WEATHER RISK MANAGEMENT: AN ETHIOPIAN PILOT

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December 2006

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EXECUTIVE SUMMARY

Document Overview. This document investigates prospects for the use of index based weather insurance in Ethiopia for commercial and semi-commercial farmers. The document first summarizes the impact of risk—weather risk in particular—on Ethiopian agriculture and the need to balance investments in weather risk mitigation and weather risk management. Because the focus of this document is on risk management in the face of potential weather shocks, this introduction is followed by a summary of the traditional risk-transfer tool available for managing agricultural weather risk, multi-peril crop insurance. It outlines the limitations of this approach in the Ethiopian context. Finally, the first section of the paper provides an overview of the index based weather insurance product, which is the focus of the remainder of the document.

Narrowing its scope to the potential use of index based weather insurance products in Ethiopia, the research discusses whether the prerequisites or enabling conditions for this type of product exist and whether there are any major impediments to developing a weather insurance program in the country. It was determined that the major pre-requisites for a ***pilot*** program appeared to be in place. The research took a project implementation approach to determining the technical feasibility of this type of program, despite some misgivings about scalability. The pilot implementation approach in Ethiopia is broken down into eight major steps:

1. Identify potential pilot areas, crops, and delivery channels;
2. Carry out market research through a participatory assessment to determine the major risks and demand for insurance in the pilot areas;
3. Design contracts to meet the needs of the farmers;
4. Test the contracts and different payout structures of the contracts;
5. Finalize insurance arrangements and contractual agreements between participants in the pilot;
6. Provide technical training to the EIC and "train the trainers;"
7. Market the product to potential clients and establish contractual agreements between participants;
8. Execute and monitor the contracts;

Summary. Before starting work on a pilot program, the research explored based on experience in other countries, the three major prerequisites for implementation of an index based weather risk management program, including the need for weather data, identification of a risk taker to write or intermediate the contract, and institutional settings and options for delivering the contract to clients. The research on the availability of weather data looked at the quality and length of historical weather records available for weather stations nationwide. Slightly more then thirty stations were identified as viable locations for a weather insurance program. The Ethiopian Insurance Corporation (EIC) showed its interest in implementing a pilot program in one of these areas and holding the risk associated with the program. When looking for institutions who could deliver these services to farmers—including input providers, financial services providers, farmers organizations, and the EIC itself—it was difficult to identify any organization or organizations that had sufficient incentive and outreach in the rural sector to market these product to clients. Ultimately, the EIC agreed to take on this role by partnering with two local cooperatives.

The Alaba woreda of Southern Nations, Nationalities, and People's Region was identified as the target area for the pilot project. The EIC carried out the project through its head office in Addis Ababa and its field office in Awassa. Potential clients were identified who were members of two different cooperatives and living within close proximity of the Alaba town weather station. These farmers were identified as potential clients through a field-based assessment of their exposure to weather risk and demand for weather insurance. While considering other crops such as pepper and wheat, the greatest demand for an insurance product was one that would provide coverage for shortfalls in maize yields due to drought.

After this initial field research, based on the findings and scientific inputs such as agronomic research and crop growth models, a rainfall index was designed to serve as a proxy for yield loss due to drought. The index that was developed looked at historical rainfall data as well as agronomic inputs and field based research to determine the impact of shortfalls in rain during the critical growth periods for maize. This index was used in turn to design an insurance contract which would payout when adverse weather occurred. The contract broke the growing season into three stages as well as an initial sowing period. After the contract was designed, it was field tested with the farmers to determine if the contract met their demands for a weather insurance product but also accurately reflected losses. Refinements were made based on farmer's feedback, and the finalized contract was marketed to the two identified cooperatives with the assistance of a local Development Agent

Lessons Learned. While a pilot was implemented and a small group of farmers purchased the insurance contract, the greatest benefit of implementing the pilot was to highlight the challenges that would need to be overcome to make this pilot scalable and sustainable. Significant challenges remain to the development of a robust index based weather insurance market. Foremost among these are the limited weather data, lack of a strong marketing channel, and intermediary for the products. On the positive side, as a result of the collaboration on the pilot program, EIC understands index based weather insurance contracts and can design contract parameters. This has laid the initial foundation for growth of the market for these instruments in Ethiopia, but investments in data acquisitions and provision are critical. In addition, related to the need to identify an appropriate intermediary, decisions about the future of the Government's

lending guarantee to agriculture will have a significant impact on the market for, and the development of, an index based weather insurance market. This guarantee currently impacts the incentives for banks to become interested in market-based approaches. Index based weather insurance could be used as one tool to assist the government in transitioning to a more market-based approach.

The document found, in general, that the pre-requisites for the implementation of an index based weather insurance program in Ethiopia were met for the purposes of a pilot. However, without additional investment and potential policy changes, the environment is not currently conducive for the development of a larger weather insurance program. These findings are summarized below and highlight the enabling vs. disenabling conditions for implementation of a wider scale index based weather insurance initiative in Ethiopia. This summary is drawn from the research in Ethiopia on the necessary prerequisites for pilot implementation, as well as issues that arose during the pilot program implementation itself.

1. Weather Data. While suitable data was found for a number of stations in Ethiopia, there is, in general, a lack of sufficient data for the development of weather insurance contracts on a large scale. As summarized in the text this is primarily due to missing data at existing stations and a relatively thin geographical distribution of stations.

2. Marketing Channels. The research and the associated pilot, despite looking at a variety of potential players, failed to identify any organizations that could be used to reach clients effectively and provide the necessary capacity building and product education to farmer clients. The prime candidate for marketing this product to farmers was financial institutions, but this proved inappropriate, because the current government guarantee for fertilizer minimizes incentives for financial service providers to participate in such market-based initiatives.

3. Risk Taker and Risk Capacity. In Ethiopia the Ethiopian Insurance Corporation (EIC) was willing to fill this role and provide the needed risk capacity for the pilot. Because the eventual 2006 pilot transaction was small, having a single insurer participate without reinsurance seemed appropriate, but had the pilot program been larger, it would have been necessary to seek reinsurance because no other insurers were interested in participating in risk sharing within the country.

4. Risk Assessment and Contract Design. Related to the previous discussion of the need for a stronger risk taking framework, further capacity needs to be built within banks and insurance companies to carry out weather risk assessment and contract design. Giving the insurance companies and banks the ability to quantify clients' risk and, in the case of insurers, design contracts would improve the ability to offer appropriate products and serve as the basis for a diversified product offering, as well as market growth.

The table below summarizes the major enabling and disenabling conditions for implementation in more detail.

Table 5.1: Summary of the enabling and disenabling conditions for the development of index based weather insurance in Ethiopia with a ranking from 1 to 10 for pilot pre-requisites and scale-up feasibility
(10 meaning full enabling conditions exist, no further activity needed, 1 implying none exist and a pilot should not be pursued in the immediate future)

	Needs	Pilot	Scale-Up	Limitations	Rank	Needed Activities
Weather Data	30 years historical daily rainfall data, with ideally less than 5% missing; Timely, reliable and secure reporting of data from the Met Department for monitoring and settlement of the contract	Historical rainfall data with few gaps existed in Alaba and was available for contract design; specific arrangements were made between the EIC and the local NMA office to get the settlement data on a weekly basis, facilitated by hiring someone locally to be responsible for this	26 stations currently have sufficient historical data and reporting capacity for use in an index based product within the country, an additional 16 stations have relatively good data and could be considered.	Without additional data or stations of the required standard scale up will be limited to those areas around the weather stations that currently meet market standards	**2**	Investment is needed to clean and in-fill historical rainfall data where possible; upgrade existing stations and reporting capabilities to met market standards; capacity building with the Met Office to improved recording and reporting procedures and their historical weather database
Intermediary	A trusted marketing channel that can deliver these products to farmers in a cost efficient manner. Often intermediaries need to have an incentive to mitigate weather risk in order to be committed to the project.	Two cooperatives were identified to serve as market intermediaries. These cooperatives were limited in their ability to deliver their product due a lack of capacity and therefore to engage and educate farmer clients. In addition, because these cooperatives did not hold the same or similar weather risks of the farmers, their incentives to serve as a strong intermediary were low.	While cooperatives could potentially serve as intermediaries on a larger scale many of them lack capacity and have little incentive to serve in this role. Financial institutions in other countries have filled this role because they hold the same risk as their clients. However in Ethiopia their risk is mitigated through a government fertilizer lending guarantee.	Without strong, motivated intermediaries it is impossible to effectively market the product. With the current lending guarantee and related lack of incentive by financiers to participate the project will need to continue relying on cooperatives.	**2**	Discussions with Government about using index based weather insurance or other potential instruments to transition away from more non-market based approaches to lending guarantees.
Risk	Insurer who has the	EIC provided the	EIC could hold more	In order to promote a	**6**	Bring in additional insurers to

Taker/Risk Capacity	capacity to hold risk within its own portfolio and/or intermediate this risk to the international market	needed risk capacity and was interested in holding greater risk internally.	risk in a future scale up, but no other insurance companies currently have the capacity or the desire to enter into this market. Although not tested it is believed that if the data security and quality was good enough and the transaction size large enough EIC could find additional risk capacity in the international reinsurance market.	competitive environment and provide the ability to facilitate smaller transactions, particularly in the early stages of market development it is important to bring in additional insurance companies.		promote market growth. Develop current pilot portfolio and transaction size and show evidence of potential further market growth to interest reinsurers and test their demand for this risk.
Capacity Building, Training and Contract Design	Insurer understands and can design product offerings that can meet farmer and clients' needs and can understand and manage its portfolio of transactions.	EIC participated in contract design. While the contract in general was designed by the World Bank, EIC provided key inputs and ultimately decided the terms of the contract.	While EIC has a good understanding on the design of these products in the short-term it would need additional training and support in order to design contracts and understand the finer aspects of managing a portfolio of weather insurance contracts in several pilot areas for the long-term. With training this capacity could be built within EIC. To grow the market robustly it would be necessary to bring other insurers or actors	Contract should be designed locally in Ethiopia. Without building sufficient capacity in-country to provide this service, EIC and other potential participants will rely on outside expertise for contract design. This will increase the cost of products and limit the appropriateness of the contracts being offered and understanding of the business from the insurer perspective.	**5**	Training and capacity building on contract design and portfolio management for insurers, potentially banks and other interested parties. This would require significant investment in a training curriculum, study tours, and other related activities.

			interested in developing this new market into this process. This would indicate a need for additional training and capacity building to facilitate greater stakeholder involvement			

I. RISK IN ETHIOPIA AGRICULTURE AND THE MICRO-LEVEL IMPACTS OF WEATHER RISKS

Overall growth and poverty reduction in Ethiopia is very dependent on an agricultural sector which employs more then 85% of the labor force. The primary farming activity is the production of cereals for domestic consumption, especially wheat, maize, teff, and sorghum. Agriculture is almost entirely rainfed with only 1.4 percent of total cropped area irrigated, less than half of the African average. Dependence on rainfed agriculture not only reduces productivity but greatly increases growth volatility and the vulnerability of the poor.

Production Risk

Droughts are a recurrent feature of the Ethiopian landscape. Some 80 percent of rural households have suffered a harvest failure in the last 20 years (Table 1.1). Three out of five Ethiopians live in parts of the country that are endowed with only 20 percent of total water resources (World Bank 2005d). Drought limits the ability and motivation of farmers to invest in agricultural technology and yield-increasing inputs, reduces overall yields, and negatively affects consumption and income. In a drought year, household farm production may decline by up to 90 percent (World Bank 2005a). The long-term impact of these consumption shortfalls can be severe. Severe drought is also a source of lower long-run *growth* of household income: according to a 1995 estimate, households in areas hard-hit by the 1984/85 famine were 16 percent poorer than those in moderately affected households (Dercon, 2000). Livestock, often the major store of wealth of rural households, suffer in poor rainfall years, and prices of livestock tend to drop when harvests are poor due to the distress sales for survival. Thus productive asset bases are depleted, leading to classical poverty traps, with long term deleterious impacts of drought on productivity and wealth. Distressed asset-sales and de-stocking in the short-run to protect consumption can lead to long-term destitution, a phenomenon apparent in food-insecure areas in Ethiopia. Currently some 10 percent of the rural population is classified as chronically food insecure.

Table 1.1 Droughts is the major risk and source of hardship for rural Ethiopian households

Event	% of Households Reported to have been Severely Affected in Past 20 Years
Harvest failure	78
Policy shock	42
Labor problems	40
Oxen problems	39
Problems with other livestock	35
Land-related problems	17
Loss of assets	16
War	7
Crime/Banditry	3

Source: Dercon, 2002. Based on Ethiopian Rural Panel Data Survey (1994-1997).

In Ethiopia, deficit rainfall during either of the two bimodal rainfall periods, the Kiremt and the Belg, is the most indicative proxy for changes in yields and farm output. The Kiremt rains are associated with the Meher growing season and Belg is the name of both the minor rainfall season and its associated growing season. Meher is the main season in most parts of the country and accounts for up to 95% of the national production. Belg season production is only 5% of national production but these rains are extremely important in more vulnerable areas of the country in addition to being vital to pasture regeneration, water supply, and in the planting of long cycle crops (sorghum and maize). If the Belg rains are low, the yields of long cycle crops will be affected.[1] Both the Kiremt and Belg rainfall seasons are usually not reliable, are relatively short, and even small deviations in rainfall can cause complete production failures. Because Ethiopia faces highly variable rainfall, it suffers from both national and regional droughts that can have extreme impacts on farmers who utilize traditional agricultural practices.

Production risk is compounded by volatility and uncertainty in the price of staple foods**.** The principle underlying reason for price variability is, again, climatic shocks, compounded by weak domestic markets and lack of integration with world food markets due to poor infrastructure and a poorly timed influx of foreign food aid (World Bank, 2005a). While risk is a perennial part of the rural landscape in Ethiopia, it is important to note that neither production risks nor price risks are particularly high compared with other countries in Africa, and in fact, are lower than in several countries of southern Africa (Table 1.2). However, the extreme poverty of many rural households and lack of livelihood diversification in Ethiopia makes the rural poor especially vulnerable to shocks. Several studies document the long-term deleterious impacts of shocks on productivity and assets.[2]

Table 1.2 Comparative statistics on production and price variability

	Ethiopia	Kenya	Malawi	Zambia
Variability of production, 1995-2004[a]				
Maize	12.6	8.9	21.6	30.6
All cereals	10.5	9.8	20.3	27.2
Agricultural GDP	7.7	4.5	9.2	4.6
Variability of wholesale/retail prices in major city, 1994-2003[a]				
Maize	20.6	21.6	37.5[b]	28.2[b]

[a] Measured by the Cuddy-La Valle Index which closely approximates the coefficient of variation around the trend.
[b] Retail prices. Others are wholesale prices
Source: Computed from FAOSTAT data.

Risk and Vulnerability in Ethiopia

Extreme poverty also makes households more risk-averse, since they have more to lose from an adverse outcome. The World Bank's Risk and Vulnerability Assessment (2005) found that potential rainfall shocks are the cause of vulnerability for 38 percent of the "vulnerable" population (those with a 50 percent likelihood of falling below the poverty line). This matters intrinsically for well-being, but also for growth. Given high levels of risk, households have incentives to seek to assure subsistence food needs first and will be averse to the greater risk associated with higher value inputs (of fertilizer and seeds) associated with technological upgrading. Variability in yields due to weather shocks also has a negative impact on farmers' incentives. Producers are less likely, given the risks, to use yield-enhancing inputs (or to use them at 'recommended' levels), as this is unprofitable in poor-rainfall years. Additionally, weather risk, among other risk factors, also makes it extremely difficult for farmers to obtain credit for production inputs which results in farmers remaining reliant on low risk, low yield

[1] Skees et al.
[2] See, for example, Carter et al., 2004 and Dercon and Christiaensen, 2005.

production patterns and traditional coping mechanisms. With few assets to sell and limited access to credit, farmers have had rely on informal channels such as family and communities to deal with shortages. But the covariant nature of weather risks makes it difficult to rely on neighbors in times of rain shortfall because in all likelihood if a farmer is facing hardship his neighbor is also.

The high level of exposure of Ethiopian farmers to risk and its consequences implies the need to focus on a range of policy areas to reduce risks as a core part of a *growth*-oriented strategy. Informal arrangements can be a source of insurance. In Ethiopia, informal institutions such as *iddir*, a burial society, and *Equb*, a savings organization, help households cope with unexpected expenses. But even where local informal insurance is extensive, there remains vulnerability to covariate shocks as are many weather events in rural Ethiopia. A comprehensive strategy must therefore include formal mechanisms both to reduce risk and help households manage risk including the following:

1. Risk reduction: small-scale irrigation and improved soil and water management
2. Risk management including improvements in rural finance and savings that would reduce the asset depletion that often accompanies poor harvest years, combined with insurance markets for weather and price risks
3. Reducing vulnerability through 'countercyclical' productive safety nets including employment schemes (ideally employment guarantees) and other productive safety nets program based on food or cash transfers

Box 1.1 Risk management approaches of farmers and other rural producers

Rural producers and communities employ several mechanisms to deal with the risky business of farming, and any interventions must account for the likely effect on these mechanisms and the resources available to farmers. Mechanisms include:

Information gathering:

- *Using and improving information available* in decision making, for example, market prices, regional rainfall probabilities, new crop varieties, emerging markets etc.

Avoiding risks:

- *Adopting a precautionary stance*, with the costs balanced against the possible reduction in serious negative consequences.
- *Using less risky technologies* of lower but reliably yielding drought-resistant crops, or production of crops with more stable markets over those with potentially higher but less certain returns.

Diversification:

- *Diversifying production systems* through planting a variety of crops for separate markets to mitigate climatic, disease, pest and market vulnerability.
- *Adjusting income generating/ productive activities* to changed circumstances, reflecting physical assets and markets.
- *Financing farm activities* with credit, and borrowing in cash or in kind based on social capital in order to invest in diversification of income sources.

Sharing of risk:

- *Using informal and formal insurance* through making small investments expected to provide returns only in the event of difficulty or catastrophe, for example, cash or gifts, "banking" through social capital.
- *Using risk pooling* in formal or informal arrangements to share outputs and cost of production.

- *Using contract marketing and futures trading mechanisms* (such as forward contracting to sell all of a crop at an agreed price, futures contracts, and hedging) to reduce price risks for commodities not yet produced, or for future inputs.

Source: Authors

As stated above a multifaceted approach including increased irrigation and greater investment in productive activities is ultimately needed to reduce the overall vulnerability of those in the agricultural areas. These efforts need to be coupled with improved access to risk management instruments including greater access to efficient, sustainable risk management programs. This paper looks at the use of index based insurance as one risk management alternative that can help households manage risk more efficiently. While there are a number of different approaches to crop insurance, index based weather insurance which uses measurable weather events as a proxy for losses has been piloted in a number of countries in recent years showing potential to deliver insurance efficiently and cost effectively.

II. CROP INSURANCE APPROACHES

Crop insurance programs both in developing countries and developed countries are not new. Concern for risks that stifle investment, limit access to agricultural credit, and contribute to vulnerability of the rural poor have for decades been the driving force behind various types of agricultural insurance (typically "crop insurance"). Crop insurance is a financial tool to transfer production risk associated with farming to a third party risk off taker via payment of a premium that reflects at least the true long-term cost of the insurer assuming those risks.[3] For many crop insurance programs, insuring small farmers against crop losses due to adverse weather or other hazards has attracted public sector involvement. In addition, many governments have seen agricultural insurance as a way to attract private sector investment in agriculture through credit markets and other investments.

With few exceptions, such public interventions to provide insurance and enable the poor to cope in times of hardship have typically encountered severe problems and failed. One of the causes of failure has been the ad hoc response of government in times of severe calamity due to a lack of objective criteria for what "triggers" an insurance payment. This leads to high potential for political interference and reduced opportunity to obtain reinsurance. Further problems have arisen because traditional, publicly supported crop insurance is *all-risk* or *multi-peril*, covering either all the supposed production risks or a very broad spectrum of those risks.[4] Multi-peril crop insurance usually involves payments to the grower as compensation for any shortfall when yield declines below a level set in the policy (Gudger 1991). The widely documented constraints of multi-peril approaches include asymmetric information, which can give rise to adverse selection and moral hazard. Because it can be both challenging and expensive for insurers to quantify individual client's risk exposure, premiums for clients could be either too high or too low to match their risk. While these issues could be minimized through monitoring and detailed risk assessment, these activities can be quite costly. Without extremely close monitoring, moral hazard complicates these issues because farmers' yields are linked to both the risk they face but also their own production practices. Furthermore, if farmers are not made to bear the full cost of the risk associated with their activities, this can lead to excessive risk taking, such as growing crops in high-risk regions, thus increasing farmers' exposure to future losses.

As a result, comprehensive publicly-supported crop insurance programs have traditionally been ineffective and fiscally burdensome. Assumption by the public sector of massive insurance losses also reduces opportunities to participate in broader reinsurance markets. The ad hoc nature of government policy has frequently been coupled with an ineffective and uncertain regulatory framework that increases uncertainty for private sector providers. These government interventions have involved heavy subsidization of premiums, large delivery and service costs, and high aggregate losses. One measure of the success of these programs proposed by Peter Hazell has been to look at the overall profitability of the programs. The table below shows an evaluation of a subset of countries' programs during the 1970's and the 1980's. To be profitable,

[3] This note specifically excludes the area of price insurance; see the AIN, "Commodity Price Risk Management"

[4] Worldwide experience has shown that in most cases traditional crop insurance requires public support. This is directly through government insurance companies providing crop insurance, or indirectly where the public sector provides subsidies, reinsurance capacity, and design/pricing of insurance products, but it is the private sector that ultimately delivers the crop insurance to producers.

the ratio of average administrative costs plus average insurance payouts to the average premiums paid must be less than one. For most countries in the table, the government supported crop insurance programs ratio has far exceeded one, indicating that the programs have been unsustainable without heavy subsidization. This is not to say that other countries in recent years have not seen more success in implementing publicly-supported crop insurance programs, but it highlights some of the challenges faced in administrating these programs cost effectively.

Table 2.1: Performance of State Run Agricultural Insurance Programs

Country	Period	(A+I)/P
Brazil	75-81	4.57
Costa Rica	70-89	2.80
Japan	85-89	2.60
Mexico	80-89	3.65
Philippines	81-89	5.74
USA	80-89	2.42

Condition for sustainability: $(A+I)/P < 1$
A = average administrative cost
I = average indemnities paid
P = average premiums paid
Source: Hazell

Box 2.1 Typical insurance problems

*Distorted incentives***.** When insurers know that government will automatically cover most losses, incentive to pursue sound insurance practices when assessing losses is reduced. Insurers may even collude with farmers in filing exaggerated or falsified claims.

Asymmetry of information. Successful insurance programs require that the insurer has adequate information about the nature of risks being insured. However, this is very difficult for farm-level yield insurance where farmers will always know more about their potential crop yields than any insurer.

Adverse selection. Due to asymmetric information it is possible that a farmer's risk will be underestimated. This could result in these clients being charged premium rates that do not reflect their true risk. The converse is also true where true risk exposure of a client could be overestimated or misclassified resulting in premiums that are higher then the actual risk. As a result, those clients who premiums are lower then their actual risk are more likely to purchase insurance.

Moral hazard. Asymmetric information can also lead to moral hazard. Because clients have more information about their risk then the insurer or risk taker moral hazard can arise. One example with a crop insurance program would be when an individual's behavior or management negatively influences crop yield rather then some outside factor such as weather or other peril.

Administrative costs. Adverse selection and moral hazard caused by asymmetric information can be avoided through careful monitoring of the programs and greater investment in risk assessment and classification. But doing this, particularly for small farmers, can drive up the administrative costs for the insurance making the premium prohibitive.

Source: Authors

Index Based Insurance

Another major impact of traditional crop insurance programs is that they have often crowded out or created negative impressions of insurance programs for agriculture which in turn has limited the introduction by the private sector of more efficient innovative approaches to insuring yield risk. Foremost among these approaches has been the recent piloting of index based weather insurance for agriculture. While a robust market for index based products, both derivatives and insurance, has grown in the US and European energy industries, only recently has the private sector begun to offer these products to protect against the yield losses associated with agriculture. Pilot experiences with index based weather insurance show that with appropriate facilitation and technical assistance, the private sector can deliver crop insurance.

Index-based weather insurance product uses a weather index based on data from national meteorological stations as a proxy for yield losses. By identifying the impact that deviations in weather have on yields it is possible to determine levels of compensation for farmers affected by the weather event. Index-based insurance has a number of advantages over traditional insurance products. With index based weather insurance it is not necessary to measure actual losses instead an index is used to estimate losses based on changes in weather. One of the primary benefits is the objective determination of payouts based on the index. In essence by measuring changes in the weather relative to the needs of the particular crops it is possible to estimate losses of farmers near the weather station. The second key benefit is the timeliness of payouts: almost immediately after a critical weather period, the insurance company can trigger payouts to farmers, because weather data is reported on a real time basis to the insurer.

Using weather-based index to insure against natural disasters offers increased affordability and accessibility of insurance services for the rural poor. Because triggers can be verified independently, vulnerability to political interference and manipulation of farm losses is reduced. Since index based insurance eliminates the need for on farm visits to visually see damages an index based program is practical to implement, and has low administrative and transaction costs.

A major concern and disadvantage of index-based weather risk management products is basis risk—the potential mismatch between contract payouts and the actual loss experienced. On considering weather-index insurance as a product for growers, Skees and Hess (2003) write, *"The effectiveness of index insurance as a risk management tool depends on how positively correlated farm-yield losses are with the underlying area-yield or weather index."* This statement relates to the question of whether insurance based on a weather index can substitute for a traditional crop insurance policy and *indemnify* the grower for his losses.

Basis risk is a concern for all weather variables but it is particularly important for rainfall, which exhibits a high degree of spatial and temporal variability. For example a weather station on which a weather contract is based may not experience the same rainfall patterns or totals during the calculation period as the locations an end user wishes to protect. For this reason, contracts based on hail are not products that are offered by weather market providers; hail is a highly localized meteorological phenomenon, although it can be indexed to an observing weather station, it may not be an effective risk management strategy for an end user. Although historically an index and losses may correlate strongly—showing than an index could be used as an underlying trigger to indemnify losses in an insurance contract—a good correlation is not a guarantee that the underlying contract payout will match the actual loss experienced. Basis risk therefore—which can often be minimized by effective or intuitive structuring and by using local stations—is always an issue when dealing with an index-based risk management solution. A potential basis risk outcome can be quantified by using historical data; however, the key point to consider, as outlined above, is the efficacy of the hedge and the effective reduction the insured party's overall operational value-at-risk (VaR) (Hess, 2003).

Experience worldwide with index base weather insurance for agricultural uses is limited. This is an emerging market and many of the initial pilot programs are still in their infancy. While, as mentioned above, the growth of index based products has been rapid in the energy market this has primarily been in the US, Europe, and Japan. The most developed of index based weather insurance program for agriculture has occurred in India where an initial pilot program in 2003 has grown and created a robust market for index based products (for more detail see Appendix 1). In addition an initial pilot program was carried out in Malawi for groundnut farmers. This program is still in the initial stages but shows potential for significant market growth (see Appendix 2). These pilot programs, among others, have highlighted the need for index insurance in enhancing current risk management practices in developing countries and demonstrated a potential role for index based products in phasing out inefficient traditional insurance programs.

Keys to Growth for this New Market

The overall objective for agricultural insurance should be a market-based approach and demand-oriented system in which farmers (including smallholders and the landless) are able to access services supplied by the private sector and whose premium reflects the true long-term cost of assuming those risks. Given the current lack of supply of insurance products by the private sector there is a role for the public sector in catalyzing this market. Good practice for the role of the government in development of agricultural insurance markets is still evolving, but important implementation issues include:

Public sector initiation of agriculture risk management services. A public sector role could be to finance a "layer" of risk. One example would be for the government to absorb the most catastrophic "tail risk" that will be faced by the agricultural sector, and allow the private sector to develop commercial insurance products for less severe events. This would allow the government to absorb a layer of the risk in an objective fashion while making insurance products relatively more affordable to the end users.

Box 2.2: Subsidies for crop insurance

Traditional multi-peril crop insurance often requires heavy government subsidization: one important form is through subsidized premiums. This creates several problems since: it encourages farmers to assume more risks on the margin; it benefits large commercial farmers disproportionately if the subsidy is a percentage of total premium rather then a more neutral lump sum approach; it may cause rent-seeking by the private sector and so require more subsidies to expand coverage, and thus becoming a fiscal drain. If governments wish to support agricultural insurance with some form of subsidization, this should focus on the catastrophic layer of risks (Skees and Barnett 1999). This can be justified in terms of cognitive failure by the farmers (that is, unwilling to pay for risks that occur with remote probability), and the fact that governments already "own" large systemic risks affecting rural people in that losses from large systemic risks are socialized across all taxpayers.

Source: Authors

Data collection and actuarial modeling. In designing insurance products for any type of risk, insurers (both public and private) must understand the relevant statistical properties. This requires both credible long-term statistical information and actuarial models to define the relevant risk probabilities and to predict the likelihood of various events. Various indices (for example, area rainfall or soil moisture indexes) may be particularly attractive for their practicality and cost effectiveness (see box 10.12).[5] An important area of public sector support can be the development of information sources such as risk maps that improve the institutional capacity of both public and private sector providers to identify and analyze risk. This information can form a common foundation upon which the transparent identification and pricing of risk (premium rates) can be based. Donors can support both the development of information systems and the building of the capacity of institutions (such as the ministry of agriculture) to build databases that can overcome information-related constraints to private sector participation.

Creating a favorable regulatory environment. To encourage market development, the policy and regulatory environment must be deemed by all stakeholders as fair, credible, stable, and enforceable. Toward this end, donors can contribute useful policy advice and capacity building support (see box 10.13). In addition, to create a stable regulatory environment promotion of contract enforcement would add credibility to the products being offered. This would give farmers have confidence to participate and also allow insurers to mitigate the risk of litigation from issues such basis risk or index design.

Educating stakeholders. Education of stakeholders is important if farmers are to understand the benefits of insuring against certain events. Workshops, information packages, media and other mechanisms are needed to explain the characteristics of insurance schemes and the different opportunities available. Further, technical assistance should be provided to both public and private sector suppliers to ensure that the needs of producers (particularly the most vulnerable) are met. Such assistance might be best provided through co financing for business service providers.

Investment in Weather Data Collection and Infrastructure. There is a key role of the state in making necessary weather data available for the development of index based weather risk management contracts. One of the key issues dictating the scalability and sustainability of weather insurance for smallholder farmers is the presence of a dense, secure, high quality weather station network. Investment in weather and communications infrastructure by the state would significantly increase the areas which can be reached through index based weather insurance.

Investment in technical training on product development. Index based products are new to the Ethiopian market and were only introduced in international markets within the last ten years. As a result knowledge about these markets and technical capacity to design these products will remain low without a concerted initiative to build capacity among insurers and banks. Therefore there is a role for Government support of capacity building initiatives on contract design and implementation parameters.

[5] See the IAP, "India: Innovative Rainfall-Indexed Insurance"

III. Exploring the Feasibility of Insurance in Ethiopia

Expanding on previous work that looked at the general feasibility of introducing index based products in Ethiopia; this research looked at the development and implementation of a weather insurance pilot program for farmers. The research took the form of a pilot program which was developed during 2005 and 2006 and resulted in transactions in March of 2006. Work on this pilot program was carried out by the Commodity Risk Management Group at the World Bank which drew upon its experience in other countries to develop the pilot program. Based on these experiences CRMG identified three primary prerequisites for the implementing an index based weather insurance program in Ethiopia:

1. Weather data and analysis of where index based insurance might be feasible
2. Risk taker to write or intermediate the contract
3. Company or institution to deliver the contract to farmers

Weather Data

Historical weather data is the primary pre-requisite for designing an index based weather insurance contract. In Ethiopia there are 600 weather stations which gather weather data. These stations are controlled and monitored by the National Meteorological Agency (NMA) in Addis Ababa. Of these, 17 are 24 hour synoptic (SYNOP) stations, which report every three hours to WMO Global Telecommunication System (GTS), when communication permits; an additional 50–60 stations report daily to the Addis Ababa office.[6] In the future NMA plans to increase its observation network to 2,500 stations, 200 of which will be Class 1.

Historical data from the existing station network is available from the NMA data centre. While a handful of stations have relatively complete historical data sets years of civil war have limited historical data from some regions, for example: several stations in the Tigray region, particularly in the north, have data missing for four to five years in the early 1990s;[7] other regions have one or two years of data missing in the early 1990s. Despite these gaps, most stations were established in the mid-1970s or earlier and there are several stations with complete 30-year or 50-year records. In addition because Ethiopia is a federal country states have responsibility for collecting their own weather data. This creates large discrepancies in the amount of data that is available across states, some of which whose weather data measurement and reporting infrastructure has been as consistent.

Due to lack of data and limited capacity for reporting the data, there are a limited number of stations which could be used to develop insurance products for communities in Ethiopia. The table below contains all of the stations (Class 1 and others) that report daily to the NMA. The important figure to highlight is the percentage of missing data for each station. It can be assumed that for stations that are missing more then 20% of data from the past thirty years that the insurance premiums, which take into account the uncertainty missing data creates, would be prohibitively high to justify an insurance program.

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[6] These are Class 1 stations: fully equipped meteorological observing stations recording pressure, temperature, relative humidity, wind speed and direction, rainfall, evaporation and soil temperature every three hours from 06.00 to 18.00.

[7] For example, Mekele station in Tigray region has data missing for 1989-1991 because of civil conflict. But these years were not extreme drought years.

Table 3.1 Ethiopian Weather Stations

Station code	Station name	Zone	Station est. (year)	Cleaned: start	Cleaned: end	% daily missing from 1974**
0104030	Maychew	Southern	1975	1992-04-01	2004-06-30	49.47
0104031	Mekele Airport*	Mekele	1963	1992-01-01	2004-06-30	12.53
0301100	Gonder Airport*	North Gonder	1952	1980-01-01	2004-06-30	0.56
0304090	Combolcha*	South Wello	1958	1981-01-01	2004-06-30	0.14
0305020	Alem Ketema*	North Shewa	1973	1974-01-01	2004-06-30	0.00
0305050	Majete*	North Shewa	1962	1974-01-01	2004-06-30	0.00
0306080	Debre Markos*	West Gojam	1953	1974-01-01	2004-06-30	0.00
0306081	Mehal Meda	North Shewa	1980	1974-05-01	2004-06-30	1.08
0307042	Bahr Dar branch office*	West Gojam	1994	1986-01-01	2004-06-30	0.17
0402030	Gida Ayana	East Wellega	1958	1981-01-01	2004-06-30	5.44
0402080	Kachise	W/Shewa	1955	1986-04-01	2004-06-30	30.94
0402100	Shambu	Eastern Wellega	1950	1987-02-01	2004-06-30	33.08
0402140	Anger Gutin	East Wellega	1972	1979-02-01	2004-06-30	9.10
0402141	Nekemt*	Eastern Wellega	1970	1980-01-01	2004-06-30	0.05
0403050	Arjo*	East Wellega	1955	1979-01-01	2004-06-30	0.91
0403110	Gore*	Illubabor	1952	1979-01-01	2004-06-30	0.59
0405050	Ejaji	West Shewa	1965	1983-05-01	2004-06-30	18.31
0405100	A.A. Bole*	3	1955	1954-01-01	2004-06-30	0.00
0405101	Shola Gebya*	North Shewa	1962	1962-03-01	2004-06-30	0.00
0405110	Fitche*	North Shewa	1954	1973-03-01	2004-06-30	0.00
0405120	A.A. Observatory	1	1944	1954-01-01	2004-06-30	0.00
0406100	Debre Brihan	North Shewa	1956	1975-01-01	2004-06-30	1.38
0407030	Nazreth*	Eastern Shewa	1963	1972-01-01	2004-06-30	0.00
0407090	Zeway*	Eastern Shewa	1968	1975-01-01	2004-06-30	0.00
0408030	Gelemso	East Hararge	1962	2002-01-01	2004-06-30	33.87
0408060	Kulumsa*	Arsi	1963	1975-01-01	2004-06-30	0.00
0408140	Robe*	Arsi	1968	1980-01-01	2004-06-30	1.73
0410040	Jijiga	Jijiga	1968	2000-01-01	2004-06-30	47.03
0410060	Alemaya	East Hararge	1954	1997-01-01	2004-06-30	26.38
0410110	Dire Dawa*	Dire Dawa	1952	1980-01-01	2004-06-30	0.13
0411150	Ginir*	Bale	1959	1981-01-01	2004-06-30	0.83
0412051	Yavello	Borena	1980	1987-01-01	2004-06-30	31.70
0413010	Negele	Borena	1966	1993-01-01	2004-06-30	7.33
0504020	Degehabour	Degehabour	1968	1997-03-01	2004-06-30	> 20.30
0508040	Gode	Kebri Dehar	1967	1993-08-01	2004-06-30	29.97
0603030	Assosa	Assosa	1850	2000-01-01	2004-06-30	25.53
0701010	Woliso/Ghion	W/Shewa	1962	1983-05-01	2004-06-30	30.59
0701050	Debre Zeit*	Eastern Shewa	1951	1965-01-01	2004-06-30	0.00
0702040	Hosana*	Hadiya	1953	1972-03-01	2004-06-30	0.00
0704021	Awassa*	Sidama	1972	1972-08-01	2004-06-30	0.00
0707030	Jinka*	South Omo	1983	1979-01-01	2004-06-30	0.69
0708030	Wolayita Sodo*	Wolayita	1962	1972-01-01	2004-06-30	0.00
0708040	Mirab Abaya*	Norh Omo	1972	1972-03-01	2004-06-30	0.00
0709040	Jimma*	Jimma	1952	1980-01-01	2004-06-30	0.19

By using station data as a means test for inclusion in the program the list of stations that in the short term could possibly be used to market weather insurance falls to 33 which have less then 20% missing data and 31 that have less then 10%. This highlights the need to improve the availability of data in order to make index based weather insurance a viable product in Ethiopia.

The main way to approach this would be through improving the capacity of the NMA to both enhance data collection and improve historical weather data. Improving the quality and quantity of rainfall data can have significant impacts on the outreach of this type of insurance in the future. While a full assessment of the needs of the NMA is yet to be completed some keys areas have been identified including improving of the quality and quantity of historical data available, building the capacity of staff, strengthening recording and reporting of data, and installing of new, or upgrading of old, weather stations to increase reporting network density.

Risk taker to write or intermediate the contract

Another key prerequisite for the development of index based insurance contract is an efficient risk transfer mechanism. While there are markets which trade weather risk in developed countries, in developing countries these markets are either inaccessible or inappropriate to manage weather risk. Therefore as a first step in developing a pilot project for index based weather insurance it was necessary to identify a local insurance company and/or an international counterparty that would be willing to write these contracts or intermediate the risk. In some countries risk could be held by a number of different institutions, in Ethiopia for any type of insurance product insurance companies must either hold the risk or intermediate the contract for the reinsurance market. In Ethiopia the law (Proclamation No. 281/1970) allows only domestic companies, defined as a share company having its head office in Ethiopia and in the case of a company transacting a general insurance business and companies conducting life insurance transactions at least 51% and 30% of the paid-up capital must be held by Ethiopian nationals respectively, to participate in the insurance business. Therefore in order to implement an index based insurance program, the participation of at least one insurer, even if it did not ultimately market the product to the client, was necessary.

In Ethiopia the insurance sector had has minimal experience with agricultural insurance and lacks the technical know-how to develop index based products. The state owned Ethiopian Insurance Corporation (EIC) has issued traditional agricultural insurance policies for large farmers in some Southern woredas that cover agricultural risks such as pests but excludes drought and other weather events. The remainder of the insurance sector, which is fairly fragmented and highly competitive, has no experience with agricultural insurance products and focuses on its core businesses, auto and life, in urban areas. Index based insurance is a completely new product and before the initiation of the pilot program there was limited knowledge within insurance companies to market or to design these products.

Despite a lack of familiarity with the product, when looking for potential partners for the pilot three insurance companies showed some interest in index based weather insurance. One of these companies was EIC who had been already researching new products that they could market in the agricultural sector. The other two were private companies who showed low levels of interest in the program but had little or no outreach in the rural sector and a much lower capacity of risk holding and staffing then the EIC. Ultimately, as will be discussed in more detail later, because of EIC's high level of interest in the product, public sector mandate to look for agricultural insurance alternatives, and relatively high level of technical capacity it became the "risk off-taker" for the pilot program.

Institutional Settings and Options

In addition to data availability and insurance intermediation, another key to getting an index based weather insurance product into the hands of farmers has been identifying institutions sufficiently imbedded in the agricultural sector to effectively deliver this product to a wide number of clients. While index insurance does not face the same constraints as traditional insurance such as asymmetric information, moral hazard etc. it does hold one similar limitation. Due to the costs associated with poor infrastructure and communications, it is extremely costly to develop a client base particularly when that company has not been previously engaged in the rural sector. In order to minimize these costs it is necessary to identify an organization to market the insurance product which can leverage existing outreach to rural areas. Previous work done by Jerry Skees et. al 2004 looked at different means of implementing weather insurance in Ethiopia and came up with a number of different alternatives including[8]:

1. Linking rainfall insurance to loans
2. Linking rainfall insurance to input usage
3. Stand alone rainfall insurance
4. Tying rainfall insurance to international food aid

Building on this initial work in developing the pilot, for the pilot program three of these four approaches (finance linked, tied to input service delivery, as a stand alone product) were explored in detail as possible means of marketing index based products to farmers.

Reaching Weather Insurance Clients through Financial Institutions

One possible marketing channel for index based weather insurance products that was explored in Ethiopia was to sell these products through local banks or financial institutions. In many countries banks have indicated that severe and systemic weather events are one of the primary causes of default on agricultural loans. Banks could sell weather insurance and at the same time help mitigate that risk by bundling a loan with an index based insurance product. This relationship has been tested through other pilot programs for index based weather insurance including recent programs in India and Malawi where there has been a direct link between delivery of financial services and weather insurance. Different models include:

(1) The finance institution could purchase a contract from an insurance company and then distribute index based weather insurance as a retail product to its borrowers and others who wish to utilize the service.
(2) Banks could formally link the provision of lending to the purchase of a weather insurance policy. Thereby banks would protect their lending by bundling the lending with the insurance product. Insurance payouts would automatically pay down loan dues.
(3) A variation of (2) is weather indexed lending whereby the loan agreement specifies weather events leading to the reduction of repayment obligations. In exchange for a premium deducted from loan proceeds, the borrower would get a legitimate "break" in case of extreme

[8] Skees, Jerry, William Jack, Anne Goes, and Kimathi Miriti, "Analysis of Weather Risks and Institutional Alternatives for Managing those Risks in Ethiopia," prepared for the World Bank, 2004.

weather events. The lender would use the premium to insure itself with a weather insurance product. [9]

(4) Finally banks could simply buy a weather insurance policy in order to insure the weather risk exposure of its rural portfolio, in particular crop lending.[10]

If there was an interested bank in Ethiopia index based weather insurance could allow Ethiopian banks to lend to clients who would be profitable on a risk adjusted basis thereby decreasing their risk while possibly extending their outreach. While, as mentioned above, this has been tested with some success in other countries in Ethiopia this type of approach proved more challenging because of the limited lending that goes to agriculture. The financial sector in Ethiopia is dominated by two large parastatal companies and a number of other smaller private banks. The largest banks, Commercial Bank of Ethiopia (CBE) and the National Bank of Ethiopia, have secured a large majority of deposits and provide most of the lending in the country. Currently CBE has 80% of the deposits in the country. Most of this lending is based in the urban sector and outreach of credit in the rural sector is marginal. For lending from banks (public and private) that does go to the agricultural sector typically 100% collateral is required. As a result lending in the agricultural sector is concentrated with medium to large agribusinesses. The only exception to this is the lending given by CBE to local administrations and cooperatives to finance agricultural inputs (this is discussed in the next section).

While the commercial banks have limited outreach in the rural sector there are a number of microfinance organizations, some of which have member bases as large as 70,000 farmers and are the largest in Africa, who are major providers of financial services in rural communities. The biggest of the microfinance organizations are Oromia Credit and Savings, Amhara Credit and Savings, and Dedebit Credit and Savings. These three organizations account for the large majority of microfinance lending in the country and all three primarily lend to rural clientele. Both Oromia and Amhara Credit and Savings had hesitations about pursing weather insurance because most of their current borrowers are in agricultural areas that face limited weather risk. Neither of these two took a significant interest in extending their lending to areas or clients which could benefit from a weather insurance product. Additionally most of their borrowers, although in rural areas, are focused on small scale enterprise development rather then agriculture. The organization that showed the most interest in a weather insurance program was Dedebit Microfinance Organization (DECSI) based in Tigray which described in more detail in the box below.

Box 3.1 Profile on DECSI

The Tigray region, located in north eastern Ethiopia, has faced consistent drought and food shortages. While eighty-two percent of the population relies on agriculture for their livelihoods, forty-five percent of the households are producing less then 50% of their food needs. Dedebit Credit and Savings Institution, Dedebit, lends to over 200,000 members either through 1) group lending, 2) individual lending programs packaged with MSE, and 3) individual collateral with physical assets or a co-signer. DECSI is based in Mekele but has nine branch offices and 97 functionally decentralized sub-branches, and eleven microfinance offices. While servicing rural areas throughout Tigray the summary of their loan portfolio below shows that agricultural remains a small percentage of their business.

[9] For a full explanation of the use of weather insurance with lending products see "Innovative Financial Services for India, Monsoon-indexed lending and Insurance for Smallholders, Ulrich Hess, Agriculture and Rural Development Working Paper 9, August 2003.

[10] The MFI Basix in India used this option to protect its crop lending portfolio extreme weather events.

Number of Active Clients as of May 31, 04	
Regula	112,039
Packag	139,862
Agricultural	47,680
MSE	408
Tota	299,989

Loan Outstanding as of May 31,	Bir	USD (11.2 Birr/
Regula	113,455,036	10,129,914
Packag	245,861,007	21,951,876
B. of Agric	5,889,123	525,815
MSE	6,669,027	595,449
Tota	371,874,193	33,203,053

Despite being in a relatively drought prone area which contained areas for which insurance was not a viable alternative because of the frequency of the risk DECSI management believed, because that within their area outreach there were a number of customers in specific areas who could benefit from this type of coverage. CRMG pursued the idea of launching a pilot program with DECSI but found there was little to no weather data in the region. The weather data that was obtained from the local meteorological office, showed on average 43% of missing data over a thirty year period 1975-2004[11], due partially to the history of civil unrest in the region. Since this data was unavailable this made, despite the interest of a local partner institution, a localized weather insurance project a non-starter in the Tigray region.

Tying Weather Insurance to Input Provision

Another approach for reaching potential weather insurance clients is tying weather insurance to input provision. Because of the importance of increasing agricultural yields and providing farmers the opportunity to invest in higher risk, higher return activities insurance is especially important for improving the functioning of agricultural input and credit markets in Ethiopia. Fertilizer is by far the most important cash input--following the success of the Sasakawa Global 2000 program in the mid-1990s, where fertilizer-seed packages were actively promoted by the extension service to hundreds of thousands of farmers, special input supply programs were put in place to ensure smallholder access to fertilizers. Fertilizer use increased from 110,000 t (21 kg/ha) in 1991 to 323,000 t (32 kg/ha) in 2004/05. To ensure the uptake of these technological packages and absorb risks for credit institutions, regional governments started a 100% credit guarantee scheme in 1994. About 90 percent of fertilizer is now delivered on credit.

Farmers access fertilizer through the institutions they work most closely with among local government, cooperatives, or, in limited cases, directly from input providers. To facilitate access to inputs each year the district authorities sign an agreement with the Commercial Bank of Ethiopia (CBE) that it (the local government) will cover any default that occurs. Credit for fertilizer and seed packages is then extended to farmers by CBE through cooperatives, local

[11] Nine weather stations from the Tigray region were considered. The station with the least amount of missing data was Mekele weather station located at the regional airport: it only had 13% of data missing from 1975-2004.

government offices, microfinance institutions, and, in one region, a cooperative bank. In some cases this requires an upfront payment by the farmer but the rest is given on credit. Even though the fertilizer is given on credit farmers do not have a formal agreement with a financial institution. The program now reaches some four million farmers with a guaranteed credit of nearly $70 million (Table 3.2). While this program has had some successes, it has also been associated with considerable costs.

- Credit recovery, using extension workers and a degree of coercion by local officials, was generally successful until the collapse of maize prices in 2001 and the subsequent drought.[12] In Oromiya, for example, recoveries had averaged above 80 percent, but this figure dropped to 60 percent in 2002, forcing major rescheduling of loans by the Bureau of Agriculture and Rural Development (BoARD). As a result of the credit guarantee, the amount of the defaults has been deducted from the Federal government block grants to each of the Regions. The write off to loan guarantees amounted to ETB 84 million in 2001, but by 2005 liabilities had again accumulated to ETB 183 million (DSA, 2006). The guarantee is an outright subsidy that is not accounted for in the regional budgets and therefore need to be taken from other programs, leaving unplanned gaps and possibly disrupting ongoing development activities.

- Another concern is how this guarantee has limited the entry of other lenders into input lending. Currently the guarantee is crowding out lending for fertilizer from other sources as well as a demand for weather insurance. With the guarantee in place and lending interest rates of 4-5% few other banks can compete with CBE.

Table 3.2 Estimate of total fertilizer sales and guaranteed loans by Region

Region	Diammonium Phosphate (DAP)		Urea		All	
	Sales (tons)	Total cost (ETB million)	Sales (tons)	Total cost (ETB million)	Total sales (tons)	Total loan (ETB million)
Oromiya	101,571	307,283	45,252	110,867	146,823	292,705
Amhara	61,263	184,665	41,927	98,465	103,190	198,191
Southern Nations, Nationalities, and People's Region	27,270	84,537	6,111	15,950	33,381	70,341
Tigray	5,395	16,091	3,438	8,629	8,833	17,304
Total	195,499	592,576	96,728	233,911	292,227	578,541

[a] Assumes 30% down payment

- The government believes the increased application of fertilizer is a critical area of intervention for improving agricultural productivity. They do not believe the private

[12] When extension agents and cooperatives become responsible for input distribution and debt collection their role changes from Development Agents (DAs) to loan collector.

> sector alone will adequately meet fertilizer needs for farmers. Fertilizer tied to credit programs and fed by government targets for fertilizer consumption at the local, regional and national levels, has stifled the development of private input markets. Those farmers that have some resources are not able to purchase fertilizer for cash since there are very few private traders.[13] This situation does not encourage careful use of credit and the development of independent financial management skills by farmers. Lack of private markets also results in poor service at the farm level, including timeliness and quality. A significant proportion of farmers in recent year (as many as half in some regions), report late delivery of fertilizer. Timely availability of fertilizer is critical in rainfed agriculture—fertilizer applied late causes it to be unprofitable, or planting is delayed which can have even higher costs. The current system has retarded growth of the rural financial system since the availability of subsidized or fully-guaranteed credit on easy terms, crowds out the development of alternatives. Additional financiers will not on the risks associated with lending for fertilizer and CBE has stated that they are unwilling to take on risk and will only lend with 100% guarantee from the government.

Because of the government guarantee program the introduction of a weather insurance product linked specifically to input finance is impractical in the current environment. The guarantee eliminates a role for weather insurance to facilitate lending in two ways. First by covering any type of default, not just weather or a particular calamity, the government's current guarantee to CBE is more comprehensive then a weather guarantee. Second it crowds other lenders out of the input financing business. Despite the lack of an immediate need, weather insurance could serve as a catalyst of disengagement from the guarantee business for the government. While there are a number of reasons the government continues to be involved in the fertilizer market, among them maintenance of political control within the rural area, by providing an alternative market approach to a lending guarantee the government could still achieve is objectives while making the system more efficient. Some ideas on how this transition could occur are highlighted in the box below.

Box 3.2: Utilizing Weather Insurance to Phase Out a Lending Guarantee

The use of index based weather insurance does not necessarily preclude the presence of a government guarantee but the current guarantee in place demand could be difficult to generate. While in the short term prospects are limited for linking index based weather insurance to credit, there could be room to shape a government guarantee program or facility in a way that it would work in concert with the insurance. This would require an explicit phase out of the guarantee over time or a guarantee that covered only non weather default events. Otherwise this guarantee will continue to crowd out the need for weather insurance. If the guarantee could be modified to complement the

[13] In addition the agricultural input market in Ethiopia is managed closely by government through allowances on imports, access to credit, and access to foreign exchange. Few private companies have been able to make significant inroads into the market and the agricultural input market is dominated by Agricultural Input Supply Company (AISCO) the state owned input supplier who holds the majority share of the input supply business. This input supply process begins with district authorities estimating input demand before each season and passing the anticipated needs to input providers. With this information AISCO and the other few private input suppliers secures loans before being awarded the necessary foreign exchange from the government to make the purchases. Access to foreign exchange is one of the main competitive advantages of the state owned company. Its competitors are often limited in their foreign exchange allocation and have difficulty accessing credit which therefore limits their ability to import fertilizer. Once the fertilizer and inputs are imported they are sold on a cash basis. Fertilizer companies do not take on risk and because of the stronghold on the market AISCO it has minimal incentives to do so.

implementation of a weather insurance product implementation could happen through a number of different institutions:

- **Bank:** CBE purchases weather insurance on behalf of its borrowers and passes on the costs of that insurance to the borrower either through the interest rate or as part of the principal. Any payout from the insurance would go directly to CBE to pay down the principal or interest of the loan.

- **Cooperative:** The cooperative who is delivering fertilizer to the farmers on credit could purchase insurance. The cooperative could pass the cost of this insurance on to the farmers as part of the principal of the loan or interest and deduct it from the outstanding balance when the farmer sells his crop. Any payout from the insurance would go directly to the cooperative to pay down the principal or interest of the loan.

- **Farmer:** Farmers would be required to purchase weather insurance in order to get a loan. They would then present proof of the possession of insurance to the cooperative in order to access fertilizer. Any payout from the contract would go to the farmer to be used towards paying down the principal of the loan.

- **Regional Government:** Insurance could also be used to protect the government guarantee and replenish funds in case of a major weather event. In this way the regional government would purchase weather insurance to protect its own risk to weather events. The government would pay the premiums itself but could charge a facility fee to access the credit guarantee.

Replacing the current government guarantee with a weather insurance product would not provide the bank, cooperative, or farmer the same level of security as a comprehensive guarantee and many financiers could be hesitant to accept less then a 100% guarantees. At present CBE is willing to lend with a full guarantee and without this guarantee would be unlikely to remain involved in the business. Without a change in policy by CBE or an intervention of another bank withdrawal of the government guarantee could eliminate the lending for inputs altogether.

Despite offering only a limited guarantee, index based weather insurance could become part of the overall approach and discussion of the phasing out of fertilizer lending guarantees in Ethiopia. Coupling weather insurance with a phasing out of the subsidy could allow fertilizer borrowers to build credit history while protecting against catastrophic drought events. Minimizing weather risk would allow banks to base lending decisions on credit history and the strength of the clients business.

Insurance Companies

As discussed above insurance companies will already need to intermediate the transaction but could also play a larger role and provide this insurance directly to clients. While bundling weather insurance with other services such as credit, inputs, or extension has proven successful in other countries, in some countries insurance contracts could be sold by insurance companies on a stand alone basis directly to farmers and potential beneficiaries. Many insurers have little interest in this role because they are typically heavily focused on urban areas and don't have outreach to the rural sector that would be necessary to market the product. Additionally many do not have interest in taking on agricultural risk and have limited experience and expertise with the agricultural products. For this reason in addition to discussing the need to intermediate the product with insurance companies, these companies in Ethiopia were investigated as possible primary agents for the product. Throughout this process, only EIC showed interest in developing insurance and was interested in taking front line role in offering these products to their clients.

Cooperatives, traders

Finally cooperatives or traders in the marketing chain could act intermediaries and provide this product to farmers. In Ethiopia the development of cooperatives is being strongly encouraged by the government as a means to facilitate service delivery for marketing, processing, and extension and improve the ability of farmers to market their products. Ethiopia has three primary types of cooperatives that are providing services to the agricultural sector -- multipurpose, single purpose, and financial cooperatives.

1) Multi-purpose service cooperatives. Multipurpose cooperatives provide marketing services often with a profits sharing arrangement as well as milling, storage, and processing of agricultural by products such as oil. In addition they often provide credit to their members (this is described in more detail below)

2) Saving and credit cooperatives. These are financial cooperatives which operate in both rural and urban areas. Typically members can borrow based on the amount of savings they have with the cooperative. Typical terms require repayment within three years time and interest rates are 3 % and 7.5% for savings and loans respectively.

3) Single purpose cooperatives. Since purpose cooperatives operate much like multipurpose cooperatives but provide service dedicated to a single industry. These are most common for high value crops such as dairy and have seen particular growth in the coffee sector.

Cooperatives tend to have the greatest outreach into the rural sectors. Levels of technical capability and capacity vary greatly between cooperatives in Ethiopia. Many of these cooperatives were organized during the rule of Derg and tend to be weaker in organization; while many others have been organized more recently and have put significant investments in creating stronger financial and organizational structures. Some of these cooperatives have been reformed under the new cooperative laws which require greater emphasis on financial accountability and business management but many others maintain a much looser affiliation of members and looser accountability. Cooperatives, depending on their capacity and their specific business activities, could be a means of outreach for delivering products to farmers. The major constraint to working with cooperatives on this type of project is a lack of technical skills and expertise needed to manage the delivery of a new product. While some have greater capacity then others the added administrative burden needed to deliver the product as well as the staff time and effort needed to market could be a strain on many of these institutions.

IV. Implementing a Pilot Project

The research and discussion described above was used to determine if a pilot program could be implemented for the 2006 crop season and based on initial impressions and discussions with stakeholders this seemed possible. As mentioned above the first discussion of pilot implementation was with DECSI in Tigray who wanted to offer this product to farmers for crop production and possibly an insurance product related to livestock. DECSI would have bundled a weather insurance contract written by EIC with their lending product but without sufficient weather data this could not be pursued.

The Ethiopian Insurance Company (EIC) also wanted to implement and ultimately did implement the pilot independently of DECSI. EIC seemed like an appropriate partner for this pilot because of their desire to pursue the development of the product, their previous forays in agricultural insurance, and because of their relatively large outreach in the rural areas through its branch network when compared to other insurers. EIC worked closely with the Commodity Risk Management Group at the World Bank to develop a workplan for a small pilot program. The major steps of the workplan were:

1. Identify potential pilot areas, crops, and delivery channels
2. Carry out market research through a participatory assessment to determine the major risks and demand for insurance in the pilot areas
3. Design contracts to meet the needs of the farmers
4. Test the contracts and different payout structures of the contracts
5. Finalize insurance arrangements and contractual agreements between participants in the pilot
6. Provide technical training to the EIC and "train the trainers"
7. Market the product to potential clients and establish contractual agreements between participants
8. Execute and monitor the contracts

1. Identify Potential Pilot Areas and Crops

The first step in the development of a pilot project with EIC was to determine the where the pilot program would take place. The selection criteria were:

- EIC interest in piloting a weather insurance product in that area
- Medium-low exposure to drought risk (a high exposure would entail excessive financial risks for the insurer and high premiums for the farmers)
- Presence of a NMA weather station
- Availability of historical weather and yield data
- Preliminary expressions of interest from farmers and local institutions.

Based on these criteria EIC selected two woredas, Alaba and Lemmo & Bilbilo, as the primary regions for the pilot and four kebele within those woredas (Hulageba Kuke and Guba Sherero in Alaba Kulito, and Koma Ketera and Enkola Gerjeda in Lemmo & Bilbilo). All of these kebeles are within 30 kilometers of a weather station. The table below gives some basic demographic information on the two woredas selected.

Table 4.1 Background data

	Alaba Kulito	**Lemmo & Bilbilo**
Area (ha)	65,193	151,600
Population	180,915	228,266
# of kebeles	73	39
# households	32,284	22,088
# female headed households	3,360	2,420
# kebeles by agro ecologic zone		
Highland		22
Midland	73	9
Lowland		3
Average land size (ha)	1.5	2.5
Main crops in order of importance [14]	maize, teff, wheat, pepper, haricot bean, finger millet, sorghum	wheat, barley, linseed, teff, field beans, rapeseed, field peas, maize, sorghum, oats, lentil, haricot bean, vetch, chick pea
RAINY SEASONS		
Belg	March-April	February-April
Meher	June-September	June-October

While EIC did have a branch in close proximity to both of these pilot areas they had little to no experience in marketing micro products to farmers and wanted to use local organizations who were closer to the farmers as agents for the product. A number of different organizations were considered including the Kebele administration, cooperatives, funeral societies, and microfinance organizations. Omo Microfinance Institution and Oromiya microfinance organization operate in Alaba and Lemmo & Bilbilo respectively but mainly lend to urban-based small enterprises with little or no lending to the agricultural sector.

While a spectrum of potential channels were explored cooperatives seemed to be the most promising avenue and have the most business incentive to become involved in the pilot program. In addition cooperatives are most closely linked to farmers through existing marketing activities**.** In the two target woredas, cooperatives are the rural institutions most engaged in service provision to farmers, including input supply, and credit and saving facilities. In Alaba there are 11 cooperatives, eight of which are active, licensed cooperatives, with a total of 4100 members in 36 kebeles. A number of these are marketing cooperatives which provide inputs to farmers on credit and provide flourmill services for maize farmers. In addition there are water use associations which provide services such as seed production and marketing, irrigation management, and seed supply.

Box 4.1 Funeral Societies in Ethiopia

In Ethiopia, funeral societies are known as Iddir, associations that provide a payout at the time of the funeral for the deceased relative of a society member. There are several kinds of Iddir in the target villages for the pilot programs, each one with its own bylaws and regulations. One of them in Hulageba Kuke (Alaba), for instance, requires each member to pay 1 ETB a week, more or less 50 ETB a year. When a member's relative dies, other associates pay an extra 7 ETB. Payouts differ depending on who is the relative who dies.

Another example is an alternative Iddir system that does not require members to pay a regular premium, but only to pay an initial sum of 2-5 ETB which is used to purchase materials for funeral ceremonies. Members then contribute 8 ETB each in case of death in a member's family. While there is no ongoing payment the maximum pay out is lower. Farmers in the lowest wealth group are more likely to belong to this type of Iddir. A study by Stefan Dercon, Tessa Bold, [15]etc., suggested that Iddir societies could play a role in agricultural insurance delivery.

Table 4.2 Cooperatives in Alaba Woreda

Name	Type	Members	# of Kebeles	Year of establishment
Guba Sherero*	Multi-purpose	572	5	1996
Regdina Tuka*	Multi-purpose	427	4	1996
Absha	Multi-purpose	165	3	1998
Tefo-Gufissa*	Multi-purpose	291	4	1998
Hantezo*	Multi-purpose	297	3	2001
1st Tuka *	Multi-purpose	235	3	2001
Konicha*	Multi-purpose	233	3	2001
Mekala*	Multi-purpose	185	3	2002
Muda-2nd	Marketing	120	2	2004
Gortancho- Hulegeba	Marketing	1260	3	2004
Bedene Alemtena*	Water Use	315	3	2004
TOTAL		4100	36	

*= active cooperatives

In Lemmo & Bilbilo there are 18 cooperatives which cover almost all of the Kebeles. Twelve of these were established during the Derg rule and five of them are part of the Galema Cooperative Union. Like Alaba there are multipurpose cooperatives that supply inputs on credit for their members but also provide additional services such as flour milling, oil production, and grain storage services. In addition to multipurpose cooperatives Lemmo & Bilbilo has a number of savings and credit cooperative both in the rural and urban areas. These cooperatives allow members to borrow the maximum amount of 3 times their savings, and are expected to repay in three years time. Interest rates are 3 % and 7.5% for savings and loans respectively. As for 2004, total lending to members was ETB 411,146.95. Finally there are a number of dairy cooperatives that collect and market milk under a profit sharing arrangement with their members.

Table 4.3 Typology of cooperatives in Lemmo & Bilbilo

Cooperative type	Total number of members	Total capital (ETB)
Multi-purpose (12)	15,935 6,153 non-member households receive services	2,671,280.32
Dairy cooperatives (1)	98	147, 815
Saving and Credit (5)	622	1,105,470

Table 4.4 Cooperatives in Lemmo & Bilbilo

Name	Year of establishment	# of kebeles	Number of member households		
			Male	Female	Total
Wochitu Goto	1989	1	257	11	268

[15] Stefan Dercon, Tessa Bold, et al., **Extending insurance? Funeral associations in Ethiopia and Tanzania, December 2004**

Koji Kubsa	1968	3	1,458	129	1,627
Bilbilo Far echo	1970	3	1,203	117	1,320
Merino	1970	4	1,523	183	1,710
Sultana	1969	6	2879	381	3,260
Lemur Aria	1969	3	2,267	268	2,635
Bikini	1969	5	2,563	213	2,776
Gin bite	1970	5	1,278	308	1,586
Garza Enola	1996	1	253	52	305
Limo Original	1997	1	360	12	372
Lemur Gleam	1996	1	204	16	220
Total		**34**	**14,245**	**1,690**	**15,935**

In our target areas, the NMA weather stations are located, respectively, in Alaba town (Alaba worked) and Meraro town (Lemmo & Bilbilo woreda). The Alaba station is a Class 3 station and was established 25 years ago. Weather data is mailed monthly to the NMA in Addis Ababa and to Awash NMA regional office. The Merero weather station is also Class 3, established in 1989.

Alaba woreda can be defined as a medium-risk area. According to local MoARD officers, rainfall over the past 10 years has been variable. A severe drought occurred in 2002, when the local administration appealed for food aid. In recent years, even if rainfall total amount was fairly good, distribution was inadequate. A good example is 2004, when a good rain at the beginning of the season (April) was followed by two dry months, and then by excess rain and hail in July, resulting in significant yield losses. Rainfall varies within the woreda as well: about 20 kebeles north of Alaba town, and three kebeles east, have been repeatedly affected by rain shortage and drought, and four of them participate in food for work schemes. In the remaining 25 kebeles rainfall has been, in general, satisfactory for agricultural production.

Lemmo & Bilbilo woreda is on average low-risk with respect to drought. The area has been known for good rainfall in the past decade. Since 1997, however, rain shortages have negatively affected agricultural yield in some parts of the district. MoARD local officers indicated 2003 as the worst year, when most farmers lost their crops, and many kebeles received food aid. About eight kebeles[16] in the woreda are known as rainfall deficit areas. However, their soil is very fertile, which partly compensates the negative impact of adverse weather conditions. No kebeles in the woreda receive food aid on continuous bases.

2. Determining Risks and Demand through a Participatory Assessment

The initial identification of the woredas was not sufficient to determine the potential demand and need by farmers for an index based weather insurance product in the given kebeles. In order to get answers to the question of demand and utility of the product a participatory assessment was carried out in the identified kebeles. The participatory assessment aimed to address how weather insurance would affect farmers' livelihoods and investment behaviors. It also aimed to get an understanding of the demand and willingness to pay by farmers for weather insurance in the target areas, with a special focus on whether an insurance product can be made accessible to small producers.

[16] Mechito Guto, Wabe Kebena, Wageda Kecha, Legena Guajeba, Gadissa Derara, Woltei Nega, Enkolo Gerjeda and Sirbo

Because the study intended to explore the feasibility of pilot insurance transactions in specific communities, its findings are not broadly representative. The value of the exercise was in its applied and multidisciplinary nature, involving the exchange of relevant information between social scientists and experts in economics and weather risk management, aimed at designing an insurance scheme which makes sense to farmers. The fieldwork was structured so to allow continuous feedback from social and technical experts, and vice versa. The first part was devoted to introduce the weather insurance concept to farmers and local institutions, and to collect background data on the weather and agronomic data in the target area. The resulting information was used by the Ethiopian Insurance Corporation (EIC) and World Bank to design the contract prototypes. As will be discussed later in the contract design subsection the field findings were also used to guide the design of the prototype contracts and implementation decisions. Approximate 150 farmers were involved in the participatory assessment from the four identified kebeles. The farmers were chosen from among farmer cooperatives in those areas and in order to ensure a representative selection, farmers from high, medium, and low wealth groups were chosen. The study consisted in 12 focus groups and five in-depth interviews with farmers, and eight interviews with other stakeholders (kebele authorities, cooperatives, the woreda Agricultural and Rural Development Bureau).

The two main tools that were used to determine the utility of a weather insurance product in these woredas and the demand for the product were:

- *Risk matrix and risk pair wise ranking* were used to identify the different risks affecting farmers' livelihood, and the relative importance of weather risk in this context. Farmers were invited first to make a random list of those risks, and then to compare each item of the list with all the others, as a means to establish the priority problem.
- *Wealth ranking* to identify, based on farmers' own categories, the different wealth groups within the community

Wealth ranking

One of the other key factors in designing an index based weather insurance program is determining who potential clientele are for the product. One of the biggest constraints is cash availability to pay the premium in advance of the season. In general it is often difficult for small farmers to pay the premium up front since the majority of their cash income is received post harvest. Additionally in previous pilot programs outside Ethiopia subsistence farmers have been reticent to pay an insurance premium for a non cash crop that will only be used for household consumption. Therefore it is important to understand when and how farmers are making money in order to determine if they will to pay the premium and from where they would find money for this type of expenditure. Also by looking at the absolute wealth of the farmers it is possible to determine the size and characteristics of target clientele. Tables 4.5 and 4.6 show the distinctive features and proportional distribution of wealth categories in target communities, based on farmers' own criteria. [17]

[17] Farmers were asked to list the criteria by which different wealth categories are locally defined. The names of 100 household heads were then written on cards. Farmers assigned each card to the respective category, indicating as result the percentage distribution of each wealth group.

Table 4.5 Wealth ranking in Haulage Kuke, Alaba Woreda

Criteria	Rich (Kebatamo [18])	Medium (Mererancho)	Poor (Butich)
Size of land	More than 2 ha	1 ha	Less than 0.5 ha
No. of oxen	2 or more	1	0 [19]
No. of milking cow	More than 2	1	0
Size of land under eucalyptus tree	More than 0,25 ha	Less than 0,25 ha	0
No. of goat	More than 5	1 or 2	1
No. of sheep	More than 5	1 or 2	**1**
Back yard coffee and chat	Yes	No	No
No. of donkey	More than 1	1	0
Percentage of village population	**20%**	**32%**	**48%**

Table 4.6 Wealth ranking in Koma Ketera, Lemmo & Bilbilo Woreda[20]

Criteria	Rich	Medium	Poor	Very poor
No. of oxen	More than 5 pairs	2 pairs	1 pair	
No. of milking cow	More than 5 (milking at the same time)	4	1	0
No. of sheep	More than 50	More than 20	2	0
No. of male horses and mules	2	1	0	0
No. of female horses	5	1	0	0
No. of donkey	More than 5	2	1	0
Owns flourmill	Yes	No	No	No
Owns house in town	Yes	No	No	No
Percentage of village population	**7%**	**28%**	**27%**	**38%**

Judging from cattle ownership, it is evident than farmers in Lemmo & Bilbilo woreda are much better off than those in Alaba. On the other hand, while Alaba farmers are more or less equally distributed between the two categories of rich/medium and poor, wealth distribution appears more skewed in the other woreda, with poor and very poor farmers representing the great majority of community members. In both areas, the poor do not own livestock, and earn their income by performing seasonal work on others' land, or by working in menial jobs in town and therefore have little or no cash to spare. Farmers in the rich and medium wealth categories seem the most obvious target for insurance marketing.

[18] Alaba language

[19] The poor do not own oxen. They can use someone else' oxen by plowing 2 days for the oxen owner's field, and the 3rd day for their own. Due to this, poor farmers usually plow later than the others.

[20] In Lemmo & Bilbilo the average land size (2.5) is higher than in Alaba (1.5), and farmers do not consider this as a relevant criteria to define wealth.

Risks and Pair Wise Ranking

While drought risk is significant in Ethiopia it is not the only risk faced by farmers and rural communities. Different areas at times face other more significant risks that could undermine the importance of weather insurance. Making the determination and ranking of risk is key element of project implementation and should be established before a weather insurance product is offered. To determine the relative importance of different risks in the kebeles under consideration a pair wise ranking was carried out.

In **Alaba** the two kebeles maintain that the most important risks they face are drought, hail, and pests. The result of the pair wise ranking for maize is shown in Table 4.7. The pair wise ranking and discussions with farmers showed that crops may tolerate hail, depending on the stage of crop, and pests can be controlled by insecticides or may be less pernicious if crops are infested at a later vegetative stage. The rust "wag" pest only affects pepper and may cause yield loss at the flowering stage or just before it. However, drought has an impact on all crops and it is therefore the first risk in order of importance, as shown by the pair wise ranking exercise.

Table 4.7 Pair-wise ranking of risks, Holageba-Kuke, Alaba

Risks	**Hail**	**Migratory pest**	**Rust (*"wag"*) infestation**	**Drought**	**Rank**
Hail		Hail	Hail	Drought	2
Migratory pest			Migratory pest	Drought	3
Rust (*"wag"*) infestation				Drought	4
Drought					1

In Lemmo and Bilbilo the risk analysis presented a different outcome. Particularly, in one of the two target kebeles (Koma Ketera, located at an altitude of 2950m), farmers reported that frost rather then drought is the most important risk for barley, as shown by table. Frost most frequently appears in October, at flowering and seed setting time, resulting in a complete crop loss. Frost events are highly disruptive but concentrated in small areas, and seemed to be some spatial variability to the impacts. This has allowed farmers in the woreda to cope by borrowing grains from non affected ones, or farming plots of land in different places. Drought is the second most important risk because of its relationship with cutworm infestation during the seedling or sowing stages. Although a less frequent event, drought affects a larger number of people, and, as in Alaba, farmers typically sell their livestock to survive. In the second kebele (Enkola Gerjeda) drought is the preeminent risk, immediately followed by pests, frost, and wind.

In both Alaba and Lemmo & Bilbilo while a number of weather and pest related risks were mentioned by farmers they also emphasized that declining soil fertility and the cost, poor quality, and limited volumes of seed and fertilizer were also having significant impacts on their yields.

Table 4.8 Pair-wise ranking of risks in Koma Ketera, Lemmo&Bilbilo

Risks	**Frost**	**Rain shortage**	**Cutworm**	**Bad distribution of rain ("rain at wrong times")**	**Rank**
Frost		Frost	Frost	Frost	1st
Rain shortage			Rain shortage	Rains shortage	2nd

Cutworm				Bad distribution of rain (“rain at wrong times”)	4th
Bad distribution of rain (“rain at wrong times”)					3rd

Table 4.9 Pair-wise ranking of risks, Enkola Gergeda, Lemmo & Bilbilo

Risks	**Rain shortage**	**Frost**	**Cutworm**	**STRONG WIND**	**Rank**
Rain shortage		Rain shortage	Rain shortage	Rain shortage	1st
Frost			Cutworm	Strong wind	4th
Cutworm				Strong wind	3rd
Strong wind					2nd

Related to the risk ranking activity farmers were asked how they coped with droughts and other events when they occurred in order to determine the relative efficiency of index based insurance over current coping mechanisms. In Alaba when a drought does occur, better off farmers are obliged to sell livestock, their most important asset, while the poor participate in food for work program.

In Lemmo & Bilbilo selling livestock and temporary or permanent migration are the most frequent coping strategies when a drought occurs. Some farmers previously owned as many as 200 sheep and large number of cattle but have had to sell these livestock in order to repay fertilizer credit year after year. In previous years the recovery from drought and crop failure has taken a long time and in Lemmo & Bilbilo the number of livestock is declining. The tables below outline the primary coping strategy associated with the major risks as identified by farmers in Alaba and Lemmo & Bilbilo.

Table 4.10 Risks and coping strategies in Holageba-Kuke, Alaba

Risks	**Coping strategies**
Hail	Substitute with other crop if time allows for re sowing. Wait for the next season if time does not allow.
Migratory pest	Spray insecticide, freely supplied by Ministry of Agriculture. Substitute with other crop, as damage occurs at early crop stage
Rust (“wag”) infestation	
Drought	Substitute with other crop if time allows for re sowing. Wait for the next season if time does not allow. Those who own livestock can sell it to buy food. The poor goes get food for work (food aid) Women do additional work to collect and sell a local grass on the market.

Table 4.11 Risks and coping strategies in Koma Ketera, Lemmo & Bilbilo

Risks	Coping strategies
Frost	Plant in April instead of June Borrow grains from unaffected farmer. Farm plots in different places
Rain shortage	Sell livestock Rent out land
Cutworm infestation	Consult extension staff and apply insecticides. Apply herbicide (if applied within 40 days after planting, it kills cutworm)
Bad distribution of rain ("rain at wrong times")	Dig ditches to drain out excess water from the farm. Plant at different times on different plots of land

Table 4.12 Risks and coping strategies in Enkola Gergeda, Lemmo & Bilbilo

Risks	Coping strategies
Rain shortage	Sell livestock to buy food Those who do not own livestock temporarily migrate to find work Some permanently migrate (to Bale). Those less affected and better-off ones help the others.
Frost	Plant early on *belg* cropping plots. Help each other in the kebele: there are some parts less affected by frost. Children travel to factories for work and get cash to buy food.
Cutworm infestation	Apply insecticide
Strong wind	

Some conclusions were drawn from the risk analysis conducted in the two woredas. The findings confirmed previous studies done in Ethiopia, showing that distress sale of assets (livestock in particular) is the most frequently adopted coping strategy when droughts occur. There are significant negative effects of distress asset sales. As Stefan Dercon argues "……rainfall shocks are not only strongly affecting food consumption in the current period, but its impact lingers on for many years: the evidence suggests that a ten percent lower rainfall about 4-5 years earlier had an impact of one percentage on current growth rates".[21]

The risk analysis also indicated that the relative importance of rain shortage events is quite different in the two kebeles in Lemmo & Bilbilo woreda, pointing out to the erratic nature of rainfall within a limited geographical area, and therefore to significant levels of basis risk if a weather insurance product were to be introduced. In addition this research gave some evidence that the initial assumption that holding weather insurance could allow farmers to keep their livestock and in some cases prevent them falling into a poverty trap could potentially be undermined by risks that are not covered by a weather insurance policy but which result in yield losses.

[21] Stefan Dercon, *Growth and Shocks: evidence from rural Ethiopia*, January 19, 2004

3. *Contract Design*

Based on information gathered in the participatory assessment and the general characteristics of the two woredas, contracts were designed for maize and pepper in Alaba woreda and barley in Lemmo & Bilbilo woreda. The aim of the contract design process is to structure an insurance contract that protects farmers as well as possible from the risk of drought, but is simple and can easily be conveyed and understood by the target clientele. The contracts should be designed to balance simplicity to make them understandable to farmers and stakeholders, with the complex dynamics that characterize water stress impact on the crop. An index-based weather insurance contract must identify the relationship between changes in a weather measurement or index – in the case of these contracts millimeters of rainfall during different times of the season – and changes in yield of a given crop. All weather insurance contracts have some similar characteristics. Each contract has a maximum sum insured which represents the maximum liability per contract of the insurance company in the case of a drought. They each also have a "trigger level(s)" which is a level of the index above or below which, depending on the contracting, an insurance payment is due. Finally they each have "tick rates" which give a payment rate for incremental drop in the index above or below the trigger and "limits", the rainfall level(s) at which the maximum payout, the sum insured of the contract, occurs.

To design a contract it is first necessary to design the weather index that most accurately predicts yield losses. To do this some basic inputs are needed including weather data, yield data when possible, input from farmers, and agronomic information on the plant. These inputs can then be used to determine how changes in the measurable weather variable or a weather event affect yield.

Weather Data

As described at the beginning of the paper in Ethiopia the National Meteorological Agency has historical records of rainfall for a number of stations throughout Ethiopia. Meraro weather station (Lemmo & Bilbilo woreda) was established in 1989 and therefore only had 17 years of historical data for the 2006 pilot; Alaba Station was established in 1966 and had 40 years of historical data. Both data sets were checked for errors, long gaps and statistically significant discontinuities in the historical record due to, for example, station location changes: none were found. Alaba receives 996 mm a year annual rainfall on average, with a standard deviation of 238 mm; Meraro 773 mm a year annual rainfall on average, with a standard deviation of 82 mm. There are no significant increasing or decreasing trends in annual or monthly rainfall for either station.

Access to both historical and real time data is important. The historical data was easily gathered by requesting and collecting the data from the NMA data centre in Addis Ababa in return for a small, standard processing fee. Securing the real-time data flow was more challenging as both stations are not primary Class 1 stations in the NMA network. That is they do not report to Addis Ababa on a daily basis and therefore this is not a part of the stations' normal operations. However during the development of the pilot discussions were held with the observers at both weather stations and with the NMA in Addis to ensure that for the stations involved in the pilot ongoing data would be received by the EIC every week from the NMA.

Yield Data

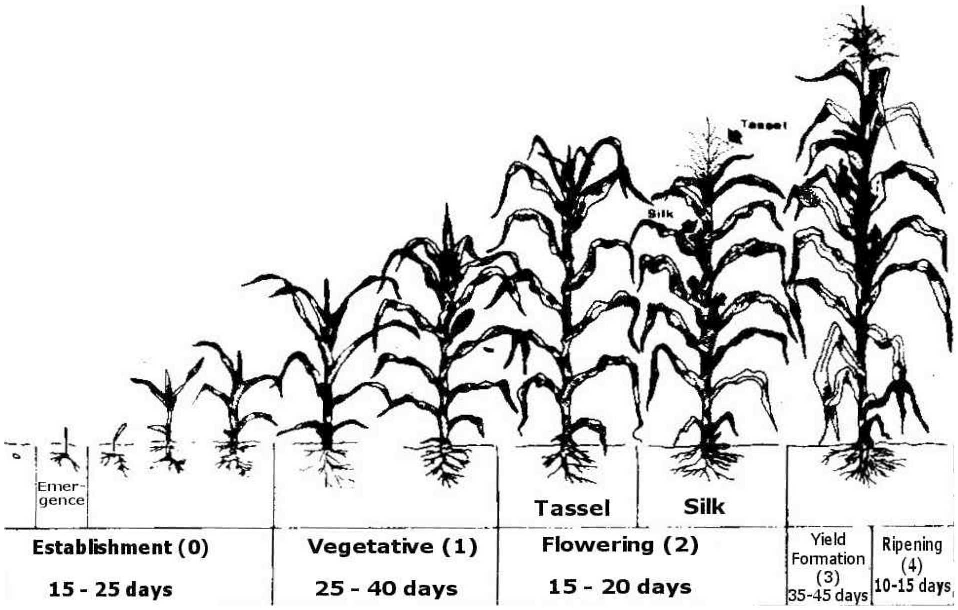
Maize and barley yield data was available for both woredas from 1996 and 1998 respectively from the Ministry of Agriculture and Rural Development (MoARD) and was used to help calibrate and cross-check the index and contracts. However it should be noted that in many other countries yield data, of the necessary quality to determine the accuracy of the index or contract design, is often unavailable. Yield data is often missing or erroneous or the drought risk contained in the data is often contaminated by other factors that impact production, such as changes in farming practices and technology over time, pest attacks, input availability, and other weather risks for example. Yield data is also not always collected in the same manner or with the same statistical robustness every year in some countries, which can also contaminant the historical record. The methodology used to collect such yield statistics, as well as the other factors that can impact production, should always be considered before using the data in any way. Yield data should never be used blindly to design weather insurance contracts unless its reliability is known, as calibrating an insurance contract to erroneous data or data which is reflecting another risk will result in a poor insurance product for a farmer. In Ethiopia the yield data collected was cross-checked against farmers' recollections of good and bad years and crop-model results.

Use of a Crop Model in Contract Design

To aid the design of the weather insurance contracts the project used the FAO's Water Requirement Satisfaction Index (WRSI) model to index maize and barley crop yields, and therefore production, to rainfall variability (a more detailed description of the model is given in Appendix 4). The key advantage of using a model such as the WRSI is that it uses rainfall as the only variable input parameter. Therefore when looking over several rainfall seasons, by using historical rainfall data from a weather station, one can observe the impact *due to rainfall deficit and deviation only* on a crop's yield from year to year. In other words the model does not capture other aspects that can impact yield levels, such as management practices, technological changes, and pest attacks. These other risks are captured in the historical yield data and because of this using historical yield data can lead to misleading results in quantifying the risk and impact of only rainfall on a crop's performance. By considering the variations in WRSI from the long-term average, from the previous year or some other baseline, one can quantify the *relative* difference in yield from that baseline due to the impact of rainfall alone. It is this quality that we can exploit to inform the design of weather insurance contracts. For situations where no historical yield or production data is available, a crop model such as the WRSI offers an alternative source of information for designing a weather insurance contract.

The WRSI model was used to check the historical yield data collected from the MoARD and to guide the contract design process. Because a participatory assessment was also carried out the model was used to cross-check the farmer-designed index and contracts, such as confirming farmers' opinions on which parts of the crop season were more critical for plant growth and the contract's ability to capture yield variability due to rainfall.

Figure 4.1: Water Requirements of Maize

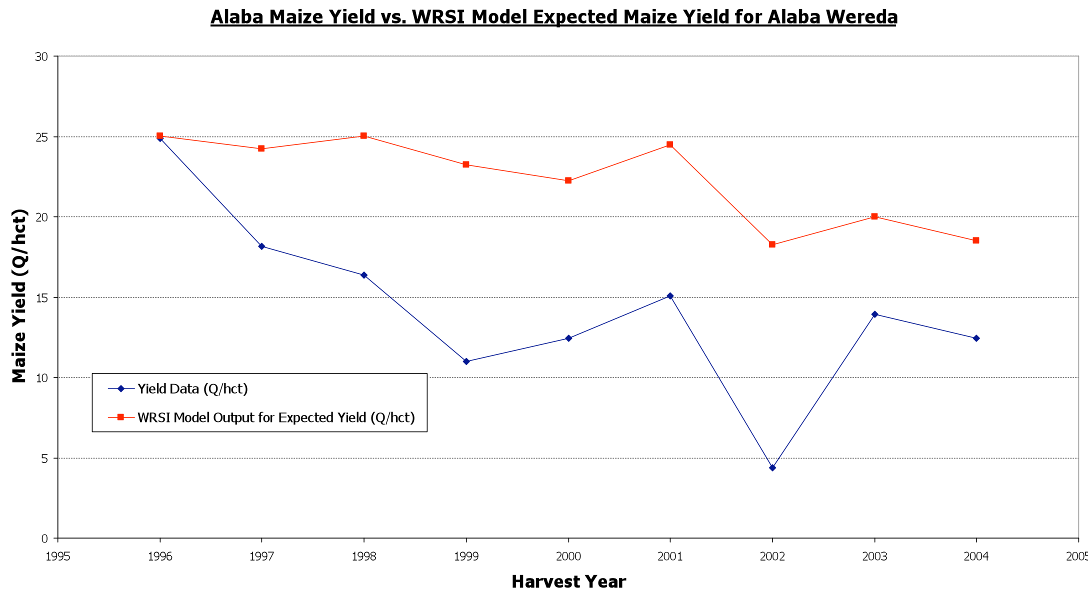


Source: FAO

For example, the historical maize yield data for Alaba woreda was compared to the WRSI crop model expected yield data for the area, using rainfall data from Alaba Town weather station for 1996-2003, shown in Figure 4.3. The correlation coefficient between the interannual variations in historical yield data and the interannual variations in modeled yield is 72%, significant at the 99% confidence level. It is clear from the figure below that the modeled data picks up the decreasing trend in maize yields observed in the actual yield data. Given that the only variable in the WRSI model from year to year is rainfall, the decreasing trend in modeled yield, at least, can be attributed to increasing erratic and/or insufficient rainfall in recent years. It is also clear that the model picks and confirms the best and worst years of the actual yield data. The best year, in both the modeled and actual maize yield data for Alaba is 1996, the worst year is 2002. It is interesting to note that 1996 was one of the highest rainfall years ever recorded in Ethiopia; 2002 was one of the worst rainfall-deficit years, the most recent devastating drought which required a significant humanitarian aid intervention (WFP, 2005).

However, it is clear from Figure 4.3 that there is much more variability in the actual yield data than in the modeled data. This is to be expected as the actual data contains information about risks other than drought within it. In particular it is clear that the unfavorable rainfall in 2002 had a much more severe impact in reality than in the controlled model environment, i.e. the model appears to underestimate the impact of erratic or deficit rainfall on a farmer's field. This may be in part due to the limitations of the simple WRSI model or the uncertainty in the inputs, such as water holding capacity, used to parameterize the model. It may also speak to the other production risks and to the impact of sub-optimal management practices of farmers themselves. The WRSI model assumes the farmer will use optimal management and farming practices on his field *to optimize yield*. In reality, this may not be the case. For example, a farmer may choose to optimize income instead of yield and in a bad year may choose to abandon a crop and focus on some other income-generating activity if the production is expected to be significantly below average, rather than tend the under-performing crop up until harvest. Such a decision would result in a lower yield than if the crop was attended to till harvest time. In reality, farmer also in general do not use or have access to inputs of the necessary quality and quantity to optimize the yield of a crop. In summary, the model provides a good cross check to the historical data. However it is clear that the increased sensitivity of actual crop production to drought must be considered when interpreting the model results.

Figure 4.2: Actual vs. Modeled Maize Yield in Alaba

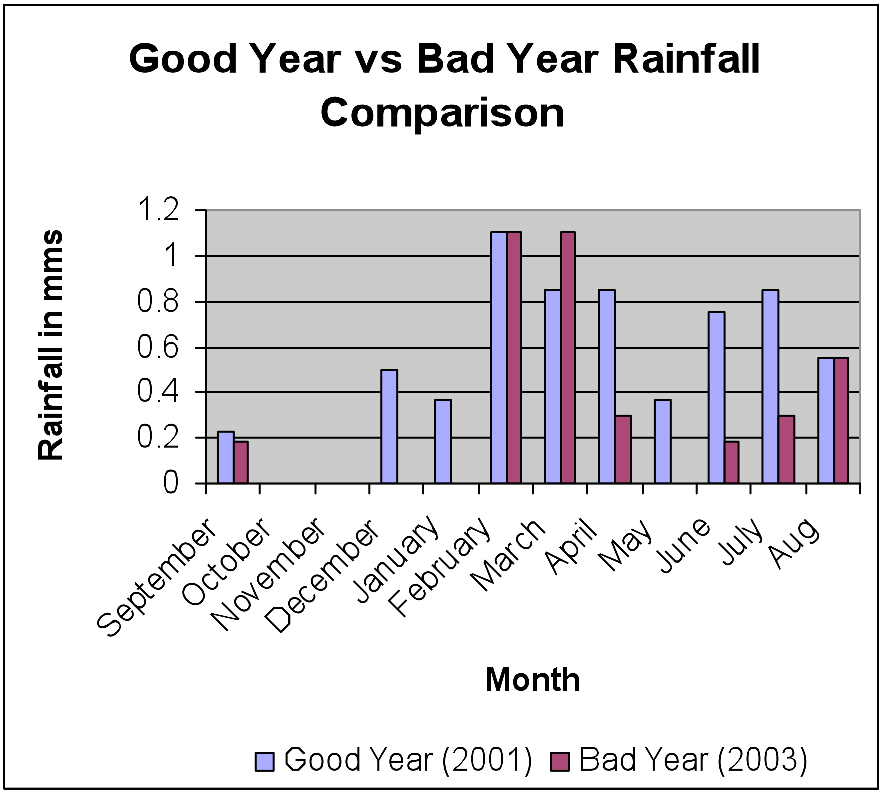


Participatory Design Approach

Information gathered from the participatory assessment described in the previous section was a key component of the contract design process. The information gathered during the first round of the participatory assessment was used to determine key elements of the weather insurance contract design including the maximum sum insured, the premium amount, and the monthly weights of the index. Contracts were designed for three different crops maize (Alaba), barley (Lemmo & Bilbilo), and pepper (Alaba). These crops were chosen mainly because of their relative importance and farmer demand. In the case of pepper the contract was designed to test the marketability of weather insurance for a cash crop, however ultimately pepper was ruled out by farmers as they felt that too many factors besides rain shortage could affect yield. Two different types of contracts were designed for maize and barley in order to determine which was most desirable to farmers. For each crop, the two contracts were set to the same premium level, but were structured to cover either a) more frequent risk or b) more extreme risk respectively to elicit the risk preferences of the farmers. All four contracts (frequent and extreme risk cover for maize in Alaba and barley in Lemmo & Bilbilo) were tested through the participatory assessment.

One of the key elements of contract design is identifying both the needed intensity of rainfall for a crop and the optimal distribution. Agronomic models, such as the WRSI, need to be ground proofed and adjusted based on local conditions and local knowledge of the agronomic environment in the contract area. To get a picture of these issues the participatory assessment through the *seasonal analysis instrument*, asked farmers in the potential pilot areas to arrange a calendar indicating the needed rain amount and distribution for each crop, and the most critical growth stages. Figure 1 shows an example of this highlighting the good and bad rainfall distribution for maize growth in Alaba, taking year 2001 and 2003 as examples of, respectively, a good and bad rainfall year. As can be seen by the diagram while the absolute amount of rainfall was higher during some months of 2003, the distribution of the rainfall during the good year was more spread across the growing months.

Figure 4.3: Farmers' description of good and bad rainfall distribution for maize growth – Holageba Kuke, Alaba



The following information was collected for maize from the farmers during the first participatory assessment in Alaba, as described in the previous section. Through discussions and the seasonal analysis work farmers indicated that they usually plant long-cycle (180-day) maize in Alaba in a sowing window that starts from late March to mid-May. The farmers choose to plant when they receive sufficient rainfall during the sowing window for seed germination. This usually corresponds to receiving approximately 25mm or more during a 10-day period according to MoARD (see Appendix 4), with at least 20mm in each on the next 10-day periods. Farmers usually plant in late March or April, and this is considered to be the optimal time for planting of maize by farmers. If the Belg rains in February and early March have been good and the soil has enough moisture for planting and therefore germination, they will tend to plant earlier in the sowing window, rather than waiting towards the end. Planting in May is considered to be more risky as the crop will come to maturity in November and the Kirmet rains may not be sufficient or may not extend into October to ensure the full maturity of the later-sown crop. If the rains are insufficient for planting during the sowing window, farmers will not plant maize and will opt for a lower yield short cycle crop such as wheat, barley or teff instead which they will plant when the Kirmet rains begin in June. If the farmers have planted maize with the rains, but then there is a gap in the rainfall causing reduced germination rates and sowing failure, they will either re-sow maize if there is still time in the sowing window when the rains start again, or switch to a short-cycle alternative. From discussions it was clear that the farmers considered the sowing period to be the most critical and risky part of the growing season. In particular, they were concerned that rainfall would be erratic and/or insufficient during the sowing window and they were worried that they would not receive sufficient Belg rains to guarantee good sowing opportunities in April, which they considered to be the optimal time to sow maize in Alaba. Rainfall in April was also viewed to be critical to ensure sufficient soil moisture to see crops through the gap between the expected Belg and Kirmet in May. Therefore they considered April to be one of the most critical rainfall months in terms of deficit rainfall risk.

Farmers also had concerns about deficit rainfall during the remainder of the growing season. In particular, following successful sowing in April, they were also very concerned about rainfall in June, July and August. They said that this period was most critical for the growth and yield of the crop; if the rainfall is erratic or insufficient during these months crop production will be severely impacted and in a worst case scenario the farmers can suffer a complete harvest loss. When asked about the remaining months, farmers said May was not as critical as April or June-August in terms of deficit rainfall risk. They explained that if rainfall was good in April, there should be sufficient moisture to sustain the crop through the gap between the Belg and Kirmet rains, which usually occurs in May. From the seasonal analysis it was established that farmers felt that May was a third as important as April or June-August in terms of deficit rainfall risk and its impact on maize. Farmers went on to say they were not as concerned with September rainfall deficit, as if the previous months have been sufficient, rainfall in September is not as critical for the crop's health. From the seasonal analysis it was established that farmers felt that September was a third as important as May in terms of deficit rainfall risk and its impact on maize. Finally the farmers said they were not concerned about deficit rainfall in October or November. In fact they said that excess rainfall is the biggest risk in these two months, deficit rainfall is preferable, as rainfall at harvest time can damage a crop and make harvesting very difficult. If the farmers plant maize at the beginning of April, they can expect to harvest the crop in the middle of October.

Given the farmers' comments and results from the seasonal analysis the relative weighting of deficit rainfall risk for the months in the maize growing season are given in the following table:

Table 4.13: Deficit Rainfall Weights for Maize in Alaba Woreda

Month	Deficit Rainfall Weight
April	1
May	0.3
June	1
July	1
Aug	1
September	0.1
October	0
November	0

These weights reflect farmers' perception of deficit rainfall risk, with the higher weighting reflecting greater farmer's concerns about the impact of deficit rainfall on maize yields during that month. The table can be compared to the parameter of the maize WRSI model.

One of the key elements of the WRSI model developed by the FAO is the crop coefficient, Kc, which relates water requirements of a specific crop at different stages to the reference potential evapotranspiration (see Appendix 4 for more information on the WRSI model and FAO (1998) (http://www.fao.org/docrep/X0490E/X0490E00.htm for more information on evapotranspiration). The amount of water required to compensate for the evapotranspiration loss from the cropped field is defined as a crop water requirement. The Kc coefficient essentially indicates the amount of water (rainfall) needed during a given point in the growing season to satisfy the plant's specific water requirement given the location to ensure optimal growth. The table below is taken from the FAO's WRSI model for maize. The maize grown in Alaba follows a 180-day growing cycle and the table below gives the general characteristics of the maize growing season as it relates to the water needs of the plant. As can be seen in the table maize needs the most rainfall to satisfy its growth requirements during the 60-day growing period called "mid-season" which included the critical tasseling and silking phase of maize and the early yield formation stage. It is also the phase that is most sensitive to water stress as reflected by the higher yield response factor to water stress, Ky.

Table 4.14: Crop Characteristics of 180-day Maize in the Horn of Africa[22]

Crop characteristic	Initial	Crop Development	Mid-season	Late	Total
Stage length, days	30	50	60	40	180
Depletion Coefficient, p	0.50	0.50	0.50	0.80	-
Root Depth, m	0.30	>>	>>	1.00	-
Crop Coefficient, Kc	0.30	>>	1.2	0.5	-
Yield Response Factor, Ky	0.40	0.40	1.30	0.50	1.25

Source: FAO, http://www.fao.org/ag/agl/aglw/cropwater/maize.stm

Let us assume a farmer sows his maize crop in the first dekad of April[23], the first 10 days of April. The period 1st – 30th April will cover the initial phase of the crop; 1st May – 20th June will cover the crop development stage; 21st June – 20th August will cover the mid-season stage; 21st

[22] The double arrow symbol (>>) in the table denotes a linear interpolation with time of the coefficient in question. For example the Kc value during the 50 day crop development stage increases linearly from 0.3 at the every beginning of the phase to 1.2 at the end.

[23] For simplicity in the discussion below, and for the insurance contract design, each month in the calendar year is divided into three dekads, or ten-day periods. Dekads are usually used in agro meteorology to track the different phenological phases of growing crops. The first dekad of each month is defined from the 1st to the 10th of the month; the second from the 11th to the 20th of the month; the third, from the 21st to the end of the month, can have from 8 to 11 days. For example, dekad 1 is always 1-10 January, dekad 6 is always 21-28/29[23] February, dekad 8 is always 11–20 March; dekad 36 is always 21–31 December.

August – 31st September will cover the late maturing stage and the farmer will harvest at the beginning of October, weather permitting.

We can therefore see that the farmers' perceptions of deficit rainfall risk in Table 4.13 reflect the maize characteristics outlined in Table 4.14. The mid-season corresponds to the months farmers were most concerned about deficit rainfall, June-August[24]. May, the crop development phase, requires less water as than June-August, and is also less sensitive to water stress, with an average Kc value of 0.7 during the month. September, the late phase, does not need as much water as the previous phase or May. It is not as sensitive to water stress as June-August, however it has a slightly higher yield response factor to water stress than May, although the total water requirement is less. However, overall it is clear the farmers' perception of rainfall deficit risk is captured by the standard maize characteristics for this part of Africa.

It should be noted that the WRSI model as it is presented in Table 4.14 assumes there is always sufficient rainfall for planting – the model is often used to schedule irrigation times for optimal yield formation and growth – therefore it does not reflect the critical importance of the initial 30-day establishment phase in rain-fed agriculture, essentially April, as highlighted in the farmer comments. Although the water requirements during the early germination and establishment stage are obviously not as high as during the vegetative growth and yield formation stages of a plant, without the initial, small water requirements for sowing a plant cannot grow in the first place. Therefore the farmers' concerns regarding the deficit rainfall risk in April are still very valid, despite not being reflected in Table 4.14.

Weighted Deficit Rainfall Contract

Using this information a "weighted deficit rainfall" contract was designed for Alaba maize with the following features:

1. A no-sowing condition which was used to identify years when precipitation during the sowing window was insufficient for germination.
2. A weighted deficit rainfall index (WDRI) to capture deficit rainfall events during the growing season, April-September.
3. A tick rate per WDRI, i.e. the payout rate per mm of cumulative deficit rainfall, was established using the historical yield data.
4. Trigger levels and limits to determine when the deficit rainfall compensation for the farmer begins and when the farmer receives a maximum payout.

While contracts were designed for both frequent and extreme events as well as maize, pepper, and barley the follows section details each of the four features listed above for the "Frequent Risk Cover" contract for maize. Because this was ultimately the contract that was used for the pilot it is described in more detail.

Defining a no sowing condition. First a no-sowing condition was defined to identify years when precipitation during the sowing window was insufficient for germination. In order to the capture events on the ground an agricultural weather insurance contract should begin when the farmer

[24] Note that the crop coefficient, Kc, increases linearly from 0.3 to 1.2 during the crop development phase, therefore it is relatively higher during the first two dekads of June than in May.

sows his crop. Because these insurance contracts are index-based, an objective method must be defined to identify when farmers choose to sow (see discussion in Appendix 4, “Model Inputs and Assumptions” section). In Ethiopia, assuming a farmer acts rationally, he will sow his crop once the Belg rainy season begins in earnest, i.e. sometime between late March and mid May in Alaba, and when there is enough moisture in the soil to plant his crop. Planting during this limited sowing window should secure good probability of seed germination whereas planting late can mean the cessation of rains early in the plant’s growth cycle when it still needs water during its vegetative phase. According to agro-meteorological in Ethiopia, successful sowing is usually associated with 25-30mm of rainfall in a dekad, which is line with the physical reasoning behind seed germination (see Appendix 4). Therefore it was decided that if there was not 25 mm or more of rainfall during the first five dekads of the season starting with 1st-10th April and ending with 11th-20th May, it would be considered that the farmers were unable to sow. In this circumstance if 25mm or more of cumulative rainfall was recorded during a dekad it would be a good proxy for a farmer’s decision to sow and it could be assumed that the farmer had planted. If the successful sowing condition was not satisfied during the sowing window, i.e. if none of the dekads in the sowing window recorded 25mm of rainfall or more, it was expected that farmers would not have planted, or would have unsuccessfully planted and therefore would need to be compensated for their investment in seed for production.[25] EIC choose to compensate farmers a sum of 200 Birr in case they were unable to sow as dictated by this sowing criterion. 200 Birr was considered to be enough to finance the re-sowing of a short-cycle crop and compensate the farmers for the pro-rated premium for the rest of the maize insurance contract, which becomes void if a no-sowing event is triggered.

Constructing a weighted deficit index. The index weights deficit rainfall during different months of the growing season based on that month’s relative importance and sensitivity of water stress to plant growth and yield. Deficit rainfall is defined in terms of deviation of cumulative rainfall below the 30-year monthly average and the index is the weighted sum of rainfall deficits during the six months in the contract period, April-September. The weights were determined from the discussions with farmers outlined above. The relative values generated from these discussions through the seasonal analysis were in line with those expected by the WRSI model and from discussions with agromet experts and therefore were not adjusted further. In the case of the Alaba maize deficit rainfall contract the weights and monthly cumulative rainfall averages were as follows:

Table 4.15: Drought Weight for Maize in Alaba Woreda

i	Month	Drought Weight	Cumulative Rainfall Average (mm) 1976-2005
1	April	1	145
2	May	0.3	126
3	June	1	83
4	July	1	106
5	Aug	1	128

[25] Given the climatology of the area, i.e. a well-defined rainfall season, this no sowing criterion is the simplest and most robust definition that could be applied. MoARD and early warning systems such as FEWS-NET use a slightly stricter definition of 25mm or more during a 10-day period, with at least 20mm in each on the next 10-day periods to define successful sowing in the agricultural areas of Ethiopia.

6	September	0.1	119

Source: Authors

The weighted deficit rainfall index (WDRI) is therefore defined as follows:

$$WDRI = \Sigma_{i = 1, 6}\ DW_i * \max(0, \text{Cum. Rainfall Average}_i - \text{Actual Cum. Rainfall}_i)$$

where DW is the drought weight for each month, i, defined above. An example is given below for the 2002:

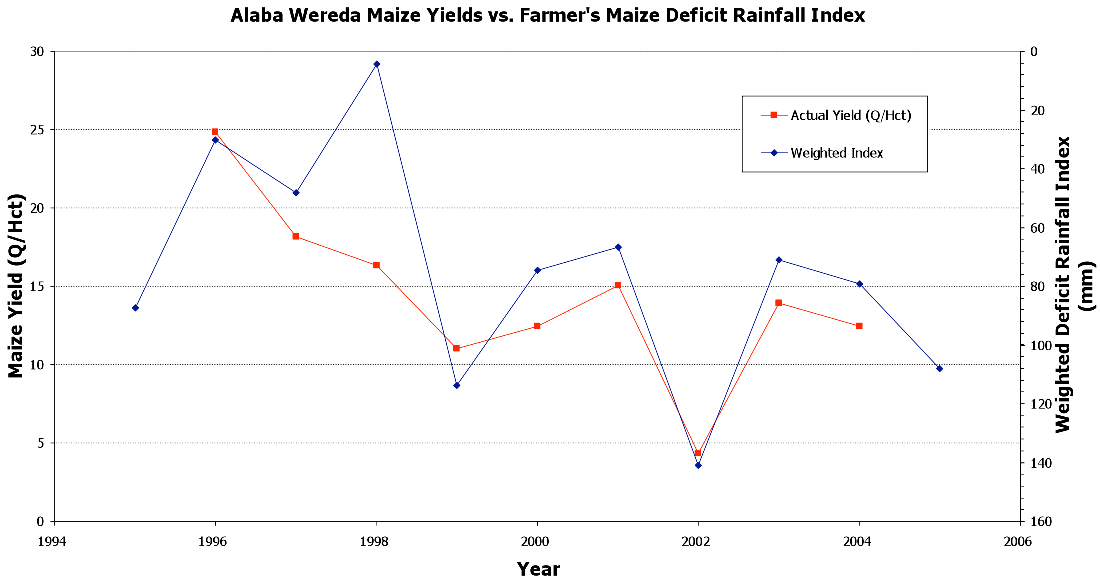
Table 4.16: Calculating the Weighted Deficit Index for Maize in Alaba, 2002

Year	Cumulative Rainfall Average 1976-2005 (mm)	Cumulative Monthly Rainfall, 2002 (mm)	Deficit (mm)	Drought Weight	Weighted Deficit Rainfall (mm)
Apr	145	86.3	58.7	1	58.7
May	126	57.2	68.8	0.3	20.64
Jun	83	78.1	4.9	1	4.9
Jul	106	71.1	34.9	1	34.9
Aug	128	109.3	18.7	1	18.7
Sep	119	87.9	31.1	0.1	3.11
				WDRI	**141**

Source: Authors

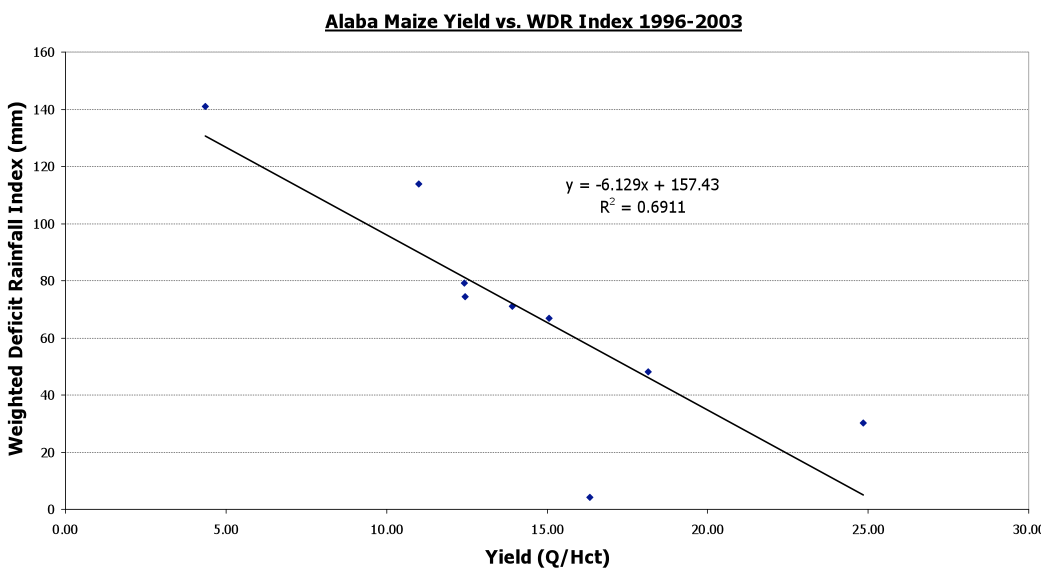
The WDRI was compared to historical maize yield data for Alaba (1996-2003). The correlation coefficient, r, between interannual variations in maize yield data and interannual variations in the WRDI was -83%, significant at the 99% confidence level. In other words there was a strong statistical relationship between the index constructed using farmers' perceptions of deficit rainfall risk and the historical woreda-level yield data. In other words a high WDRI value – implying high levels of deficit rainfall – corresponds to a lower maize yield value, as expected. In particular the index captured the worst year for yields in Alaba. The worst year historically was 2002 which had 4.86 Q/hct yield and a WDRI of 141 mm. By comparison the best year historically according to the yield data was 1996, 24.8 Q/hct which corresponded to a WDRI of 30mm. As this is a deficit rainfall index, it should be noted that the index is only designed to capture the drought years and should not be expected to capture the years of high production well.

Figure 4.4: Comparing historical maize yield data and WDRI in Alaba



Source: Authors

Figure 4.5: Linear regression between historical yield data and WDRI



Source: Authors

Determining the payout rate per mm of cumulative deficit rainfall. A tick rate per WDRI, i.e. the payout rate per mm of cumulative deficit rainfall, was established using the historical yield data. Given the strong correlation between the farmer-designed WDRI and the historical yield data from the farmers' woreda, the latter was used to calibrate the index from mm of deficit rainfall to a farmer's financial exposure per hectare of maize farmed. In order to capture the actual impact of drought on the crop rather than the modeled impact of drought, the historical yield data was used over the modeled yield data described above. A simple linear regression was performed and the WDRI was regressed against the historical yield data to obtain the following linear best-fit relationship between WDRI and yield: WDRI = -6.1 * Yield + 157, i.e. a 6mm WDRI increase corresponds to a 1 Q/hct yield decrease, or a 1 mm WDRI increase corresponds to a 0.16 Q/hct yield decrease. According to farmers one quintal of maize costs approximately 30 ETB at normal market prices, therefore a 1 mm WDRI increase corresponds to 5 ETB loss for a farmer per hectare. The tick rate was therefore set at 5 ETB per mm of WDRI.

Establishing trigger levels and limits for the contract. First a trigger level was determined above which the farmer would begin to receive compensation for the impact of deficit rainfall on his crop at a rate of 5 ETB per WDRI mm. Second a limit level was identified above which the farmer would receive the maximum limit (payout) of the contract, which in this case was set by EIC at 1000 ETB per hectare. According to the paticipatory assessment, 1000 ETB is the average input and production costs a farmer invests per hectare of maize in Alaba. Farmers also stated they were willing to spend up to 100 ETB per hectare on premium for a deficit rainfall insurance product (10% of the sum insured). With this premium limit in mind the following trigger levels were set (see "Frequent Risk Cover" entry):

Table 4.17: Contract Parameters for Maize in Alaba per Hectare[26]

Contract Type	Lower Trigger Level (mm)	Upper Trigger Level (mm)	Tick Rate (ETB/mm)	Sum Insured (ETB)	Frequency of Payout	Frequency of Maximum Payout
Frequent Risk Cover	130	300	5	1000	27%	0.03%
Extreme Risk Cover	220	320	15	1500	4%	0.06%

Source: Authors

As previously discussed a contract was also designed for extreme risk cover to elicit the risk preferences of the farmers, i.e. a contract that had the same premium value, but triggered only in the more extreme deficit rainfall years, however in those cases gave the farmers a greater payout than the frequent risk cover option. Both contracts were set to the same 100 ETB per hectare premium level. In order to keep the premium constant the contract parameters of the "Extreme Risk Cover" option had to be altered as shown in Table 4.17. A very similar methodology was used to design frequent and extreme risk cover weighted deficit rainfall contracts for barley farmers in Lemmo & Bilbilo woreda, details are given in Appendix 5. All four prototype contracts were tested with the farmers in Alaba and Lemmo & Bilbilo respectively.

Pricing the contracts. Detailed information on the pricing of index based weather insurance contracts is beyond the scope of this document and only a brief introduction is given below. Readers are referred to Appendix 1 of the Managing Agricultural Production Risk World Bank report (2005) which contains more detail and further reading recommendations.

[26] Frequency of payout estimates are taken from Monte Carlo simulations (see *Pricing the contracts* section below).

While there are a variety of methodologies for pricing it should be acknowledged that premium calculation is often driven by other factors than the statistical probability of loss as predicted by the contract and historical rainfall data. For example providers will take into consideration their own risk appetite, business imperatives, and operational costs. Despite this caveat in general the pricing for all contacts will contain an element of the expected loss, *E(P)*, plus some loading or risk margin:

$$Premium = E(P) + Risk\ Margin$$

Additional costs or loadings can be added to represent the cost of administrative overheads. Whereas the *E(P)* is determined actuarially from the historical rainfall data from the weather stations being used, the risk loading differs from insurer to insurer and many use a combination of methods to determine the risk margin included. One example of a simple method that has been suggested in the literature to approximate the "cost of risk" for the commercial risk taker is to consider the *value-at-risk* (VaR) of the contract for the insurer, $VaR_X(P)$, and calculate the premium as follows:

$$\text{Premium per hectare} = E(P) + \alpha * (VaR_{99}(P) - E(P))$$

where P denotes the historical payouts of the contact per hectare at the weather station; *E(P)* is the expected loss of the contract per hectare i.e. the average or expected payout of the prototype WDRI maize insurance contract each year; $VaR_{99}(P)$ is the 99th-percentile of the potential contract payouts per hectare, i.e. the economic loss for the insurer that is expected to be exceeded with 1% probability at the end of the contract. The method uses VaR as the underlying measure of risk and therefore α represents the "cost of VaR". Value-at-Risk is a term that has become widely used by insurers, corporate treasurers, and financial institutions to summarize the total risk of portfolios and determine the capital reserves these institutions are required or expected hold to reflect the risks they are bearing.

The payout statistics *E(P)* and $VaR_{99}(P)$ must be determined from the historical rainfall data. Any significant trends or changes in station location that have a significant impact on the historical time series should be taken into account and adjusted for today's levels before the statistics are calculated. As mentioned earlier in the document, no significant trends or discontinuities were identified in the 42-year Alaba time-series. In addition, no seasonal forecasts or other information was available at the time of pricing to indicate that there were any climatic conditions developing in the ocean-atmosphere system, such as an El-Nino Southern Oscillation event in the Pacific Ocean, that pre-disposed Ethiopia to a below-average rainfall season in 2006: information that can impact the expected value of *E(P)* and hence the premium.

$VaR_{99}(P)$[27] is a harder parameter to estimate from historical data than *E(P)*, particularly for trigger levels set far away from the mean. The contracts also had a no sowing condition which can trigger a 200 ETB payout, an event that had not occurred in the 42-year record but that was

[27] The worst-case recorded historically can often be used as a rough cross check for VaR and an indicative starting point.

in theory possible. As a result a Monte Carlo method[28] was used to simulate 10,000 WRDI values. From these 10,000 contract payouts were calculated to estimate $E(P)$ and $VaR_{99}(P)$ for the premium calculation. The premium was then defined as follows:

$$\text{Premium per hectare} = E(P) + 6.5\% * (VaR_{99}(P) - E(P))$$

where $E(P)$ and $VaR_{99}(P)$ were calculated from 10,000 rainfall seasons that were generated by the Monte Carlo simulation. The 6.5% loading was set at a level that has been observed for similar weather insurance transactions in other developing countries and selected by EIC to represent their cost of risk for the pilot.

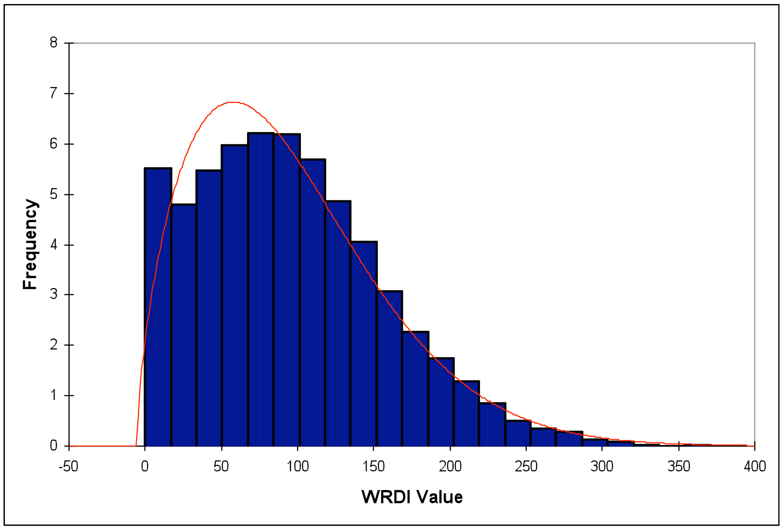
For the two WDRI maize contracts in Alaba the following payout statistics were calculated from the Monte Carlo simulations for the prototype contracts outlined in Table 4.17:

"Frequent Risk Cover" Option: $E(P)$ = 59.6 ETB; $VaR_{99}(P)$ = 759.2 ETB ; Premium = 105 ETB per hectare insured
"Extreme Risk Cover" Option: $E(P)$ = 16.9 ETB; $VaR_{99}(P)$ = 927.5 ETB; Premium = 76 ETB per hectare insured

Both contract premiums were rounded to 100 ETB per hectare for simplicity and ease of communication to the farmers[29]. The distribution of WRDI values for Alaba from the 10,000 simulated rainfall seasons is shown in Figure 4.6 for illustration.

Figure 4.6: Histogram of WRDI values derived from Monte Carlo simulations

[28] A Monte Carlo method simulating cumulative rainfall totals for consecutive 10-day periods from March to October, calibrated to the historical data, was used. Kernal distributions were fitted to the historical 10-day rainfall totals from 1962-2005 and simulations were performed using a Gaussian copula to preserve the autocorrelation structure between 10-day rainfall totals within season. The WRDI was calculated from the 10-day rainfall totals simulated for each season (see Figure 4.6).
[29] As in the end only the "Frequent Risk Cover" contracts were retailed to farmers the rounding up of the "Extreme Risk Cover" contract premium was not considered to be a problem.



4. Contract Testing and Prototype Feedback

The prototypes contracts described above were then presented to the farmers in the relevant woredas to determine how accurately they reflected both their risk and also to determine their preferred payout structure. While four kebeles were initially identified for the pilot program after the first round of discussion one of the four target communities (Koma Ketera kebele, in Lemmo & Bilbilo woreda) was eliminated as a potential target for the pilot since the farmers there saw frost risk and excess rain risk, rather than drought risk, as the most important risks faced. Additionally the pepper contract was not tested since it was not as heavily requested by farmers in the initial round of the participatory assessment. Therefore these follow-up discussions were held in three out of the four communities on the maize (Alaba) and barley (Lemmo & Bilbilo) prototypes.

Two different payout options were presented for both the maize and the barley contracts. One was an "Extreme Risk Cover" contract where payout would only be given in "catastrophic drought years" but in a higher amount. The alternative "Frequent Rick Cover" contract provided more frequent payouts, but the maximum sum insured was smaller.[30] The two different payout structures are given below.

Figure 4.7: Prototype for Maize in Alaba, Extreme Risk Cover Option

[30] See Appendix 5 for the barley insurance prototype structure details.

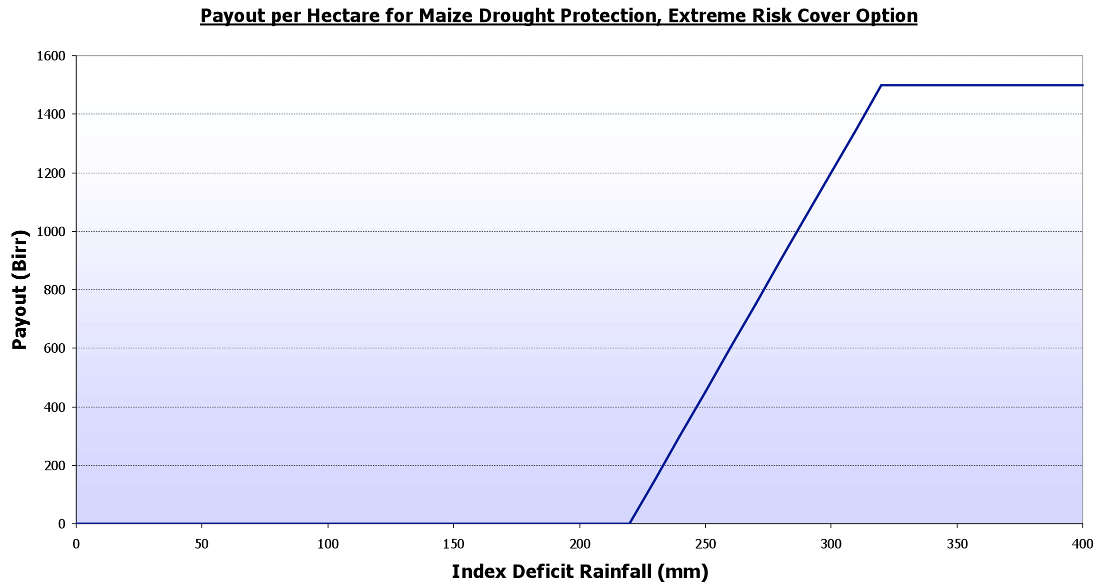
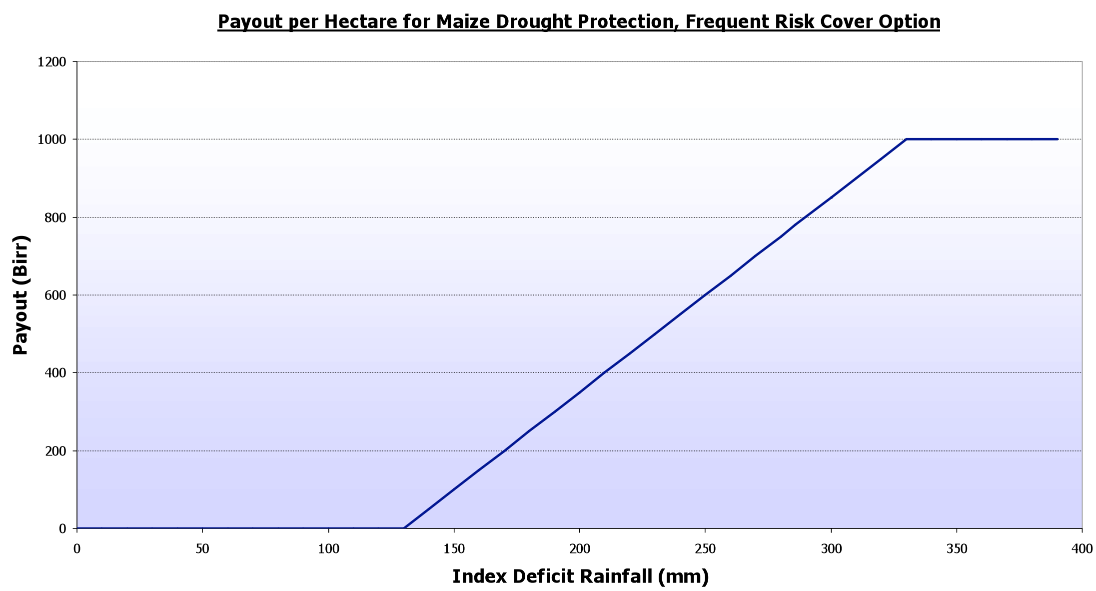


Figure 4.8: Prototype for Maize in Alaba, Frequent Risk Cover Option



To more effectively communicate the difference between the two contracts structures graphs were used to indicate the would-be historical payouts of the barley and maize insurance contracts. In other words, the graphs show when farmers would have received a payout if they had held an insurance policy in the previous 40 years and the amount of the payout.

Figure 4.9: Historical Payouts for Index Insurance Contract in Alaba (Frequent Risk Cover)

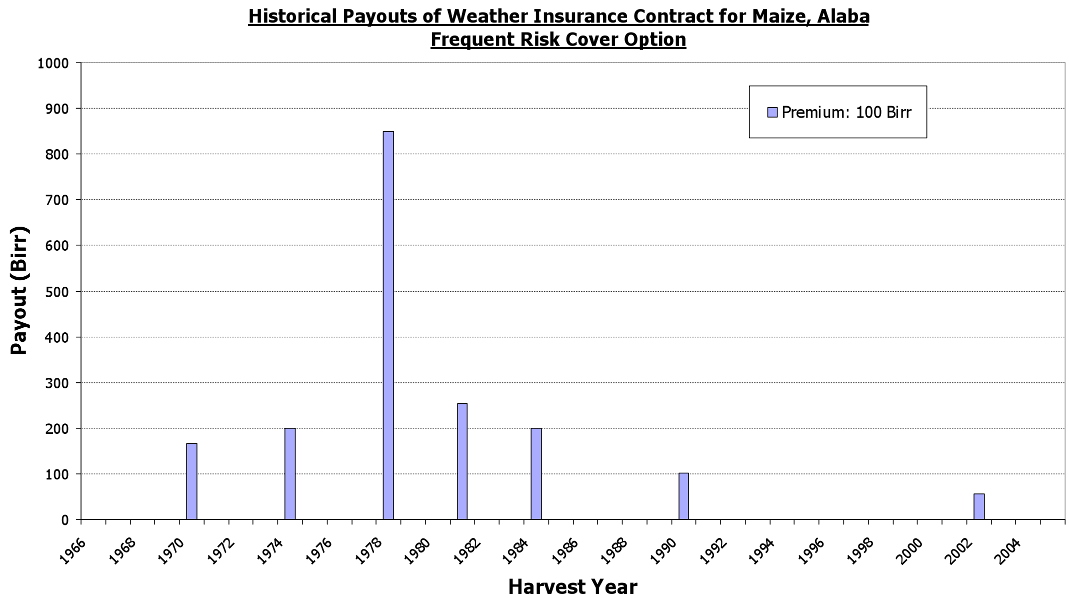


Figure 4.10: Historical Payouts for Index Insurance Contract in Alaba (Extreme Risk Cover)

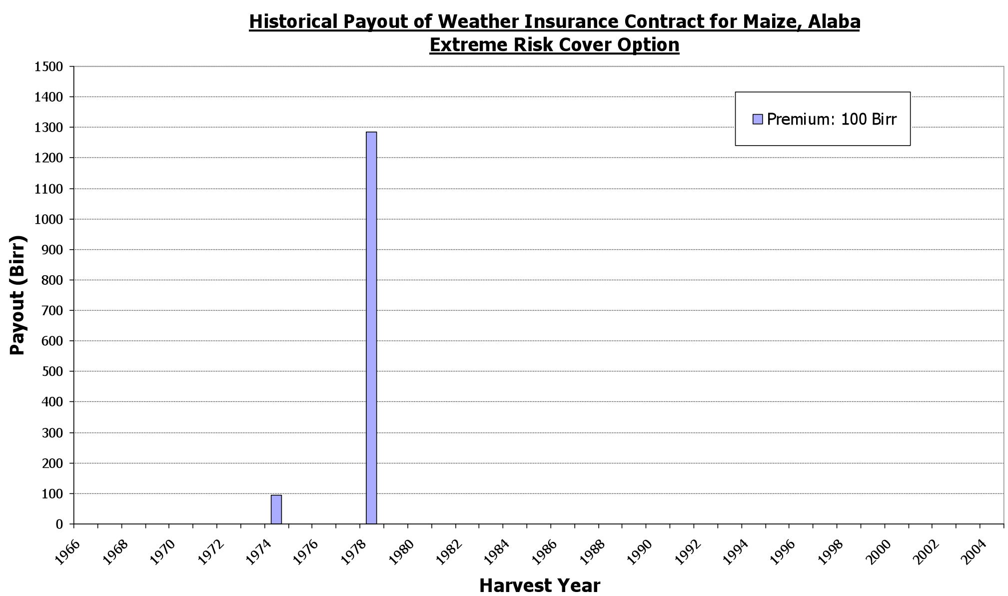


Figure 4.11: Historical Payouts for Index Insurance Contract in Lemmo & Bilbilo (Frequent Risk Cover)

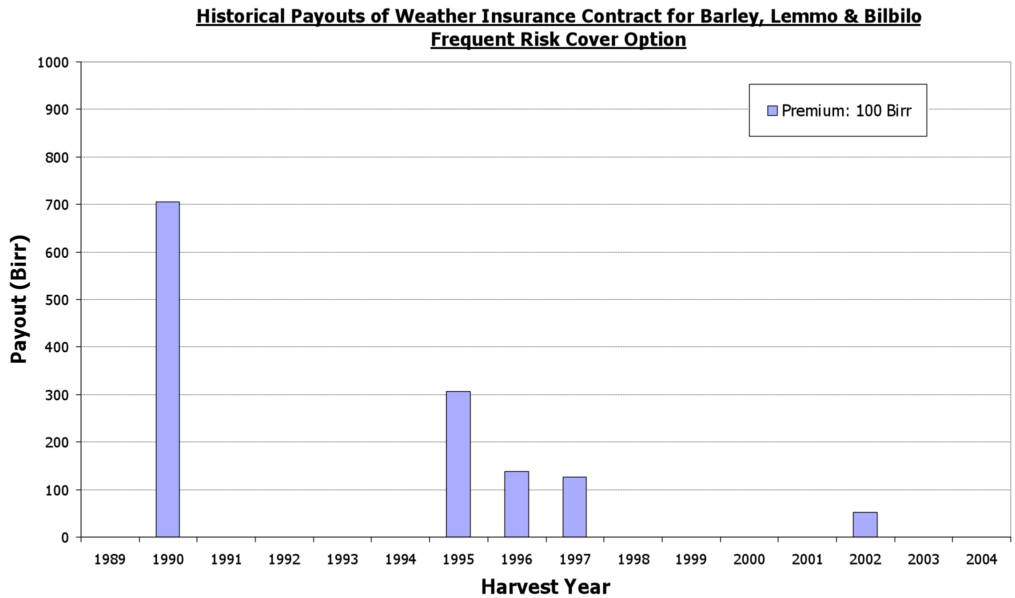
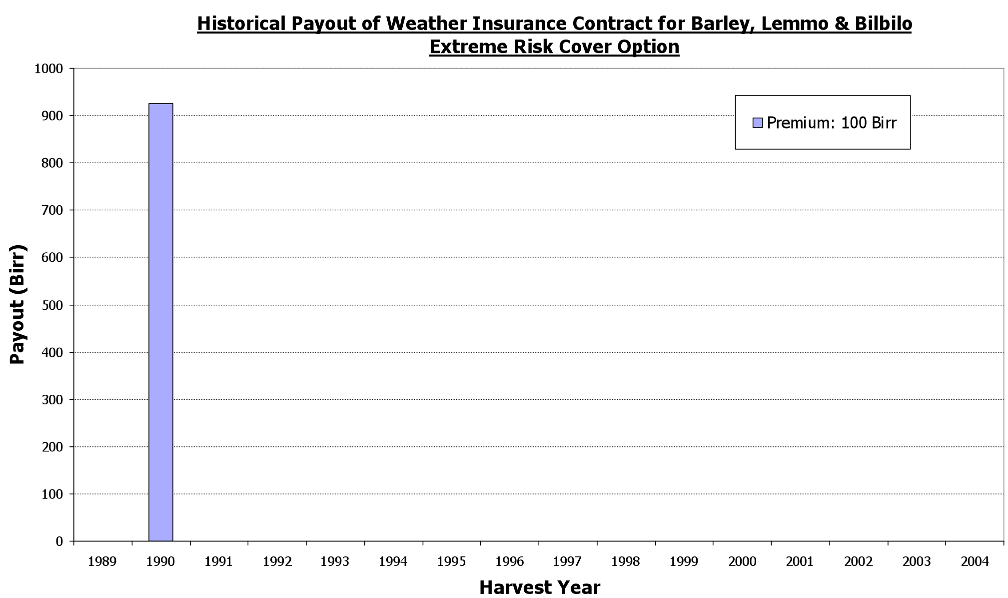


Figure 4.12: Historical Payouts for Index Insurance Contract in Lemmo & Bilbilo (Extreme Risk Cover)



In all communities, farmers preferred the “Frequent Risk Cover” contract option. Because many farmers are cash constrained a payout once in every 15 or 25 years would not show significant enough return on their investment and would be too “extreme”. Farmers in both woredas foresaw frequent occurrences of moderate yield loss, and valued some coverage for rain shortages, that, even if not extreme, are likely to disrupt their livelihoods. But even in the case of the more “Frequent Risk Cover” option, insurance only starts to pay out when the WDRI is greater than a 130 mm (for maize) and 50 mm (for barley) trigger. In terms of probability these are the more extreme cases and these contracts still require that farmers retain the risk of more frequent drought. For many rural households even this level of retention is unrealistic due to the underlying vulnerability of the household where even relatively minor weather even can have strong negative effects on farmers. This raises additional questions regarding the need and desirability of marketing this product to more vulnerable farmers.

In addition to questions regarding the impacts of even minor droughts it is critical that a bad year as defined by the index is consistent with farmers' perceptions. The field team decided therefore to compare farmers' memories of the "worst" years in the last decade, with the insurance historical payout structure. The exercise showed that in several instances farmers perceptions did not match the outcomes of the model. In Hulageba Kuke, Alaba, farmers indicated 2002 as a bad year and many farmers in the woreda needed access food aid. Looking at Figure 4.9, however, we can see that insurance in that year would have paid 55 ETB only, although it was the worst year in most recent times. In Koma Ketera, Lemmo & Bilbilo, this is how farmers describe, respectively, the year 1998 and 2004:

"There was severe rain shortage, and not production. Even grass did not grow. We were forced to sell our oxen and sheep"

"The rain was insufficient at planting time, followed by heavy rain at seedling stage. The emergency delayed leading to delay in the seedling growth. Because the seedlings are not grown well they fail to tolerate the heavy rain in July. This led to a poor stand of the crops giving more space for growth of weed that eventually suppressed the growth of the crop".

But, according to the "Frequent Risk Cover" historical payout structure for barley (see Figure 4.11), there would be no payout in such years. The same discrepancy emerges in other years in both woredas. Discussions between social and technical experts in the team lead the group to identify a number of possible explanations one of which was that farmers' recollections are not correct. This is obviously a risk when drawing conclusions from subjective memories. To minimize the risk, information were however carefully cross-checked in focus group and individual interviews, both with farmers and woreda authorities. Alternatively this discrepancy was attributed to high basis risk. According to Meraro weather station data, the rain amount and distribution in 1998 was rather good,[31] while Enkola Gergeda farmers say that year was an extremely bad one. Enkola Gergeda farmers also mention 2004 as an example:

"On 2004, a very bad year in Enkola Gergeda, some farmers went to relatives in Meraro, where crop performance was good, to get food assistance."

A third explanation was the rainfall shortage is only one of the problems. Previous sections already showed that, besides rain shortage, there are pests, frost and wind, and the low quality and availability of fertilizers that can also have significant detrimental effects on farmers' livelihoods. This, probably in conjunction with inadequate management practices, may explain bad yields in good rainfall years. The final possible explanation was an error in the design of the contract where, in particular the trigger level for the payout, was inappropriate. For example, the

[31] See rainfall data for 1998 in barley prototype structure, Appendix 5

contracts for the pilot were based on the cumulative monthly deficit rainfall index which was calculated based on historical rainfall data, covering the past 30 years. In the 1980s Ethiopia saw frequent and serious droughts, while the 1990s rainfall was relatively good in comparison. The average rainfall index reflects a pattern of the particularly low rainfall of the 1980s. As a result the index would not have triggered during the past 10-15 years when from a farmers perspective rainfall might be quite bad because of the more extreme events that occurred in the 1980's. However from the EIC's point of view, they know that historically extreme payout events have occurred and therefore will want to charge the farmer for the risk of this occurring again in the future.

Impacts of Basis Risk on Piloting

The perception of a high basis risk undermined demand for weather insurance in a number of areas originally proposed for the pilot. For example in Enkola Gerjeda kebele, although farmers are interested in the insurance idea and have financial means to pay, they refused to get into more detailed discussion unless they received some evidence that weather station data could apply to their village. Evidence on local rainfall patterns seems to partially justify their concerns. Introducing weather insurance in such context presents significant political risk since not receiving a payout when yields have declined could give farmers the impression they are being cheated. Because of basis risk concerns the team decided not to conduct a pilot in Enkola Gerjeda.

Therefore Alaba woreda appeared the most suitable to conduct a pilot starting in April 2006, given the interest of the farmers in a maize insurance product for deficit rainfall, and the relatively less significant impact of basis risk. In this woreda, however, farmers are particularly vulnerable and demand insurance protection even in the face of relatively minor shocks.[32] Especially for the poorest, the cost of the premium, 100 Ethiopian Birr, is a large sum of their total income. Additionally because farmers in most developing countries have limited experience with insurance without a payout in the first year interest in the program my wane. One possibility could be adjusting the trigger to have even more frequent payouts than the current "Frequent Risk Cover" design, while reducing the amount of the payout. However this would imply either a very expensive premium, or the reduction in average payout amounts and maximum sum insured, contradicting fundamental insurance concepts as protection for extreme events. This is not to mention the increased administrative burden for EIC of making insurance payouts on a more frequent basis.

5. *Finalize insurance arrangements*

After the contract design phase and the completion of the participatory assessment it was important to work on the operational aspects of the pilot. EIC elected to move forward in Alaba for maize. Based on farmer demand in Alaba EIC believed it would be a good starting point for and initial pilot program. The first major decision that EIC made regarding implementation was that the pilot program would be small and the risk retained in the country. While eventually EIC would like to seek reinsurance because of the small contract size they decided to retain the risk

[32] However, even more frequent payouts would signify either a very expensive premium, or the reduction in average payout amounts and maximum sum insured, changing the concept itself of insurance as protection for extreme events.

themselves. In addition discussions were also held with the insurance regulator, the National Bank of Ethiopia, regarding the introduction of a new product. The regulator saw no reason not to test the use of this type of insurance through a pilot contract and only requested to see the finalized insurance contract before it was implemented.

6. Provide technical training to the EIC and "train the trainers"

Before the product could be rolled out to the farmers the CRMG hosted a number of training sessions with EIC employees on the details of the contract both in the head office and in the local Awassa Branch. These training sessions were meant to "train the trainers" on the product and provide some guidance marketing it to their potential clientele. But in addition to training EIC staff, EIC employed a local Ministry of Agriculture extension agent from Alaba who had worked on a daily basis with the farmers and cooperative leaders on other extension issues. EIC and CRMG worked closely with the Ministry of Agriculture staff member to ensure he had a full understanding of the product which he could then share with farmers and cooperative leaders.

7. Market the product to potential clients and contractual agreements between participants

Two cooperatives, as discussed at the beginning of the section, were identified as the target cooperatives for the product. EIC relied on the cooperative leaders, the local EIC staff, and the Ministry of Agriculture extension office in Alaba to market the products.

While individual farmers would be the ultimate policy holder they would elect to purchase the insurance EIC through a "bulk" contract issued by EIC to their cooperatives. The cooperatives were responsible for collecting premiums from the farmers and aggregating the total number of participants in the pilot. In return farmers would receive a certificate of participation in the contract as proof of their policy.

8. Execute and Monitor the Contract

The pilot resulted in a small transaction where 28 farmers bought index based insurance to protect against shortfalls in maize output. Because of the small size of the transaction EIC chose not to reinsure and would have had difficultly finding reinsurance for such a small contract. After signing a memorandum of understanding with the local NMA office, EIC is also receiving weekly weather data from the local meteorological department. As a result during the contract period the local Ministry of Agriculture has been providing the two cooperatives access to weather data so that they can monitor the contract.

V. CONCLUSIONS AND RECOMMENDATIONS

While a pilot was implemented and a small group of farmers purchased the insurance contract, the greatest benefit of implementing the pilot was to highlight the challenges that would need to be overcome to make this pilot scalable. Two main challenges remain to the development of a robust index based weather insurance market: limited weather data and a lack of a strong marketing agent for the products. The issues surrounding weather data could be overcome to some degree through investment but would take a number of years to see improvements. Dealing with the issues regarding identification of a strong market intermediary or marketing agent for these products would require both capacity building for institutions and policy dialogue around input lending. Two other less urgent issues that need attention but could be overcome through investment are the need to involve a larger number of insurance companies and the need to build capacity around these instruments in the banking and insurance sector.

1. Weather Data. One of the key issues dictating the scalability and sustainability of weather insurance for smallholder farmers is the presence of a dense, secure, high quality weather station network, so that insurance products are indexed to stations monitoring weather conditions that are representative for a farmer and the land he cultivates, and of good enough quality for risk transfer to the local insurance and international reinsurance market.

While suitable data was found for a number of stations in Ethiopia, there is, in general, a lack of sufficient data for the development of weather insurance contracts on a large scale. As summarized in the text, this is primarily due to missing data at existing stations and a relatively thin geographical distribution of stations. When discussing data limitations, two major issues should be highlighted. First, in Ethiopia the current number of stations with high quality data is inadequate for scaling up the use of index based weather insurance products. In addition to a lack of historical data, the reporting capabilities for many existing stations is weak and would need to be improved if these stations were to be used to underwrite contracts. Because of these data issues, a more wide-scale implementation of weather insurance programs for individual farmers would need to be defined more as a medium to long-term objective than as something that could be implemented in the immediate future. Even for implementation in the medium to long-term, significant investment would need to be made in data cleaning, installation of improvement measurement and reporting equipment, and capacity building for the staff of the National Meteorological Agency (NMA). By increasing the number and quality of weather stations in Ethiopia, as well as improving the internal capacity of the NMA, there would be increased potential for developing a more robust index based agricultural insurance program in the medium to long term. The production of synthetic historical data for new weather stations or, if not possible, guidelines on how weather insurance products indexed to the new stations should be priced given the availability of weather data from surrounding rain gauges, other primary stations and satellite-based data would allow these stations to immediately increase the universe of areas that index based products can be offered.

2. Marketing Channels. In Ethiopia during the piloting phase, it was difficult to identify an organization that had a sufficient balance between interest in the product, outreach to the farmers, and technical capacity to serve as the partner and market intermediary for these products. Despite looking at a variety of potential players, the research failed to identify any organizations that could be used to reach clients effectively and provide the necessary capacity building and product education to farmer clients. For the pilot program, the relative weakness of the cooperatives proved an obstacle for marketing, and take-up of the product was minimal as a result. Possible alternatives explored for this role included financial institutions, service providers for agricultural inputs, insurers, and other retail agents, but none of these potential partners had incentives or ability to provide this service to farmers. Input providers take on little risk in their operations and only sell fertilizer on a retail basis. As a result, they were uninterested in acting as intermediaries. The majority of cooperatives do not have the internal capacity to manage a weather insurance program or commercial incentives to take on this project. Insurance companies, including EIC, were interested but do not have the infrastructure or established client base to reach small farmers. In discussions with insurers, they focused on identifying partners organizations for delivery rather then being a direct service provider to farmers.

The prime candidate for marketing this product to farmers was financial institutions, a solution which otherwise proved inappropriate because the current government guarantee for fertilizer minimizes incentives for banks to participate in this type of program. In many of the other pilots, the link between index based insurance and finance has been crucial to incentivize farmers to buy insurance and capitalize on the sunk costs that many of these institutions have already invested in order to establish their client base. Financial institutions typically have a higher level of capacity for the conceptualization and marketing of financial products. Currently, banks and financial institutions receive a full guarantee from the government for fertilizer lending and therefore have little incentive to participate in a weather insurance program that would only provide a partial guarantee against default for agricultural lending, i.e. default only as a result of adverse weather shocks. Banks have little incentive to offer these products even if demand is present from farmers, because of their ability to lend essentially risk-free. These financial institutions could, without a guarantee in place, utilize this type of product to protect their portfolio and be well positioned to deliver this product to farmers who still do have weather risk. But currently they see no need to get involved in this type of business because they are comfortable with their current portfolio and logically would prefer a comprehensive guarantee to a partial guarantee. But fertilizer lending aside, the general promotion of rural and agricultural credit markets would need to be improved in order to promote a conducive environment for weather insurance products. Without a general market for financial services, promotion would be challenging.

3. Risk Taker and Risk Capacity. Another prerequisite for pilot implementation is a risk taker willing to either hold the risk and/or intermediate the risk to the international risk markets through reinsurance agreements. Without such a risk taker or risk intermediary, the intended risk transfer from the farmers would be impossible. In Ethiopia, the Ethiopian Insurance Corporation (EIC) was willing to fill this role and provide the needed risk capacity for the pilot. Because the eventual 2006 pilot transaction was small, having a single insurer participate without reinsurance seemed appropriate, but had the pilot program been larger, it would have been necessary to seek reinsurance because there were no other insurers interested in participating in risk sharing within the country. Therefore, in order to ensure the development of a robust market for these products, scaling up would require the inclusion of additional insurers. Based on discussions with the other insurers in the market, none were identified. Bringing in additional players would be a key challenge for scaling up the pilot project. Furthermore, interesting the international market for weather risk in these projects would be important to support the growth of the market in the future. To do that, the size of the transactions would need to increase significantly and the integrity of the underlying data would become even more critical.

4. Risk Assessment and Contract Design. Related to the previous discussion of the need for a stronger risk-taking framework, further capacity needs to be built within banks and insurance companies to carry out weather risk assessment and contract design. Banks are included here because they could utilize the risk assessment components of the contract design process to improve their credit risk analysis. Currently this assessment does not consider the quantitative impact of weather risk on lending. This type of initiative could allow banks to better assess the risks related to agricultural lending and potentially expand their portfolio in a managed and informed way. In addition, while EIC has gained a greater understanding of the products and can, on a limited basis, offer index based products, their skills would need to be enhanced to design and offer index based products on a larger scale. Because the other companies concentrate on a few standard insurance products, increasing their ability to offer or design these contracts would require significant training. Most of the contract design for the pilot was carried out by the World Bank. Giving the insurance companies the facilities to undertake this process independently would improve the ability to offer products appropriate to their clients' risk and would also serve as the basis for a diversified product offering and market growth. This type of capacity building for banks and insurers would require significant training in contract design, project management, and experience with actual pilot implementation, if and when more pilots are feasible. This knowledge transfer could be carried out through training programs and study tours but would require significant investment and hands on experience.

The table below summarizes the current environment for scaling up index based weather risk management activities in Ethiopia.

Table 5.1: Summary of the enabling and disenabling conditions for the development of index based weather insurance in Ethiopia with a ranking from 1 to 10 for pilot pre-requisites and scale-up feasibility
(10 meaning full enabling conditions exist, no further activity needed, 1 implying none exist and a pilot should not be pursued in the immediate future)

	Needs	Pilot	Scale-Up	Limitations	Rank	Needed Activities
Weather Data	30 years historical daily rainfall data, with ideally less than 5% missing; Timely, reliable and secure reporting of data from the Met Department for monitoring and settlement of the contract	Historical rainfall data with few gaps existed in Alaba and was available for contract design; specific arrangements were made between the EIC and the local NMA office to get the settlement data on a weekly basis, facilitated by hiring someone locally to be responsible for this	26 stations currently have sufficient historical data and reporting capacity for use in an index based product within the country, an additional 16 stations have relatively good data and could be considered.	Without additional data or stations of the required standard scale up will be limited to those areas around the weather stations that currently meet market standards	**2**	Investment is needed to clean and in-fill historical rainfall data where possible; upgrade existing stations and reporting capabilities to met market standards; capacity building with the Met Office to improved recording and reporting procedures and their historical weather database
Intermediary	A trusted marketing channel that can deliver these products to farmers in a cost efficient manner. Often intermediaries need to have an incentive to mitigate weather risk in order to be committed to the project.	Two cooperatives were identified to serve as market intermediaries. These cooperatives were limited in their ability to deliver their product due a lack of capacity and therefore to engage and educate farmer clients. In addition, because these cooperatives did not hold the same or similar weather risks of the farmers, their incentives to serve as a strong intermediary were low.	While cooperatives could potentially serve as intermediaries on a larger scale many of them lack capacity and have little incentive to serve in this role. Financial institutions in other countries have filled this role because they hold the same risk as their clients. However in Ethiopia their risk is mitigated through a government fertilizer lending guarantee.	Without strong, motivated intermediaries it is impossible to effectively market the product. With the current lending guarantee and related lack of incentive by financiers to participate the project will need to continue relying on cooperatives.	**2**	Discussions with Government about using index based weather insurance or other potential instruments to transition away from more non-market based approaches to lending guarantees.
Risk Taker/Risk	Insurer who has the capacity to hold risk	EIC provided the needed risk capacity	EIC could hold more risk in a future scale	In order to promote a competitive	**6**	Bring in additional insurers to promote market growth.

Capacity	within its own portfolio and/or intermediate this risk to the international market	and was interested in holding greater risk internally.	up, but no other insurance companies currently have the capacity or the desire to enter into this market. Although not tested it is believed that if the data security and quality was good enough and the transaction size large enough EIC could find additional risk capacity in the international reinsurance market.	environment and provide the ability to facilitate smaller transactions, particularly in the early stages of market development it is important to bring in additional insurance companies.		Develop current pilot portfolio and transaction size and show evidence of potential further market growth to interest reinsurers and test their demand for this risk.
Capacity Building, Training and Contract Design	Insurer understands and can design product offerings that can meet farmer and clients' needs and can understand and manage its portfolio of transactions.	EIC participated in contract design. While the contract in general was designed by the World Bank, EIC provided key inputs and ultimately decided the terms of the contract.	While EIC has a good understanding on the design of these products in the short-term it would need additional training and support in order to design contracts and understand the finer aspects of managing a portfolio of weather insurance contracts in several pilot areas for the long-term. With training this capacity could be built within EIC. To grow the market robustly it would be necessary to bring other insurers or actors interested in	Contract should be designed locally in Ethiopia. Without building sufficient capacity in-country to provide this service, EIC and other potential participants will rely on outside expertise for contract design. This will increase the cost of products and limit the appropriateness of the contracts being offered and understanding of the business from the insurer perspective.	**5**	Training and capacity building on contract design and portfolio management for insurers, potentially banks and other interested parties. This would require significant investment in a training curriculum, study tours, and other related activities.

			developing this new market into this process. This would indicate a need for additional training and capacity building to facilitate greater stakeholder involvement			

To summarize, two key issues dictating the scalability and sustainability of weather insurance for smallholder farmers are: 1) the presence of a dense, secure, high quality weather station network, so that insurance products are indexed to stations monitoring weather conditions that are representative for a farmer and the land he cultivates and; 2) the efficiency of the distribution channels used for selling these risk management products to farmers. Experience has proved to the World Bank's Commodity Risk Management Group that the success of a weather insurance pilot critically depends on the relationship the farmer has with the institution offering the insurance and on the incentives a farmer has for buying the product, such as bundling the insurance with agricultural production loans (e.g. Malawi) and inputs. To highlight these points and conclude, the table (Table 5.2) below looks outward to two other countries who in recent years have developed index based weather insurance programs. As can be seen by the table, the Indian private sector has found innovative solutions to both of these challenges, while in Malawi they are still in the process of development but have to date been able to overcome these challenges.

Table 5.2: Summary of the enabling and disenabling conditions for the development of index based weather insurance in India and Malawi with a ranking from 1 to 10 for pilot pre-requisites and scale-up feasibility
(10 meaning full enabling conditions exist, no further activity needed, 1 implying none exist and a pilot should not be pursued in the immediate future)

	Needs	Initial Piloting	Scale-Up	Rank	Further Activities
Weather Data	30 years historical daily rainfall data, with ideally less than 5% missing; Timely, reliable and secure reporting of data from the Met Department for monitoring and settlement of the contract	Historical rainfall data with few gaps and reliable reporting capabilities exist for many weather stations in both India and Malawi that enabled piloting in several locations and, in the case of India, for several meteorological risks. One weather station was used in the first round of piloting in India in 2003 for drought; four stations in the first round of piloting in Malawi in 2005 for drought.	In India every district has a primary weather station reporting all meteorological parameters on at least a daily basis, in conjunction with a network of subsidiary stations, rain gauges and airport weather stations. Although not all stations reach market standards, many do and a lot of weather information exists in-country. In Malawi, a significantly smaller country, 21 primary daily-reporting weather stations exist with excellent data, supported by a dense network of rain gauges with historical data. In addition to the existing network, during 2005/6 approximately 200 new automated weather stations were installed throughout India by private company Delhi-based National Collateral Management Services Limited on which weather insurance contracts are written and reinsured. In Malawi in 2006, the World Bank with the Met Office is piloting the upgrading existing rain gauges by	**8**	For both India in Malawi, to ensure more farmers can benefit from weather insurance, further investment is needed to: clean and in-fill historical rainfall data where possible; upgrade existing stations and reporting capabilities to meet market standards; continuing installing new stations; provide capacity building to Met Offices to improved recording and reporting procedures and their historical weather database management and value-added services.

			installing two new weather automatic weather stations to leverage the information available in that network. Because of this pilot 700 additional farmers in a new fifth location could benefit from weather insurance in the second round of piloting in 2006.		
Intermediary	A trusted marketing channel that can deliver these products to farmers in a cost efficient manner. Often intermediaries need to have an incentive to mitigate weather risk in order to be committed to the project.	Hyderabad-based MFI BASIX first piloted weather insurance in 2003 with Mumbai-based insurance company ICICI Lombard, by retailing products to farmers living in villages where BASIX have many clients. 230 farmers participated in the first round of piloting drought insurance for groundnut. In Malawi the National Smallholder Farmers Association (NASFAM) retailed weather insurance contracts bundled with certified groundnut input loans from two local banks to their farmer membership. 900 farmers availed of these products in 2005.	Since the initial pilot in India, several marketing intermediaries are being used to retail products to farmers by four insurance companies, for example: MFIs, NGOs, e-coupals, Self Help Groups, bank and franchise agents, village administrative systems. In 2006 BASIX sold over weather insurance contracts to over 11,000 farmers by simplifying and automating their product retail process. In addition in 2005 a leading Indian seed company bought a bulk weather insurance policy from ICICI Lombard, so that they could attach free weather insurance coupons to their cottonseed packets. This is the first time such bundling was piloted in India. In Malawi the second round of piloting in 2006 was still with NASFAM and the original stakeholders; the program was	**8**	In India, the bundling of insurance with inputs or loans, not yet mainstreamed within the country, will help farmer outreach and can leverage existing delivery channels. In Malawi, involving more banks and product distributors outside of the NASFAM membership will be critical. Several other MFIs and farmer-organizations have expressed an interest to be involved in future pilots. Continuing to incorporate these products into existing Government activities and policies in the rural sector, i.e. this year's subsidies fertilizer scheme, will further help mainstream the concept and product within the retail network. Weather insurance is also included in the new World Bank Country Assistance Strategy (CAS) to Malawi which will assist in this mainstreaming.

			extended to include a new station and new crop loan product for hybrid maize and (subsidized) fertilizer. In total over 2000 farmers accessed these products.		
Risk Taker/Risk Capacity	Insurer who has the capacity to hold risk within its own portfolio and/or intermediate this risk to the international market	In India ICICI Lombard was the first insurance company to pilot weather insurance in 2003. The portfolio of risk was reinsured in that year. In Malawi, the Insurance Association of Malawi (IAM) pooled and shared the risk equally between its seven insurance company members in 2005 and given the limited transaction size did not need reinsurance.	In 2004, two further insurers began offering weather insurance in India in addition to ICICI Lombard, in particular the state-run Agriculture Insurance Company of India (AICI). A fourth company began offering products in 2005. Much of the risk from the commercial companies is being reinsured. In Malawi, the IAM pooled and shared the risk equally between its seven insurance companies in 2006 also. The portfolio of over 2000 farmers was still within the risk capacity limits the insurers where comfortable with retaining as a unit. Despite no interest, several leading reinsurers have approached the IMA offering reinsurance capacity.	**8**	Developing current portfolio and transaction size and showing evidence of potential further market growth will attract more reinsurance capacity support to both the India and Malawi markets. Hassle-free and high-quality data reporting and an adherence to a regulatory framework will increase reinsurer appetite.
Capacity Building, Training and Contract Design	Insurers understands and can design product offerings that can meet farmer and clients' needs and can understand and manage its portfolio of	In India, the first pilot with BASIX and ICICI Lombard was launched in conjunction with the World Bank, who was also involved in the second round of piloting and contract refinement in 2004.	In India, the demonstration effects from the first pilot and associated literature was enough to foster the market, which is now evolving internally with little involvement from the Bank or	**India: 9 Malawi: 5**	In Malawi training and capacity building on contract design and portfolio management for insurers, potentially banks and other interested parties such as the Met Office is essential. This would require significant

	transactions.	In Malawi, the contracts were designed and priced by the World Bank with operational stakeholder input from NASFAM and the lending institutions. Little input came from the insurers themselves, who simply warehoused the risk.	other development agencies. The commercial insurers in particular are supported instead by the international reinsurance sector. The state insurer AICI requested and is receiving technical support from the World Bank on agricultural insurance, which includes assistance on index-based weather products. BASIX is now offering consulting on weather insurance retail services, given its extensive experience in this field In Malawi, during the second round of piloting contracts were again designed and priced by the World Bank with technical partner Columbia University. Conversely a second year of piloting means the operational retail channel is well tested and robust given two years of intense piloting where seeds, inputs, loans and insurance contracts must all be bundled and managed coherently. Significant capacity building on the contract design front needs to be given to insurance companies if these pilots are to be mainstreamed without continual World Bank support. The operational side of the market is in a good position to grow and support a stronger insurance sector.		investment in a training curriculum, study tours, and other related activities. By involving Columbia University, and by integrating into the CAS, the World Bank is taken a step in this direction. As piloting initiatives are also taking place in Tanzania and Kenya a regional, sector-wide approach to this training is envisioned, including training on the operational aspects of running a program as well as contract design.

APPENDIX 1: INNOVATIONS IN THE INDIAN WEATHER RISK MARKET

Market Background

The Commodity Risk Management Group (CRMG) at the World Bank started working on pilot weather risk management projects in 2003. CRMG was involved in its first index-based weather risk management transaction in India in June 2003, the first-ever weather insurance project in the country. The initial pilot, launched by Hyderabad-based micro-finance institution BASIX and Mumbai-based insurance company ICICI Lombard, with technical assistance from CRMG, was based in the Mahabubnagar district of Andhra Pradesh, where weather insurance policies protecting against poor rainfall were sold to 200 groundnut and castor farmers.[33]

From the humble beginnings of 2003, the Indian weather insurance market has rapidly grown. In 2004 BASIX continued to build on its 2003 experience and, with assistance from CRMG, incorporated farmer feedback into the design of the second generation of improved weather insurance products that were sold to over 700 farmers, several repeat customers from the 2003 pilot. In 2005 BASIX scaled-up the weather insurance program for farmers further, extending the project to all of their branches in seven Indian states. BASIX sold over 7,600 in 36 locations in six Indian states during the 2005 monsoon season. These new policies were refined versions of the 2004 products and offered improved risk management features for farmers. In addition, BASIX simplified and largely automated the underwriting process, which is why they could roll out weather insurance to every branch. Intense training sessions with loan officers, who became literally one-stop-shop full customer service agents, allowed BASIX to service a large array of rainfall insurance products to its farmer clients.

During 2004 and 2005, not only did BASIX expand their weather insurance program, a number of other institutions, including the originator ICICI Lombard, began expanding the market for weather insurance in India. By 2005, four insurance companies – IFCCO-Tokio, Government-run NAIC, HDFC-Chubb and ICICI Lombard – were selling weather insurance policies to farmers. In total it is estimated that during the 2005 monsoon season 250,000 farmers bought weather insurance throughout the country; a significant portion of this risk was reinsured into the international risk markets. Given this strong level of interest and the potential size of the end user market, agriculture weather risk management in India is set to grow and there are several innovations, highlighted below, that will help this happen.

Innovations in the Indian Weather Market

The two key issues dictating the scalability and sustainability of weather insurance for smallholder farmers are: a) the presence of a dense, secure, high quality weather station network, so that insurance products are indexed to stations monitoring weather conditions that are representative for a farmer and the land he cultivates and; b) the efficiency of the distribution channels used for selling these risk management products to farmers. Experience has proved to CRMG that the success of a weather insurance pilot critically depends on the relationship the

[33] See CRMG's recent publication "Managing Agricultural Production Risk: Innovations in Developing Countries" for more details, http://www.itf-commrisk.org/itf.asp?page=22

farmer has with the institution offering the insurance and with the incentives a farmers has for buying the product, such as bundling the insurance with agricultural production loans (e.g. Malawi) and inputs (see below). The Indian private sector has found innovative solutions to both of these challenges.

New Weather Stations

In 2005 over 70 new automated weather stations were installed throughout India by private company Delhi-based National Collateral Management Services Limited (NCMSL) in partnership with ICICI Lombard, on which weather insurance contracts were written, including many BASIX contracts. By establishing stations closer to the farmers, NCMSL gave ICICI Lombard more reliable automatic stations as settlement bases for their contracts and therefore more accurate products for the farmers.[34] Moreover, given the quality and security of these new stations[35], ICICI Lombard were able to secure reinsurance for all contracts written on new NCMSL stations, enabling them to free risk capacity and in turn insure more farmers and grow their business. From 2006 NCMSL will be able to partner with any insurance company or interested party not just ICICI Lombard and have plans to install stations in 10 states for Government-run insurance company NAIC. They also have plans to install over 50 weather stations in Uttar Pradesh as part of a World Bank project that includes a weather insurance component for farmers. NCMSL's plans to scale-up their installations throughout the country can only benefit end users like BASIX and their farmers and encourage and enable product innovation, such as that described below.

Weather Insurance Linked to Inputs

For the 2005 monsoon season a leading Indian seed company bought a bulk weather insurance policy from ICICI Lombard, so that they could attach free weather insurance coupons to their cottonseed packets. The coupons covered germination failure due to erratic rainfall at sowing time[36], the remaining significant weather risk the company felt the cottonseed they were selling was exposed to. The concept was piloted in one district of Maharashtra and the coupons were indexed to the district's weather station. The seed company sold 100,000 seed packets with coupons. Each packet costs Rs. 1600 (compared to Rs. 400 for local cotton seeds) and promised farmers that they would need to spray less pesticide and insecticide and would receive better yields. Farmers were willing to buy the significantly more expensive, but better quality, seeds as the insurance cost was paid by the seed company. In 2006 and 2007, depending on positive farmer feedback in sessions scheduled to take place in early 2006, as well as other business considerations, the seed company plans to potentially export this concept to the rest of India,

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[34] The instruments installed by NCMSL are Davis Vantage Pro2 Plus instruments imported from the U.S., which cost approximately Rs. 100,000 ($2,200) each for NCMSL. NCMSL installs the stations at a local host's property (usually a retired government or army official), who is paid a small monthly fee by NCMSL. Once a day the stations automatically dial to the main server in Mumbai and download hourly weather data (temperature, precipitation, wind speed and direction and relative humidity) for that day through the telephone line. NCMSL have a team of engineers that service the instruments on a regular basis. NCMSL cover the installation and maintenance costs, but ICICI Lombard agreed to purchase one year's worth of data from each station. From 2006, NCMSL will be able to partner in the same manner with any insurance company or interested party not just ICICI Lombard.

[35] Independently certified by Ernst & Young.

[36] Essentially an erratic start to the monsoon rains, the time when farmers sow cotton in this area.

targeting approximately 7 million farmers if deployed. Another seed company launched a parallel pilot in another district in Maharashtra with another insurance company and has similar scale-up plans.

APPENDIX 2: THE CASE OF MALAWI -- WEATHER INDEX-BASED INSURANCE HELPING FARMERS MANAGE DROUGHT

In Malawi weather index-based insurance a pilot program allows groundnut farmers to manage drought risk and access finance that was previously unavailable to them. This pilot demonstrates the feasibility of market-based weather risk insurance and its major benefits for access to finance for drought-resistant crop varieties, which reduces disaster risk.

The Problem: Impact of Weather Risk on Agricultural Finance

In the agricultural sector weather risk is pervasive and remains one of the major constraints limiting agri-businesses and farmers from accessing financial services and investing in higher return production activities. While weather risk is not the only risk that farmers face, it has enormous impacts on farmers' incomes and the ability of farmers to repay their loans.

From the lender's perspective, farmers (particularly small farmers in developing countries) lack traditional collateral and often have a limited credit history; therefore loan recovery and creditworthiness are directly linked to farmers' seasonal revenues. As a result banks who wish to diversify their lending portfolio into the agricultural sector are constrained by their inability to manage systemic risk in agriculture, notably drought.

The Commodity Risk Management Group (CRMG) at the World Bank has been piloting index-based weather insurance for developing country producers, agricultural businesses, and banks. The CRMG has been working in a number of countries around the world to pilot this approach, including India, Peru, Ukraine, and Ethiopia among others. Most recently CRMG worked with local stakeholders in Malawi to pilot index-based weather insurance for the 2005/2006 crop season in order to enhance groundnut farmers' ability to manage drought risk and in turn access credit.

Managing Drought Risk is a "Win-Win" for both Farmers and Lenders

In Malawi groundnut farmers had traditionally relied on local seed for production but had shown interest in planting with certified groundnut seed in order to improve revenues. Certified seed, while more costly, has a number of benefits over local seed, such as a higher resistance to disease such as fungal infections which can destroy a crop. In addition, certified seed can be marketed as a named variety of groundnut seed rather then a generic version. The main limitation inhibiting farmers from utilizing this seed had been lack of access to credit to buy this more expensive input.

The pilot introduces weather index-based insurance as a new product to the Malawian insurance market to help protect farmers against drought and to determine if banks would have a greater willingness to lend to weather insured farmers. One of the groups interested in testing this approach was the National Smallholder Farmers' Association of Malawi (NASFAM), which among other services provides agricultural marketing for its member farmers who are organized into clubs, and enables farmers to undertake higher return activities.

NASFAM, in conjunction with the Insurance Association of Malawi and with technical assistance from the World Bank and Opportunity International, designed an index-based weather insurance contract that would payout if the rainfall needed for groundnut production in four pilot areas was insufficient for groundnut production. Because these weather contracts could mitigate the weather risk associated with lending to farmers, Opportunity International Bank of Malawi (OIBM) and Malawi Rural Finance Corporation (MRFC) agreed to lend farmers the money necessary to purchase certified seed if the farmers bought weather insurance.

A Cost Efficient Alternative to Traditional Agricultural Insurance

Crop insurance has been tried in many different countries all over the world, but the policies have relied on measuring actual yield losses through on-farm assessment of damage. To determine the extent of yield damage and the payout, loss adjustors inspect farmer's fields.

This traditional way of insuring crops is extremely costly to administer, in particular when it comes to smallholders. The costs of "moral hazard", that is, farmers having incentives to alter their behavior due to the insurance cover, as well as the costs of "adverse selection" (the insurer tends to get the bad risks, because it knows less about the actual risk than the insured), tend to exceed smallholders willingness to pay. This is where governments start subsidizing insurance premiums in countries such as the USA, but the environmental and market distortion costs of this approach are overwhelming.

To deal with the limitations of the traditional insurance approach the Malawian pilot is utilizing an innovative index-based weather insurance product which uses a rainfall index based on data from national meteorological stations as a proxy for yield losses. By identifying the impact that deviations in rainfall have on yields it is possible to determine payouts from an insurance policy.

Index-based insurance has a number of advantages over traditional insurance products. One of the primary benefits is the objective determination of payouts based on the index. In essence by measuring changes in the weather relative to the needs of the particular crops it is possible to estimate losses of farmers near the weather station. The second key benefit is the timeliness of payouts: almost immediately after a critical weather period, the insurance company can trigger payouts to farmers, because weather data is reported on a real time basis to the insurer.

Design is Key for Meeting Demands of Clients and Financiers

The primary risk to groundnut in Malawi is drought during critical growth periods. The contracts that were offered in each of the four pilot areas were designed to compensate farmers when there was a deficit rainfall during the growing season at the weather station.

Each contract has three phases with different levels of rainfall triggering payments in order to take into account the different rainfall needs during the three major phenological stages of the plant, "establishment and vegetative growth", "flowering and pod formation", and "pod filling and maturity". The contracts also contains a "no sowing condition," which would trigger a payout to farmers if a minimum level of rainfall was not received in order for the farmer to successfully sow the plant during the initial stages of the contract.

For the pilot, 892 farmers, who are organized in farmers clubs of 10-20 members, purchased weather insurance from the Insurance Association of Malawi in order to both mitigate their weather risk and access finance. Because they bought insurance these farmers have now received loans from OIBM and MRFC. These loans stipulate that the bank will be the first beneficiary if there is a payout from the insurance.

In addition, NASFAM, who will purchase the majority of the groundnut production from the participating farmers, has agreed to pay the first proceeds from the sale of the produce to the bank. If there is no drought the farmers will benefit from selling the higher value production. The farmers received information and training on the project jointly by NASFAM, OIBM, and MRFC in order to make sure they fully understand the costs and benefits before contracting the weather insured loan product.

Great Potential for Managing Risk and Extending Agricultural Finance Outreach

Duncan Warren, head of Crop Production at NASFAM, sums up the goals and the potential benefits of linking weather insurance to financing as follows: "Drought is one of the major risks in rainfed agricultural production. In the event of a drought the farmer may face low yields, or even total crop failure. If the farmer uses production loans, he/she may not be able to pay for the loan. While the farmer may be granted reprieve through another loan, he/she still has to pay the previous loan, and hence has double the liability. The Drought Insurance Pilot Project has offered an option so that he/she will be covered by the insurance and will not face the distress of having to pay two seasons' loans in one year."

Since the pilot is ongoing the full outcome of is yet to be seen. So far this arrangement, input lending coupled with a weather insurance policy, has allowed the farmers in the pilot area to access finance that would have not been available to them otherwise. It has also allowed the participating banks to expand their lending portfolio while managing their risk.

In subsequent years the stakeholders and CRMG are looking to scale this work up to other crops such as maize and other areas in Malawi. This is the first such deal for index-based weather insurance in Africa outside of South Africa, but we expect this deal to demonstrate the feasibility of market-based weather risk transfer and we believe it shows that access to finance can be enhanced across Africa thanks to this tool. This deal also shows that severe weather risk, such as drought disaster risk, can be insured, which has strong implications for disaster risk transfer programs.[37]

[37] See the recent Ethiopia drought risk transfer program launched by WFP and "Refocusing Disaster Aid", by Joanne Linneroth-Bayer and others, Science Magazine, 12 August 2005, Vol 309

APPENDIX 3: WAREHOUSE RECEIPTS

Previous Initiatives

The introduction of warehouse receipts in Ethiopia has been considered during recent years by the government and donors. The primary warehouse receipts initiatives have been a study by the Common Fund for Commodities, some work by the National Resources Institute including drafting of the warehouse receipts law, and government through the Ministry of Trade and Industry. Despite these efforts to date there has not been a pilot or any implementation of a warehouse receipts financing facility, but a few outcomes of this work have laid the groundwork for implementation of a warehouse receipts program in the near future. The first is the establishment of the legal framework for the use of warehouse receipts (Proclamation #372/2003). Additionally much of the project implementation design was laid out by the initiatives of the CFC and NRI. Finally the project has been shifted to the Ministry of Agriculture which has established a warehouse receipts implementation office specifically dedicated to the promotion of warehouse receipt financing.

Current MoARD Activities

MOARD has hired a new manager, Ato Fekadu Delahunt, to head the Warehouse Receipts Implementation Group in MoARD. The implementation group is looking to pilot a warehouse receipt financing system this year in eight warehouses which it has licensed and certified. These warehouses will be made available for storage of up to 40,000MT of maize and wheat. The pilot warehouses are owned and managed by the National Grain Trade Enterprise. Cooperatives are anticipated to be the primary users of the warehousing facility for the pilot year but other clients such as traders and private buyers are not excluded from participation. On the financing side, Commercial Bank of Ethiopia has agreed to participate in the pilot and provide finance against warehouse receipts. The implementation group is currently approaching six other commercial banks to determine their interest in participating. The implementation group has also developed the documentation for the pilot such as receipts, licenses, and inspections manuals.

Constraints for Implementation and Scale-Up

Because responsibility for implementing a warehouse receipts program was shifted from the Ministry for Trade and Industry to MOARD the current implementation group did not participate in the initial work done on warehouse receipts. It has been relying on documents produced in 2002-2003 by the CFC and NRI for guidance on implementation. The group has limited in house expertise on warehouse receipts and the head of the implementation group was recruited from a MOARD which was not involved in the initial project development. As a result the implementation group lacks the expertise to create the manuals for banks, potential warehouse users, and other stakeholders on the functioning of the warehouse receipts system and does not have the financial resources to carry out training on warehouse receipts for these clients. It also lacks access to information about best practices in implementation of warehouse receipts activities. It is anticipated that this could affect the efficiency of the pilot but more importantly limit the ability of the warehouse receipts implementation office to scale the program up to a greater number of clients and crops.

APPENDIX 4: THE WATER REQUIREMENT SATISFACTION INDEX MODEL

The FAO Water Requirement Satisfaction Index (WRSI) establishes how production of a crop grown in a microclimate can be indexed to rainfall amount and distribution. A description follows of the WRSI model and its inputs and assumptions.

MODEL DESCRIPTION

The pilot project uses the USGS/FEWS-NET WRSI[38] model, a modified version of the FAO WRSI[39] to index groundnut crop yield and therefore production to rainfall variability. A well-timed water supply is necessary for optimum crop production. WRSI is an indicator of crop performance based on water availability during the growing season, calculated using a crop water balance model. Studies by FAO have shown that WRSI can be related to crop production using a linear yield-reduction function specific to the crop in question[40]. WRSI is defined as the ratio of seasonal actual evapotranspiration experienced by a crop to the crop's seasonal water requirement; hence it monitors water deficits throughout the growing season, taking into account the phenological stages of a crop's evolution and the periods when water is most critical to growth. The WRSI model was initially developed for use with weather station data to monitor the supply and demand of water for a rain-fed crop during the growing season. The model currently is used by FEWS-NET as one of the operational remote-sensing products to monitor agricultural areas around the world for signs of drought on a near-real-time, spatial and continuous basis using a combination of satellite-derivative rainfall estimates and rain-gauge data from the GTS to compute WRSI values.[41] There are many more robust and data-intensive physically-based crop models available, but FEWS-NET adapted the FAO WRSI model for geospatial implementation in 2002[42] because of its limited data requirements and simplicity in operational use and made it an operational model, with some modifications in the algorithm.[43] This project therefore also chose the WRSI model, which has been successfully tested against ground crop production data for Africa, including Ethiopia, to monitor crop performance.[44]

MODEL INPUTS AND ASSUMPTIONS

The inputs and data sources required to calibrate the WRSI model for a weather station and for maize in Alaba during a growing season include:

- Cumulative dekadal rainfall (mm) for a weather station for as many years as are available (Source: NMA, Alaba Town Station);
- Average dekadal potential evapo-transpiration (PET) (mm) for the station (Source: NMA);
- The water-holding capacity (WHC) (mm) of the soil in the cultivated area surrounding the station that falls within the same micro-climate as the station (Source: NMA);

[38] Senay and Verdin 2003.
[39] Frere and Popov, 1986.
[40] FAO. 1986.
[41] Senay and Verdin, 2003.
[42] Verdin and Klaver, 2002.
[43] Senay and Verdin, 2003.
[44] Ibid. This paper gives an exhaustive description of the WRSI model and the inputs required to run the water-balance calculation.

- Crop coefficients (Kc) for groundnut; Kc values define the water-use pattern and are defined for each of the critical phonological points of a crop's evolution; they are linearly interpolated between these points during each phonological stage during the growing season (Source: FAO[45], (http://www.fao.org/ag/agl/aglw/cropwater/maize.stm) confirmed by agro-meteorological experts at the MoARD);
- Maximum crop root depth (m) and the allowable depletion fraction (Source: FAO[46]); and
- Seasonal yield-response factors (Ky) for each crop to convert WRSI values to yield estimates (Source: FAO[47], confirmed by agro-meteorological experts at the MoARD).

The WRSI calculation requires start-of-season (SOS) and end-of-season (EOS) times and hence the length of growing period (LGP) for each crop considered and a potential sowing window for a crop. The LPG for the particular variety of maize used in this pilot project was confirmed to be 180 days, or 18 dekads, by farmers and by agro-meteorological experts at the MoARD. The SOS dekad must be based on an objective and consistent criterion for identifying the sowing dekad – the time during the potential sowing window when farmers choose to sow. There are several rainfall-accounting methods for identifying the SOS;[48] the method chosen for this model was the first dekad in the sowing window where the ratio of cumulative rainfall recorded in PET is greater than 50 percent; once this ratio exceeds 50 percent, the soil favours germination.[49]

This method usually corresponds to the first dekad in which cumulative rainfall exceeds 25 mm, a trigger often used in other rainfall accounting methods; however the criterion is less restrictive because it does not require a second criterion[50] and is therefore simpler to implement. In general, according to farmers, and agro-meteorological experts in Ethiopia, the potential sowing window for maize is from late March to mid-May in Alaba. If no SOS condition is met during the potential sowing window, it is expected that farmers would not have planted, or would have unsuccessfully planted maize.

MODEL OUTPUTS

WRSI can be related to crop production or yield estimate by using the following linear yield-reduction function:[51]

$$\text{Actual Yield} = 1 - (1 - \text{WRSI}) * \text{Seasonal Ky} * \text{Maximum Potential Yield} \quad (4)$$

It is often assumed that if WRSI < 50 percent at the end of the growing season, a crop has failed,[52] giving a non-linear relationship between WRSI and yield estimates. The Maximum Potential Yield for maize in Alaba was taken as the historical maximum yield value in the data collected from MoARD for the woreda. 1996 was the best maize harvest year in Alaba

45 FAO. 1998.
46 Ibid.
47 FAO. 1986.
48 Senay and Verdin. 2003; Hunde *et al.*, 2000.
49 Senay, G. Personal communication. 1 June 2005.
50 See for example Senay and Verdin, 2003.
51 FAO. 1986.
52 Senay and Verdin, 2003.

according to the information available at the time with an average yield of 24.8 Q/hct. Therefore 24.8 Q/hct was set as the Maximum Potential Yield in the model.

APPENDIX 5: PROTOTYPE BARLEY WEATHER INSURANCE CONTRACT FOR LEMMO & BILBILO WOREDA

The same participatory design approach employed in Alaba to structure prototype maize weather insurance contracts was used to construct prototype contracts for barley in Lemmo & Bilbilo woreda using data from the Meraro weather station (see Section 3 for details on approach and WDRI design).

Table A7.1: Drought Weight for Barley in Lemmo & Bilbilo Woreda

i	Month	Drought Weight	Cumulative Rainfall Average (mm) 1989-2005
1	June	0.4	74.9
2	July	1	138.0
3	Aug	0.6	162.9
4	September	0.4	72.7
5	October	0.6	44.8

Source: Authors

The weighted deficit rainfall index (WDRI) was defined in the same way as for maize in Alaba:

$$\text{WDRI} = \Sigma_{i=1,5}\ \text{DW}_i * \max(0, \text{Cum. Rainfall Average}_i - \text{Actual Cum. Rainfall}_i)$$

where DW is the drought weight for each month, i, defined above. An example is given below for the 1998:

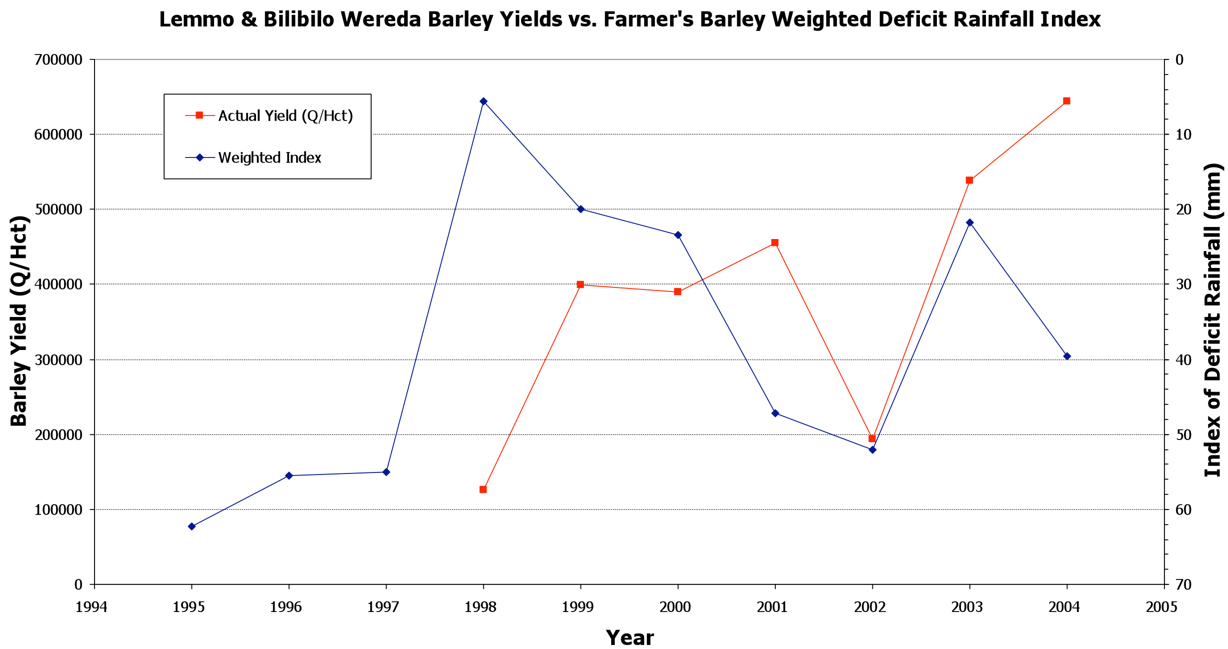
Table A7.2: Calculating the Weighted Deficit Index for Barley in Lemmo & Bilbilo, 1998

Year	Cumulative Rainfall Average 1989-2005 (mm)	Cumulative Monthly Rainfall, 1998 (mm)	Deficit (mm)	Drought Weight	Weighted Deficit Rainfall (mm)
Jun	74.9	61.8	13.1	0.4	5.2
Jul	138.0	145.4	0	1	0
Aug	162.9	185	0	0.6	0
Sep	72.7	138.8	0	0.4	0
Oct	44.8	83.4	0	0.6	0
				WDRI	**5.2**

Source: Authors

The WDR index for barley was compared to the historical barley yield data from Lemmo & Bilbilo woreda for 1998-2004. The correlation coefficient between the inter-annual variations in the historical yield data and the inter-annual variations in the WDRI for barley was only 24%, not significant at the 99% confidence level. It is clear from the figure below that the farmer-designed WDRI index did not pick up the historical worst year in the data, 1998. This result indicated that a deficit rainfall contract may not be the best approach for farmers in the Lemmo & Bilibilo woreda and highlighted that other production risks may be more important.

Figure A7.1: Comparing historical barley yield data and WDRI in Lemmo & Bilbilo



Source: Authors

The following contract parameters where set so that prototype contracts, priced at 100 ETB per hectare insured, could be shown to the farmers in Koma Ketera, Lemmo & Bilbilo in the second participatory design session. The contract design was exactly the same as for the prototype contracts for maize in Alaba and included a no-sowing payout of 200 ETB if the non-sowing criterion (as defined in Section 3) was triggered in the barley sowing window, 1st June – 20th July. However, given the mismatch between the yield data and the index, it was clear that farmers would not be interested in the product. This was confirmed in the farmer feedback sessions when the prototype contracts were shared with the farmers. Concerns about basis risk, that is the ability of Meraro weather station to represent the rainfall risk on farmers' fields, were also raised by the farmers and could explain the mismatch observed in Figure A7.1 below.

Table A7.3: Contract Parameters for Barley in Lemmo & Bilbilo

Contract Type	Lower Trigger Level (mm)	Upper Trigger Level (mm)	Tick Rate (ETB/mm)	Sum Insured (ETB)[53]
Frequent Risk Cover	50	90	25	1000
Extreme Risk	65	85	75	1500

[53] Plus a no-sowing payout of 200 ETB if there is not 25 mm or more of rainfall during the first five dekads of the barley season starting with 1st-10th June and ending with 11th-20th July,

Cover				

Source: Authors

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