals, firms, or governments and allow them to evaluate the benefits of agricultural risk management programs by comparing the cost of risk reduction investments with the resulting reduction in potential losses. They inform farmers and herders about their risk exposure and provide them with incentives to invest in risk mitigation activities (for example, irrigation) or to shift from nonviable crops to more viable crops. Risk-based premiums can also assist governments in the financial planning of agricultural losses through improved assessment of their contingent liability. By understanding their exposure, governments can better assess their liabilities in case of natural calamities and devise appropriate financial strategies.

Governments must carefully analyze the fiscal implications of government sponsored agricultural insurance programs, costs of which may not be sustainable in the long term. Subsidies on agricultural insurance premiums should be carefully considered, because they can distort price signals and provide inappropriate incentives to farmers and herders to invest in unprofitable farming activities. The World Bank survey does not support the argument that premium subsidies are always a prerequisite if farmers and livestock breeders are to purchase voluntary crop and livestock insurance, as shown by several named-peril crop insurance programs. Where subsidies are offered, planners should carefully identify which beneficiaries, crop or livestock sectors, and regions to target and whether the subsidies will be provided for a limited period or phased out over time, once agricultural insurance takes off and achieves a critical presence in the market. In start-up situations, where market infrastructure is not yet developed, a technical support unit could be established to provide specialized services to agricultural insurance companies and other risk-pooling vehicles.
This unit should have support from the government, insurers, and reinsurers. It could be either a stand-alone entity or hosted by an insurance provider (such as agricultural insurance pools or monopoly insurer). The goals of the technical support unit would include the following:

• Create a centre of expertise able to support the development and scaling up of agricultural insurance.

• Establish a core team of agricultural insurance experts to provide technical support to agricultural insurers in underwriting, product development, pricing, product delivery, loss adjustment, catastrophe risk financing, and so forth.

• Create and manage a centralized database of agricultural and weather statistics, and make the database available to agricultural insurance practitioners.

• Promote the exchange of expertise among insurance companies and access to international best practice through training courses, operations manuals, and other means.81

Agricultural Yield Insurance

The traditional risk management and coping mechanisms are often time neither sufficiently robust nor cost effective. The amount of residual risk that remains with the household in question may induce asset liquidation and poverty. Ex-post government relief actions also create incentive problems and are costly to the treasury. Agricultural yield insurance is a financial contingency contract that transfers production risk from a producer to another party via the payment of a premium that reflects the true long-term cost of the insurer who is assuming the risks. The insurer pools the risks faced by a large number of individuals and covers losses incurred by any one individual in the pool. It serves to essentially protect assets, stabilize income, and smooth consumption. However, for insurance to be viable and sustainable, there are certain “ideal” conditions for the risk to be considered insurable and for a self-sustaining market to appear.

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

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

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

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

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

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

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

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

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

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

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

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

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

Impediments to the Development of Agricultural Insurance Markets

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

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

Agricultural production losses, deviate from the ideal and tend to fall between the two extremes of being 100% uncorrelated and 100% correlated. Agricultural yield losses tend to be characterized by some degree of positive spatial correlation. The degree of spatial correlation is often inversely related to the size of the region or country where activities will be insured. Thus, relatively small countries are likely to be characterized by more positively correlated agricultural losses than a large country. Moreover, positive spatial correlation in losses reduces the benefits that can

83 Ibid.
be obtained by pooling risks from different geographical areas. When risks are perfectly correlated, insurance fails as an instrument of risk transfer, and capital market instruments such are derivatives are more appropriate.

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

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

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potential losses for the insurer. To overcome this problem, the insurer has to design better contract designs and rely on less costly systems of monitoring.

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

**Mismatch between Farmers Preferences and Willingness to Pay:** Many farmers seem to have a limited willingness to pay a premium that covers the cost of the service provided. As a result, a sustainable market does not appear. Farmers seem to prefer insurance that protects a sizeable proportion of income from multiple threats as opposed to ones that partially cover income loss from a specific threat. These types of insurance products, revenue and multiple peril, are the most costly and difficult products for private insurance companies to provide in a profitable and sustainable manner. The financial performance of multiple peril insurance

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88 http://www.ifc-commrisk.org/
programs has been universally disappointing.\textsuperscript{90} The fact that these insurances are designed to protect against losses from a multitude of perils makes the calculation of probable losses and the determination of actuarially fair premiums very difficult if not impossible. In the countries where these types of policies are offered, they normally require substantial government subsidization.\textsuperscript{91} The products that can be delivered profitably and at affordable premiums are specific or single peril policies ‘hail and fire’ and parametric or index-based products. But they have less broad-based appeal. In the case of parametric products, those that pay an indemnity when an easily observable and independently verifiable “trigger” occurs, usually a particular temperature or rainfall level is struck, suffer from basis risk. Basis risk is when insurance is bought and an economic loss is realized but the indemnity payment is not made. Due to differences in microclimates and quality of information, an individual farmer’s crop yield distribution may not closely correspond to the distribution used for the index. In the case of developing countries, like India, much more empirical research is needed to measure farmer’s risk attitudes and capacity to pay for crop insurance.

\textbf{Cognitive Failure:} Some farmers may perceive the risks they face as being smaller than they actually are. This phenomenon is called “cognitive failure” and can stem from either insufficient information or an inability to properly process and assess information. In common language, it is the feeling of invincibility: “That can’t happen to me”. Also it refers to the common feeling among farmers that “premiums paid are lost money if nothing happens”. Many farmers tend to dismiss low probability but high cost events in their decision-making processes and to just focus on developing risk management strategies for high frequency, low cost events, the “commonplace threats”.\textsuperscript{92}

\begin{footnotesize}

\textsuperscript{91} Goodwin, B. K., “An Empirical Analysis of the Demand for Multiple Peril Crop Insurance”, \textit{American Journal of Agricultural Economics}, op. cit.

\end{footnotesize}
Inadequate Legal and Regulatory Frameworks: Legal and regulatory frameworks can either help to promote or hinder the development of agricultural markets. The most common areas of complaint from insurers and observers concern the following:

Inappropriate Reserve Requirements: Often time capital reserve requirements are adequate for life, auto, property, and casualty lines of insurance but not for agricultural insurance due to higher rates of rotation in the portfolio. Many agricultural production cycles are a few months long and if capital has to be reserved for period longer than the actual length of risk exposure, it increases the reserve load in the premium and makes the product unattractive to client. Possible solutions could entail treating agricultural insurance reserves like marine insurance reserves and use of more sophisticated calculations.

Agent Licensing Requirements: How to deliver agricultural insurance to small holders is a big obstacle and one obvious way around this obstacle would be for rural microfinance institutions and rural development NGOs, and cooperatives to serve as agents for insurance companies selling agricultural insurance products. Often, the agent licensing provisions are either too strict or too lax. Some countries’ insurance laws may require a long number of years, formal training, and other high qualifications, which make it difficult for young microfinance institutions to qualify. Other time, the laws may require that the agent be a natural person, thereby eliminating the possibility for a cooperative or NGO. Traditional individual agents have little incentive to sell agricultural insurance compared to auto and life. The latter two are high margin and imply less administrative costs and time. Possible solutions to help protect consumers against mis-spelling of insurance policies but at the same time, to facilitate the development of agricultural insurance, need would be for specialized training for financial intermediaries, NGOs, cooperatives etc. in the selling of agricultural insurance and the adoption of market conduct standards subject to compliance checks.

Reporting requirements: Lastly, the reporting requirements can place a high burden on an insurance company that wants to specialize in a low-income, high-risk segment of the market. The impetus to the insurance company would be to specialize in more lucrative lines such as auto and life, where the high cost can be
more easily borne. Regulators do need information but the practical issue of maintaining computerized databases for a dispersed, low-income clientele is a serious one for crop insurers wanting to expand in developing countries. Possible solutions may involve more streamlined and effective reporting for agricultural insurers and encouragement and support for agricultural insurers to invest more heavily in wireless technology, if the infrastructure of the country permits.

*Product Classification*: Many times when an insurance company wants to introduce a weather-based index, there is a legal debate as to whether it is a derivative and therefore subject to the rules governing capital market securities or whether it covers an “insurable loss” and should be subject to the rules governing insurance products. If the crop insurance market is to develop, parametric or index-based instruments need to be classified as insurance products and not as derivatives so that easier and more flexible delivery systems can be used to get the product to small holders. The most promising retail delivery channels for parametric products and other insurance products targeting the low-income farmers are indirect ones. Urban-based brokers and insurance office outlets will not suffice. Moreover, capital market instruments are aimed at sophisticated and knowledgeable market participants and may be subject to very little regulation or a very direct regulatory regime than insurance products. The capital market regulatory regime may not include sufficiently strict financial reserve requirements nor be subject to market conduct rules equivalent to those that international standards require. Thus, small farmers, within the regime where parametric products are classified as derivatives, will not have the benefit of the regulatory protection that they need. In short, the farmer-client is at serious risk of abuse. If index-based risk management products are not recognized as insurance products with an “insurable interest” and the requirement that an insurance policy indemnifies a loss, there is a risk that the framework will not recognize payment against an index. 93

*Distorted Incentives*: When governments intervene and make ex-post unconditional emergency relief payments, forgive loan contracts, and/or offer subsidized emergency loans, it removes the incentives for farmers to purchase insurance ex-

93 Ibid.
ante and for insurance companies to innovate and offer appropriate crop insurance products. The government intervention is often justified on the ground that private insurance companies are unwilling or unable to supply crop insurance in an efficient manner. This dilemma of “crowding out” or market failure has raged, at least in the U.S. economic literature, for decades. The issue needs to be recast as finding an appropriate facilitation role for the government and distinguishing clearly between disguised income transfers and risk management tools.

**International Re-insurance Market:** The market for agricultural re-insurance is limited due to the high cost of re-insurance premiums and reluctance on the part of re-insurers to develop a cadre with the necessary specialized knowledge and information systems required to properly monitor and evaluate agricultural risks. Since crop yields are highly spatially correlated, private insurance companies cannot effectively pool risk at the regional or even at a country level, especially if it is a small country. The Maximum Probable Loss and Maximum Foreseeable Loss estimates would exceed capital reserves and thus the insurer needs to cede or transfer a portion of the portfolio risk to an external party, either an international re-insurance company, a national government, or a supranational government agency. International re-insurance companies have the capacity to absorb large insured losses and for years have done so, especially for major natural catastrophes. For instance, in 1992, international re-insures paid out $23 billion to cover insured losses in association with Hurricane Andrew and in 2005, would have paid out in the order of $60-80 billion for Hurricane Katrina. Agricultural losses due to drought or flood are likely to be less than the cost of a major hurricane or earthquake, but the levels could be appreciable and repeated from year to year. Accordingly, only a few of the international re-insurance companies have agricultural divisions, the combination of lack of analytical capacity and expensive re-insurance at the national level. At present, only four of the more than 60 re-insurers worldwide have substantial agricultural portfolios, Munich Re, Partner Re, Hanover Re and Swiss Re. Two in particular have strong expertise in analyzing weather-based indexes, Swiss RE and ACE, because they hired many former Enron employees. Enron was the pioneer in the use of weather index derivatives in energy markets in the early 1990s.
Given this list of formidable problems in the path of sustainable development of agricultural insurance, the question becomes what we have learned from previous experiences with crop insurance, what trends are discernible in Latin American markets, and what should be done to promote market development.

**Agricultural Insurance around the World**

It is estimated that about 50 percent (104 nations) of all countries have some form of agricultural insurance: of these, 86 countries have mature programmes and 18 countries are piloting new crop or livestock insurance schemes. The growth in interest in agricultural insurance both by governments and private commercial insurers is evidenced by the fact that 20 years ago only about 50 countries were identified with some form of agricultural insurance (FAO, 1991b). In 2009, the global agricultural insurance premium volume was estimated at about US$19.4 billion. The map in Figure 3.1 shows that in 2009, North America was the largest agricultural insurance market accounting for US$10.7 billion of agricultural premium (55 percent of the total), followed by Asia and the Pacific region (combined premiums for Asia and Oceania of nearly US$4.0 billion or 20.4 percent of the total), then Europe (20.1 percent of the total premium), Latin America (4.0 percent) and finally Africa with a very small share of only US$90 million (0.5 percent of the total).

![Figure 3.4: Global Distribution of Agricultural Insurance Premiums (2011)](image)

Source: Iturrioz, 2010; Mahul and Stutley, 2010

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94 Mahul, O, Stutly, C. J., Government Support to Agriculture Insurance: Challenges and Options for Developing Countries, op. cit.
The global agricultural insurance market has grown very rapidly over the past five years: in 2005, the total global premium was estimated at about US$9 billion, but in 2010...
2009, this had grown to US$19.4 billion or an average annual increase of 22 percent. Over this period, agricultural insurance premiums in Asia and the Pacific region increased even more rapidly from US$1.6 billion to nearly US$4.0 billion or an average annual increase of 28 percent. Several factors accounted for this major increase in global premium, including: (a) the increases in global demand for and prices of commodities such as soybean, wheat and maize, and thus insured crop values and generated premiums; and (b) government policy towards the promotion of agricultural insurance as a risk management tool and thus the growth of public sector subsidized agricultural insurance particularly in Brazil, China and South Asia. For decades, publicly supported agricultural insurance has been considered a failed policy\textsuperscript{95}, and this is still the view of some authors.\textsuperscript{96} However, many developed and emerging countries are developing and supporting agricultural insurance as an important tool for farmers seeking to manage risk.\textsuperscript{97} The recent international conference on agricultural insurance held in Madrid in March 2010 provided an updated and unpublished report on current developments in agricultural insurance around the world, complementing other earlier published reports.\textsuperscript{98}

\textbf{Figure 3.7}

\textit{Traditional Insurance Products}

![Traditional Insurance Products](source)

\textbf{Source:} Iturrioz, 2010; Mahul and Stutley, 2010


Mahul and Stutley (2010) have written an up-to-date and comprehensive assessment of agricultural insurance in developed and developing countries. In Table 3.5, we offer a synthesis of the most recent changes in agricultural insurance in a selection of both developed and emerging countries. Many countries, whether developed or developing, subsidize premium. There are various countries that are mature in terms of insured crops and acreage, including Canada, US, Spain and Austria; there are also countries that have experienced significant growth, including India, Russia, Brazil and Argentina. Many EU countries do not subsidize crop insurance (Sweden, UK, Germany) but provide ad-hoc payments for disasters and catastrophes. The Netherlands began offering subsidized insurance in 2009. A number of authors argue that subsidies distort farmers’ decisions and generate welfare losses because of asymmetric information (moral hazard and adverse selection). Others claim that insurance is better than ad-hoc aid compensation because it involves better screening procedures, more accurate loss adjustment procedures and more rapid compensation disbursements. Lastly, the EU has approved legislation regulating national aid programs that establish that only farmers who have contracted insurance policies are eligible for financial aid compensating for losses not covered in the contracted policies and that surpass 30% of average production.

Table 3.5
Summary of the Most Recent Experience With Agricultural Insurance In Various Countries in the World

<table>
<thead>
<tr>
<th>Country</th>
<th>Recent Trends</th>
<th>Indemnities</th>
<th>Comments and Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>25% of farmland insured in 2005.</td>
<td>Insured area grew from</td>
<td>Regulated by general</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Characteristics</th>
<th>Insured Area</th>
<th>Premium Support</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Well developed in cereal and oil-crops, undeveloped for other crops. 55% of crop insurance contracts are against hail.</td>
<td>11.2 mill ha in 2002 to 17.6 mill ha in 2009. Area, especially high in 2006-2007 season; US 75 $ mil in 2009.</td>
<td>Insurance legislation, 26 insurance companies operating. (Miguez, 2010; FAO, 2005)</td>
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<tr>
<td>Drought, the major hazard. System works with Farm Management Deposits, which allow farmers to save in good years and withdraw funds in bad years.</td>
<td>The number of policies grew from 6,022 in 1999 to 36,396 in 2009.</td>
<td>N.A.</td>
<td>Government provides compensation and support under extreme and infrequent events. Droughts, no longer assumed as extreme events. (Botterill, 2010; Bowe et al., 2003).</td>
<td></td>
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<tr>
<td>Austria</td>
<td>81% of farmland insured against hail. 71% of it also insured against other risks (multi-peril crop insurance).</td>
<td>Between 1985 and 2009, insured area grew from 600,000 ha to 1,249,000. €75 million in 2009.</td>
<td>Subsidized premium for policies covering hail and frost. Private-public system. (Rosenwirth, 2010).</td>
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<td>Brazil</td>
<td>Small penetration so far. Small insurance sector in comparison with the size of the agricultural sector. Soybean is 61.5% of farmland insured.</td>
<td>Insured area grew from 68,148 ha in 2005, to 6,669,269 in 2009.</td>
<td>N.A.</td>
<td>Government subsidies for premium between 40% and 70%. Reinsurance since 2007. (Guimaraes, 2010; FAO, 2005).</td>
</tr>
<tr>
<td>Canada</td>
<td>Dynamic settings, with frequent</td>
<td>Between 2003 and 2009</td>
<td>Between 2003 and 2009</td>
<td>Governments cover 100% of</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Country</th>
<th>Program Changes and Innovation</th>
<th>Number of Policy-Holders</th>
<th>Indemnities</th>
<th>Administrative Costs and 60% of Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>There are five programs presently offered to Canadian farmers. The focus is on whole-farm insurance, offering farms' financial margin stability. 65-70% of farmland insured.</td>
<td>2009 indemnities diminished, but insured capital grew.</td>
<td>2009 indemnities grew from €737 million to €1089 million.</td>
<td>(Pikor, 2010; Foster, 2006)</td>
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<tr>
<td>India</td>
<td>Mixed, public and private programs, with strong support.</td>
<td>Between 1999 and 2007 insured area grew from 0.78 mill ha to 27.3 mill. Ha.</td>
<td>Indemnities grew from de US $ 1.8 mill to US $ 50.055 mill.</td>
<td>Recent introduction of index-insurance. (Pati, 2010; FAO, 2005; Raju and Chand, 2008).</td>
</tr>
<tr>
<td>Italy</td>
<td>Public-private system, with</td>
<td>Number of sold policies</td>
<td>Indemnities diminished</td>
<td>Mandatory complete</td>
</tr>
<tr>
<td>Country</td>
<td>Description</td>
<td>Details</td>
<td>Source</td>
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<tr>
<td>Russia</td>
<td>Government support, but still low penetration rates. Less than 12% of crop production is insured.</td>
<td>Between 2000 and 2004, but insured area diminished from 1,037,000 ha. to 989,000 ha.</td>
<td>(Semerari, 2010; Serra, 2006; Cafiero, 2004)</td>
<td></td>
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<tr>
<td>Russia</td>
<td>Federal Agency for Crop Insurance State Support since 2003. A fund against catastrophic risks will be set up.</td>
<td>Grew between 2005 and 2008 both the number of contracts and insured area grew (from 12 mill ha to 18.2 mill ha).</td>
<td>Variable government subsidies, always higher than 50%. Insufficient regulatory framework. (Kosholkina, 2010)</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>Well developed, strongly supported by the Government. Revenue insurance is the most popular for annual crops, followed by yield insurance with 65% yield coverage. Crop insurance with 85% yield coverage is available for some crops.</td>
<td>Frost insurance contracts have diminished, but multi-peril crop insurance contracts have grown.</td>
<td>Loss ratio diminished between 1999 and 2007. (Leach, 2010; Callan, 2006)</td>
<td></td>
</tr>
</tbody>
</table>

Source: (when no other citation is mentioned): International Conference on Risk and Crisis Management and Agricultural Insurance, Madrid, Spain.
Determining whether global agriculture will improve or worsen because of climate change involves considering causation chains in which errors multiply and uncertainties add up. Most models coincide in projecting increasing climate instability and more frequent extreme events. The insurance industry has become a leading actor and stakeholder in the climate change policy debate. The higher risk associated with global warming is perceived as a business threat that must be faced using standard insurance business strategies together with further vulnerability reduction and mitigation efforts. Social, capital and human vulnerability to climate risks has increased because of increases in risk exposure and economic development. Nevertheless, climate change also offers fabulous business opportunities to the insurance sector, especially in developing countries. The insurance industry has grown by carefully analyzing previous damage and by exercising prudence in addressing unknown future risk. Climate change is a forward looking science, and evaluations of damage experienced are generally not as accurate as those that insurers tend to make. Climate scientists and insurance companies must collaborate more closely to more efficiently pursue their own interests. Governments and international organizations must actively work to enable closer cooperation between scientists and insurers.

Agricultural insurance is just a small branch of the industry. In most countries in which coverage, penetration and total liability have increased, governments have supported the industry via premium subsidization, direct participation, or reinsurance. Some emerging countries, including Russia, India, Argentina, Mexico and Brazil, have shown a sense of determination to increase the role of insurance as a risk management tool for farmers. New technological developments, index formulations, satellite images and mini data loggers have reduced the cost of delivering insurance services to farmers across a wide area. Most of the challenges posed by slow on-set of climate change will require small, gradual adjustments in insurance policies. The challenge facing the agricultural insurance sector is colossal, but it also presents a generous array of opportunities. Greater insurer exposure to climatic risks will create a need for insurers to develop strategies for diminishing

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their vulnerability. These might include imposing limitations on coverage, increasing premiums, transferring risk through private or public reinsurance, and improving the quality of loss assessment. In the field of agricultural insurance, the use of indexed products and intensified follow up regarding risk (data loggers) will increase the efficiency of insurance per monetary unit of premium paid and will decrease dysfunctions due to asymmetric information. However, some hazards, such as those derived from extreme events, cannot be so easily managed unless there is cooperation between the insurance sector and meteorological organizations whose goal is to better understand extreme climate risks. The private sector should work jointly with those agencies responsible for the collection and analysis of disaster data. As Skees et al (2008) state, insurance is not a means of adaptation, but can facilitate farmers’ adaptation. This can be accomplished by risk layering (where government underwrites the extreme layer), and by ensuring that farmers are offered a safety net which does not discourage them from pursuing other risk management strategies.107

Our review of recent developments in agricultural insurance shows that it has changed substantially during recent years in both the developed and developing countries. However, the challenge of promoting insurance in Least Developed Countries (LDCs) usually cannot be overcome without the intervention of donors and international agencies. The simulation results regarding insurance premiums under climate change versus the current climate scenario in various zones in Spain show the need for premium adaptation for both irrigated summer crops (maize) and non-irrigated winter crops (wheat). In some cases, premiums will have to be increased, whereas in others, they may be reduced. The maize adaptation strategy is an efficient instrument for limiting risk, reducing premiums in most cases, and increasing average yield.

The Monte Carlo simulations reproducing different levels of error or uncertainty regarding crop risks (variability, exposure to extraordinary extreme climatic events,

107 Skees, J.R., & Murphy, A., ENSO Business Interruption Index Insurance for Catastrophe Flooding in Piura, Peru, op. cit.
and risk profile or distribution functions) show significant differences between premiums charged under various circumstances. These sources of errors or uncertainties frequently also depend on the coverage level and deductibles used. Deductibles can be used to minimize the consequences of error.

Agricultural insurance is probably less vulnerable to catastrophic risk than are other insurance sectors because there are many possible ways of adapting to climate change in agriculture. First, there are many ways to produce food and fibres, many crops and many techniques at farmers’ disposal. Second, the damage experienced in this sector, in comparison with that faced by producers of houses or infrastructure (or the potential cost to human life itself) is generally lower. For the poorest regions in the world or those that are most vulnerable to droughts or floods, the current agricultural insurance offered is inadequate. Index-based risk transfer products have much more potential, especially for those hazards that can be least ambiguously and most easily measured. There are proven advantages in pursuing index and weather insurance in the contexts of weak institutional settings and subsistence agriculture.