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National Drought Insurance for Malawi

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Abstract

Malawi has experienced several catastrophic droughts over the past few decades. The impact of these shocks has been far reaching, and the resulting macroeconomic instability has been a major constraint to growth and poverty reduction in Malawi. This paper describes a weather risk management tool that has been developed to help the government manage the financial impact of drought-related national maize production shortfalls. The instrument is an index-based weather derivative contract designed to transfer the financial risk of severe and catastrophic national drought that adversely impacts the government's budget to the international risk markets. Because rainfall and maize yields are highly correlated, changes in rainfall—its timing, cumulative amount, and distribution—can act as an accurate proxy for maize losses. An index has been constructed using rainfall data from 23 weather stations throughout Malawi and uses daily rainfall as an input to predict maize yields and therefore production throughout the country. The index picks up the well documented historical drought events in 2005, 1995, 1994, and 1992 and a weather derivative contract based on such an index would have triggered timely cash payouts to the government in those years. This innovative risk management instrument was pioneered in 2008/2009 by the Government of Malawi, with the assistance of the World Bank, and was a first for a sovereign entity in Africa. Several piloting seasons will be necessary to understand the scope and limitations of such contracts, and their role in the government's strategy, contingency planning, and operational drought response framework.

This paper—a product of the Southern Africa Poverty Reduction and Economic Management Unit, Africa Region—is part of a larger effort in the department to analyze constraints to growth and poverty reduction. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at anucifora@worldbank.org or joanna.syroka@wfp.org.

Produced by the Research Support Team

National Drought Insurance for Malawi

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1. Introduction

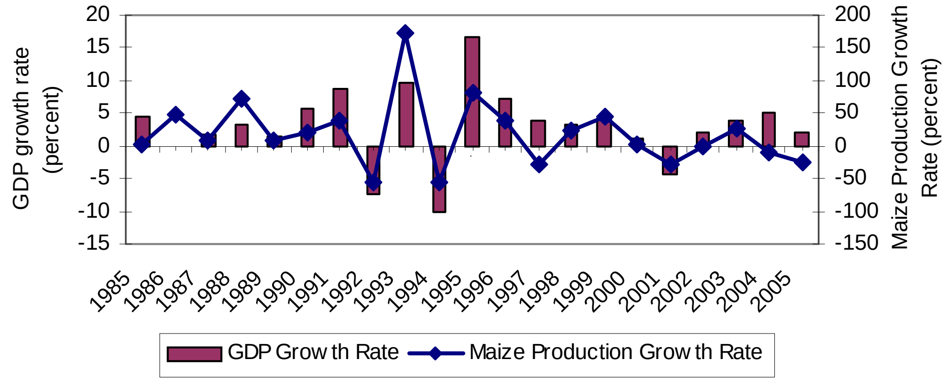
Malawi has experienced several catastrophic droughts over the past few decades. The recurrent weather shocks have resulted in low economic growth and significant volatility from year to year. This is because Malawi's agriculture constitutes about 40 percent of the economy, largely smallholder farming and mostly rain-fed maize production. As a result, weather patterns deeply affect agricultural production and Malawi's GDP. Further since the Malawian diet is overwhelmingly dominated by maize consumption, which comprises over 50 percent of total calories, changes in maize production also have a direct impact on food security. Most recently, the adverse weather in 2001, 2002 and 2005 brought dramatic swings in agricultural output in the past decade.

In recent years the Government of Malawi has been pursuing innovative approaches towards developing a comprehensive national food security strategy. In this context, the World Bank has been exploring the use of *ex-ante* market-based instruments to assist the government to manage the financial risks associated with volatility in maize production. This paper discusses an innovative instrument that has been designed to assist the Government of Malawi in managing the risks associated with the impact of weather shocks. The next section highlights some of the indirect costs faced by Malawians as a result of these shocks. Section 3 provides background information on the design and limitations of index-based drought risk management instruments. Section 4 describes the development of such an instrument for Malawi. Section 5 provides some steps ahead and conclusions.

2. The impact of weather shocks on the economy in Malawi

Economic growth in Malawi has been elusive, reaching no more than 2 percent average during the period between 1999 and 2005, with significant volatility from year to year (Table 1 and Figure 1). Much of the poor performance has been the result of the recurrent weather shocks on

Figure 1: Maize production and GDP growth in Malawi, 1985-2005



Source: Malawi National Statistical Office smallholder agricultural production, notably maize production.[1] Malawi's economy is highly vulnerable to adverse weather shocks not only because of the direct impact on agricultural production (and GDP), but also due to the indirect impact on government finances resulting from the unanticipated need for emergency interventions (which may translate into increased domestic borrowing), and increased pressure on the current account because of the need for exceptional food imports (World Bank, 2007a). In fact, every few years there is an unexpected crisis in Malawi, usually because of the impact of adverse weather on agricultural production, GDP and public finances.

The impact on government finances resulting from the weather shocks is evident from the experience during 2000 and 2004 in Malawi, when domestic public debt increased exponentially, and brought the country on the verge of a fiscal crisis. In preparing the 2002/03 budget, the government did not set-aside resources to respond to the emerging food crisis (which resulted from the combination of localized drought and floods in 2001 and 2002), and eventually spent an unbudgeted 5 percent of GDP because of the need to provide food relief. This was a combination of emergency imports of maize (amounting to 3.8 percent of GDP), and transfers to the Agricultural Development and Marketing Cooperation (ADMARC) and National Food Reserve Agency (NFRA) parastatals (1.2 percent of GDP). The cost of the 2002/03 maize imports compounded the already rising interest costs, leading to a rapid increase in domestic expenditures and the crowding out of discretionary (i.e. non-statutory) expenditures. Although government started borrowing on a large scale in 2001/02, the full effect of increased interest costs was not felt until 2003/04, when the domestic interest bill reached 9.1 percent of GDP, corresponding to a massive 40 percent of domestic revenues. Even in 2005/06, when the government carefully planned its humanitarian response to the 2005 drought and included funding in its 2005/06 budget, the actual cost of the interventions turned out to be much higher than initially envisaged, resulting in a larger fiscal deficit (including grants) by 0.8 percent of GDP.

In spite of the frequency of (weather) shocks in Malawi, only a small allowance is made in the budget for such contingencies.[2] As a result, shocks usually translate into higher domestic borrowing, and have a substantial impact on fiscal performance and macroeconomic stability. Further, the long-term impact of the volatility is substantial, as economic uncertainty hampers the country's ability to generate and/or attract productive investments, to effectively compete in international markets, and, most important, to translate economic growth into employment and income generation that benefit those who need it most (World Bank, 2004; 2007a; 2007b). High level of risk has been identified as an important explanation for slow growth in Africa in general (Collier and Gunning, 1999). In fact, insufficient anti-shock action and finance has been a recipe for magnifying economic instability and other distortions, ending up costing far more in the long-term (Gelb and Eifert, 2006). As discussed above, such costs have been extremely high in the case of Malawi.

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[1] In addition to the lackluster performance of agriculture, the poor economic growth has been exacerbated by an even worse performance in manufacturing, partly due to exceptionally high government borrowing that 'crowded out' financing to the private sector. Macroeconomic performance has improved substantially since 2005.

[2] A budget line for 'unforeseen expenditures' allows for such contingencies, amounting to about 1 percent of GDP. Malawi has traditionally relied on international assistance following climatic disasters.

In spite of the frequency of (weather) shocks in Malawi, only a small allowance is made in the budget for such contingencies.[3] As a result, shocks usually translate into higher domestic borrowing, and have a substantial impact on fiscal performance and macroeconomic stability. Further, the long-term impact of the volatility is substantial, as economic uncertainty hampers the country's ability to generate and/or attract productive investments, to effectively compete in international markets, and, most important, to translate economic growth into employment and income generation that benefit those who need it most (World Bank, 2004; 2007a; 2007b). High level of risk has been identified as an important explanation for slow growth in Africa in general (Collier and Gunning, 1999). In fact, insufficient anti-shock action and finance has been a recipe for magnifying economic instability and other distortions, ending up costing far more in the long-term (Gelb and Eifert, 2006). As discussed above, such costs have been extremely high in the case of Malawi.

The significant direct and indirect impacts of weather shocks highlight the need to plan for contingencies. Possible remedial actions include (a) establishing contingency funds, and/or (b) increasing forex reserves for external shocks, and/or (c) piloting the use of national weather insurance. The government could consider establishing a Contingency Reserve Fund (CRF), linked to the potential scale of shocks (at around 8-10 percent of GDP). These funds are normal practice in developed economies, which are much less vulnerable to shocks. CRFs are important to lower vulnerability to shocks, as they can smooth out peak financing requirements, and are especially important for countries with limited or no capital market access. However, there are also a number of issues related with them, and notably (i) difficulty in properly accounting for CRFs; (ii) challenges related to asset management and investment strategy of the CRFs; and most important, (iii) CRFs may create corruption and governance issues, especially in weak

Table 1: Malawi: Key Macroeconomic Indicators, 1999-2006[1]

	1999	2000	2001	2002	2003	2004	2005	2006
GDP (US$ million)[2]	1,799	1,727	1,731	1,935	1,765	1,903	2,076	2,239
GDP Growth (%)	4.0	1.1	-4.2	2.1	3.9	5.1	2.1	8.5
Inflation (eop)	28.1	35.4	22.1	11.5	9.8	13.7	16.5	9.9
Revenues and grants[3]	24.1	27.4	23.5	26.7	34.7	37.5	42.5	42.1
Expenditures[3]	29.7	33.2	31.2	38.1	42.5	42.9	43.5	43.5
Of which: Domestic interest payments	2.3	3.0	3.9	5.5	9.1	7.4	5.5	4.1
Overall balance (including grants)[3]	-5.6	-5.8	-7.7	-11.6	-7.8	-5.4	-1.0	-1.4
Net domestic borrowing[3]	2.1	1.2	6.9	11.8	7.7	3.0	0.3	-1.9
Domestic Debt[3]	2.8	8.9	10.2	20.4	24.8	23.8	19.9	14.8
Gross reserves[4]	4.2	4.4	3.3	1.4	1.4	1.1	1.4	1.6
Current account balance (% GDP, including grants)	-8.2	-3.0	-6.8	-17.2	-7.9	-10.1	-16.2	-7.2
Exchange rate MWK /US$ (period average)	44.1	59.5	72.2	76.7	97.4	108.9	118.4	136.3

Notes: 1. National Accounts estimates have been revised in 2007. All National Accounts figures in this report are based on the old national account series. Preliminary estimates from the revised national accounts indicate that the level of GDP has been revised upwards with an average of around 38 percent.
2. Calendar year basis.
3. Percent of GDP, fiscal year basis (Malawi fiscal years run from July 1st to June 30th).
4. Months of current year's imports of goods and non-factor services, calendar year basis.

Source: Ministry of Finance, Reserve Bank of Malawi, and IMF and World Bank staff calculations

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[3] A budget line for 'unforeseen expenditures' allows for such contingencies, amounting to about 1 percent of GDP. Malawi has traditionally relied on international assistance following climatic disasters.

institutional environment (such that the CRF becomes a slush fund for unauthorized expenditure). An alternative would be to accumulate additional foreign exchange reserves. This would allow the government to run down reserves as a first line of defense to buffer against most shocks without reserves disappearing. While this strategy removes most of the risks inherent in establishing a CRF, increasing reserves would also entail substantial sterilization costs, and therefore could only take place gradually. However for a developing country like Malawi, both approaches involve earmarking significant capital to cover events that happen infrequently and therefore incur high opportunity costs of scarce funds that could be used more productively in other government programs. An innovative and complementary approach would be to pilot the use of insurance-like instruments and explore the potential financial advantages of leveraging limited resources by transferring a portion of Malawian drought risk to well-diversified commercial portfolios.

3. Index-based drought risk management contracts

Recent developments in international risk markets imply that the government can buy an index-based weather risk management contract to transfer the financial risk of severe and catastrophic national drought that adversely impacts the government's budget to the international risk markets (Hess and Syroka, 2005; Ibarra, et al., 2005; also see Box 1). Index-based risk transfer approaches are not insurance in the traditional sense where the insured party is compensated for the precise monetary loss that can be proved to have occurred. Rather the protection is based on the performance of a specified index during the contract period in relation to a specified trigger, where the index is designed to correlate as closely as possible with the underlying risk (which in Malawi concerns the level of maize output). Payouts are automatically made whenever this index crosses the specified contract threshold at the end of the contract period, without the need of loss assessments and checks to confirm the occurrence and magnitude of an actual loss (World Bank, 2005). Often these contracts are legally structured as derivative contracts (rather than insurance contracts) although they still perform an insurance function (ISMEA, 2006).

The counterparties to such transactions, the entities to whom the risk is transferred for a premium charge, are actors in the weather risk market. The weather market has grown in recent years, with over US$130 billion of risk transferred since its inception in 1997 (WRMA, 2009). Weather market players, from both the reinsurance and financial communities are extremely interested in new, uncorrelated risks, such as Malawi's, that can diversify and therefore enhance commercial risk portfolios.

Box 1. Examples of drought risk management contracts in Ethiopia and Mexico

In 2005 the United Nations World Food Program, with technical assistance from the World Bank, entered into the first-ever humanitarian aid weather insurance contract with a leading European reinsurer (WFP, 2005; WFP 2007; Syroka and Wilcox, 2006). The contract provided contingency funding in case of an extreme drought during Ethiopia's 2006 agricultural season. The policy was based upon a calibrated index of rainfall data gathered from twenty-six weather stations across Ethiopia. Payment would have been triggered when data gathered over a period from March to October indicated that rainfall was significantly below historic averages, pointing to the likelihood of widespread crop failure. While the experimental pilot transaction only provided a small amount of contingency funding – a maximum payout of US$7.1 million for a premium of US$930,000 paid by USAID – the funds would have been available to WFP at harvest-time which would allow for an intervention four to six months earlier than the traditional appeals-based system. If a catastrophic drought had occurred in 2006, WFP would have used these funds to assist 65,000 households in November 2006. WFP are currently working with the Government of Ethiopia, World Bank and DFID on a second-phase drought risk financing program in Ethiopia for 2008-2010 (Hess, Wiseman and Roberson, 2006).

Since 2003 the Government of Mexico, through its government-owned reinsurance company, has been insuring the drought disaster relief response budgets of federal and the state governments using rainfall index-based approaches. The program was launched to address amongst other things financial disruptions to other government programmes to fund emergency responses as a result of weather shocks. In 2007 approximately 1,900,000 hectares were insured against drought. The risk was transferred to the international weather market through 230 weather stations for a sum insured of US$90 million at a premium of US$9.7 million. The program was successfully tested in 2005 by a US$10.5 million triggered payout as a result of severe drought in several states (Agroasemex, 2006; Vasquez & Castellanos, 2007).

In order to implement a successful weather risk transfer program, however, the primary technical precondition is that the data used to construct the underlying weather indexes must adhere to strict quality requirements, including: reliable and trustworthy on-going daily collection and reporting procedures; daily quality control; an independent source of data for verification; a long, clean, and internally consistent historical record to allow for a proper actuarial analysis of the weather risks involved—at least 25-30 years of daily data are ideally required, with less than 3-5 percent missing (ISMEA, 2006).[4] The strict nature of these criteria is to ensure the underlying weather data used is objective, easily accessible and independently verifiable, thus ensuring that the balance of information between the two entities is shared equally and the nature of the risk being transferred is transparently communicated. Experience shows that in most countries, including least developed countries (LDCs) that often have a long history of monitoring weather for agriculture, there is often enough weather stations and data to consider an index-based risk management approach at the national level with a little additional investment.[5]

One advantage of weather-indexed products, over products based on more subjective loss assessments, is that they create market access opportunities: the risk can be transferred from the country in question to the commercial portfolios of actors that actively seek this risk. Secondly, by using a proxy measure of risk, such as rainfall that is available on a real-time basis, a contract

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[4] Nearly all weather contracts executed in the insurance and derivative market are written on data collected from official National Meteorological Service (NMS) weather stations; ideally, although not necessarily, these are automated stations that report daily to the United Nations World Meteorological Organization's (WMO) Global Telecommunication System (GTS) in internationally recognized standard format and then undergo standard WMO-established quality control procedures.

[5] Investments include, for example, upgrading some meteorological or communication equipment or by cleaning (i.e. in-filling missing or correcting erroneous entries) historical weather data (MDA Federal, 2006, 2007).

would secure *timely* and *guaranteed* funds for the government if a contractually specified severe and catastrophic shortfall in precipitation occurs during the agricultural season. These products can be settled as soon as the data is received and verified, without having to rely on time consuming field-level assessments and often subjective loss adjustment processes to assess losses, such as those required for traditional insurance products (ISMEA, 2006), or in the case of traditional appeal-based humanitarian aid, on lengthy needs assessments (WFP, 2005; Hess and Im, 2007).

Such a *predictable* source of early emergency financing in a time of crisis – together with improvements in the country's early warning system – will give the government more flexibility in its drought preparedness and contingency planning, allowing an earlier response to shocks and saving overall costs: (a) directly, through more timely, informed and optimal operational decision making and; (b) indirectly, though a swift and sound response that reduces the overall negative developmental impact of a drought event and protects against the financial disruption of other government programs. By securing *supplemental* resources, through risk transfer to the international risk markets, the government requires less contingency capital within its budget, which can be more effectively employed on other development programs. In addition, minimizing government dependence on traditional appeals-based emergency financing which is unpredictable and often untimely, promises greater dignity for the countries vulnerable to weather shocks. Finally, discovering the market price of its drought risk will assist the government in making superior investment decisions with respect to managing and mitigating this risk within its portfolio and smoothing out drought-related expenditures across good and bad years.

It is important to highlight that index-based weather risk management instruments should be viewed as just one of a growing number of tools and options in the government's arsenal for managing food security and creating fiscal stability in the face of exogenous shocks. In order to maximize the cost benefits of timely and predictable financing, and reveal the value of transferring only severe and catastrophic drought risk, the program needs to be implemented within a comprehensive drought risk management strategy and contingency plan.

In terms of shortcomings, one of the biggest limitations of index-based risk management products is the "basis risk", defined as the potential mismatch between the index-based contract payout and the actual (maize production) losses in country, such that the payout does not adequately indemnify the government for their losses (Skees, Hazell & Miranda, 1999). Basis risk can occur both ways: for instance, the country could experience a production shortfall (e.g. a maize deficit in Malawi) that is not picked up by the index and therefore does not trigger a payout; alternatively, a country could experience an overall national production surplus but the contract still triggers a payout.

Furthermore, there are many variables not captured by the index which also affect level of production. In the context of Malawi, for example, not all maize production deficits are caused by drought: flooding, civil strife, poor farm-management, pest infestations and inadequate seed and fertilizer supplies may be as important as deficit rainfall in triggering food emergency situations. These risks are not captured by an index based on rainfall and cannot be objectively indexed for risk transfer. Therefore this approach should only be applied in countries that have made some progress and managing these additional risks. This limitation must be clearly communicated to all parties, and the underlying indices should be jointly developed with government partners to ensure that the index correlates as well as possible with the underlying risk, and to ensure appropriate country ownership and understanding of the approach. For the same reasons, wherever possible, the index should also be adapted from locally developed models that have been used by countries for some time, for example those used for early warning or production forecasting. Nevertheless, basis risk, whether real or perceived, means that index-based product offerings must always be accompanied by other risk management or mitigation opportunities, and contingency plans, if the full value of these products, and of risk transfer, is to be realized.[6]

A further disadvantage to such an approach is that the contract has an upfront, annual non-refundable cost, which is additional to the cost of a full-scale government drought response. Donors often provide additional financial resources in response to a humanitarian crisis; hence, there may be a financial loss for the government if it takes on the cost of the insurance premium annually. Such a perverse incentive against an *ex-ante* approach to risk management should be discussed with development partners to seek support in the payment of at least part of the premium.

4. Developing an index-based weather derivative contract to manage drought risk in Malawi

The very high correlation between maize yields and rainfall, and the substantial role played by maize production in the economy and in household food security in Malawi, suggest that a weather risk management contract for Malawi could be designed based on a maize production index. The Malawi Department of Climate Change and Meteorological Services', hereafter the Malawi Meteorological Services, rainfall data is of excellent quality, therefore satisfying a key prerequisite for risk transfer.

The Malawi Maize Index

The success of a weather risk management program for the Government of Malawi depends on the design of the underlying rainfall index on which the contract is based. As outlined above, an index-based strategy does not cover the actual production loss of maize; instead it covers the shortfall in rainfall needed for adequate maize growth and development during a drought year. Because rainfall and maize yields are highly correlated, changes in rainfall – its timing, cumulative amount and distribution – can act as a proxy for maize losses. Risk mitigating payouts are made from the market counterparty if the index crosses a specified trigger level at the end of the contract period, indicating situations where a loss is most likely to have occurred, i.e., payouts are made based on the index and not on the actual loss itself.

The index proposed for Malawi – the Malawi Maize Index (MMI) – has been constructed using rainfall data from 23 weather stations throughout the country (Figure 2). The MMI is based on the Malawi Meteorological Services' (MMS) national maize yield assessment model, used by the

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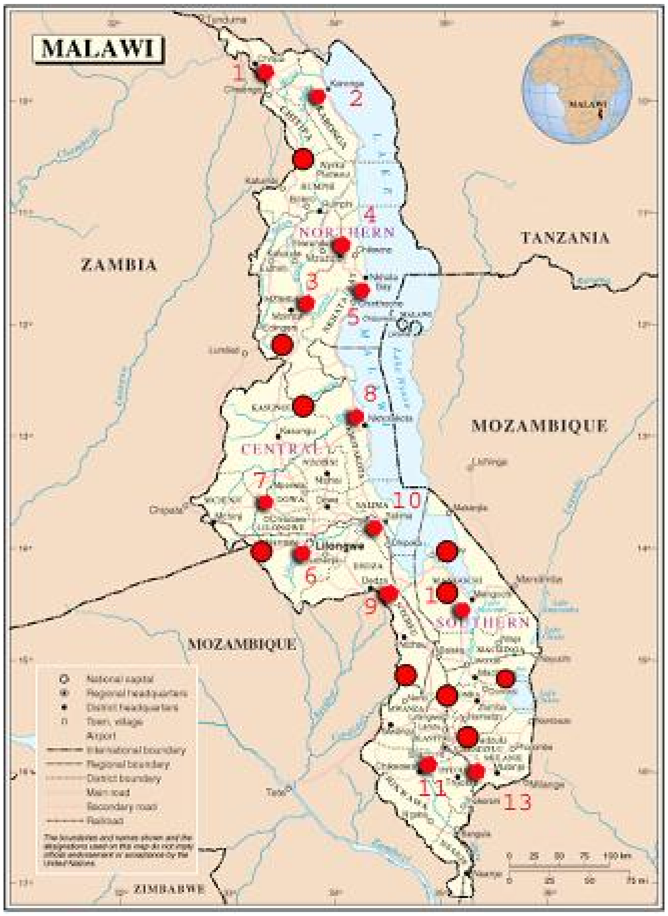
[6] See Hess, Wiseman and Robertson (2006) for a discussion on contingency planning with respect to contingency financing.

government since 1992 to produce national maize production forecasts each February. The MMS's national maize yield assessment model is based on 75 weather stations and rain gauges throughout the country. Because only 23 stations within the Malawi network satisfy the strict criteria for risk transfer to the weather risk market, the MMI only uses these 23 primary stations. Other than this difference, the methodologies and input parameters for the two models are precisely the same.

Figure 2: Distribution of meteorological stations used to construct the Malawi Maize Index



The MMS (and MMI) model is a modified version of the FAO's Water Requirement Satisfaction Index (WRSI) adapted to Malawian conditions, and uses daily rainfall as the only varying input to predict maize yields and therefore production throughout the country.[7] In this way the model,

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[7] WRSI is an indicator of crop performance based on water availability during the growing season, calculated using a crop water balance model. 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 stages of a crop's evolution and the periods when water is most critical to growth. Studies by FAO have shown that WRSI can be related to crop yield deviations and these water-balance crop growth models have been extensively tested in many climates. Indeed 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 (FAO, 1986; Frere and Popov, 1986). An adapted version of the FAO model is currently used by the Famine Early Warning Network (FEWS-NET) for their staple crop production early warning system for Africa.

and therefore the index, isolates the impact of only rainfall variability on maize production. Based on a water balance calculation, the model captures not only the total amount of rainfall received at each station, but also its distribution during the agricultural season and how these rainfall *deficits* impact maize yields. By using such a model, a contract can be structured to reflect conditions which would impact national maize production and therefore food security.[8]

The rainfall and agricultural season in Malawi starts in October and finishes in April the following year, therefore daily rainfall from October to April is used to construct the MMI. The inter-annual variations in the MMI have a correlation coefficient of 75 percent with inter-annual variations in historical national maize yields for 1984-2008 as early as three months before harvest (Figure 3) and 93 percent with inter-annual variations the MMS's national maize production forecasting model for 2000-2008.

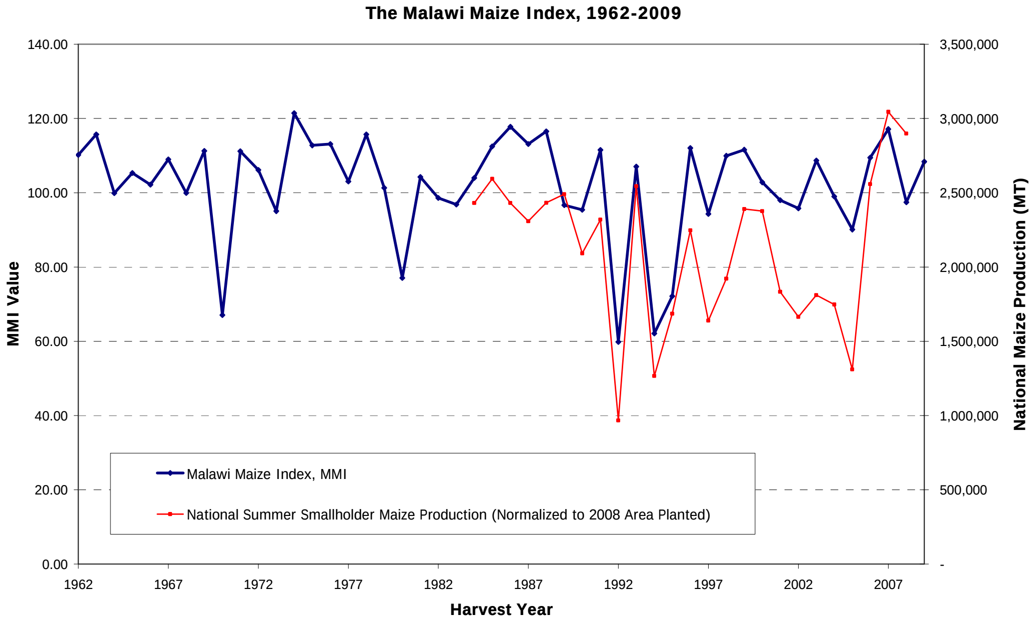
The limitations of the MMI model, as with all index-based strategies, relate to basis risk, as discussed above. Thus, payouts are based on rainfall and not on actual maize production levels in the country. With only 23 weather stations, evaluating rainfall levels for the country as a whole is still rather crude. One part of the country may experience drought while another experiences favorable rainfall. Similarly, farmers residing near a weather station may experience very different levels of rainfall and crop growth than farmers further away from the weather station. As such, although the 23 weather stations are distributed widely across the country (Figure 2), the current MMI provides a gross measure of drought for the country as a whole and is not appropriate for regional, localized or mild drought events. As more stations with automatic communication links become available, the index will improve further and can become more flexible. Investments to improve the MMS's model to better capture the impact of erratic and excess rainfall on maize yields will also improve the MMI and the accuracy of payouts when rainfall-related losses occur.

To reinforce the point that the index is not a perfect indicator of national maize production, which is also impacted by other factors that are not captured by the index, the MMI is expressed in terms of the percentage deviation of the index from the long-term average, rather than absolute metric tones of maize produced (Figure 3).

(http://earlywarning.usgs.gov/adds). Although there are many more robust and data-intensive physically-based crop models available, FEWS-NET adapted the FAO WRSI model for implementation in 2002 because of its limited data requirements and simplicity in operational use.

[8] The MMI has also been used in recent studies assessing the impact of agriculture input subsidy program in Malawi (Dorward et al., 2008; Denning et al. 2007).

Figure 3: The MMI -predicted production deviations from average versus historical total Malawi national maize production (MT)



The Contract Structure

The annual premium price and the expected (annual average) payout for such a contract would vary with the trigger level (Table 2). When establishing a price for a weather risk management instrument, market providers will take into consideration their own risk appetite, business imperatives, cost of risk and operational costs. While there are a variety of methodologies for pricing, in general the pricing for all contracts will contain an element of expected loss, plus some loading or risk margin that corresponds to a capital reserve charge required to underwrite the risk at a target level for the business, as well as administrative costs. Therefore in general the premium charge for a contract can be broken down as follows:

$$\text{Premium} = \text{Expected Loss} + \text{Risk Margin} + \text{Administrative Costs}$$

Expected loss is the average, or expected payout of the contract in any given season. In some years no payouts happen and in others payouts in excess of the expected loss can occur and the risk-taker must be compensated, through the risk margin, for this uncertainty and the internal provisions that must be made in order to honor these potentially large payouts. The values of the expected loss and the risk margin must be established from historical weather data. The approach for determining the risk loading over the expected loss differs from risk-taker to risk-taker and many use a combination of methods to determine the risk margin included. A sensible pricing methodology uses a risk measure such as the Value-at-Risk (VaR) of the contract to determine the risk margin. A VaR calculation is aimed at determining the loss that will not be exceeded at some specified level of confidence often set at 99 percent, i.e. the maximum loss that will occur with a 1% probability or less. It targets the potential extreme negative deviations in payouts for the risk taker – regulators and rating agencies, for example, use such tail-risk measures in determining the capital a bank, (re)insurer or corporation is required to hold to reflect the risks it is bearing – and therefore the associated capital charge for taking on the risk. Administrative costs are essentially the costs for the provider to run the business including charges for data, office costs, taxes and brokerage charges if necessary.

Table 2: Example indicative premiums and payouts at different trigger levels for a sample contract with a US$20 million payout limit and a payout rate of $500,000 per MMI-% below the trigger

Trigger Level	Expected Loss	Indicative Premium	Rate-on-Line[1]
95	US$ 1,480,000	US$ 2,600,000	13%
90	US$ 1,170,000	US$ 2,200,000	11%
85	US$ 900,000	US$ 1,700,000	9%
80	US$ 640,000	US$ 1,300,000	7%

Note 1: This table provides very tentative estimates of premium rates by trigger level the example contract; only through a competitive market-based process can the true price of Malawian weather risk be discovered.
Note 2: The rate-on-line is defined as the premium divided by the maximum possible payout, in this example US$20 million.

The indicative premiums in Table 2 do not include administrative expenses and provide a simple illustrative example, using a straightforward return-on-VaR pricing approach and the historical data available[9], of how premiums may expect to vary with MMI thresholds (ISMEA, 2006).

A simple example will clarify the operation of such a contract. Consider that the government enters into a weather derivative contract structure based on the MMI. The contract has a trigger level of 95 percent, i.e., a payout is only made if at the end of the agricultural season in April the MMI is calculated to be below the 95 percent trigger level (meaning that the season's MMI value is 5 or more percent below its long term average, implying the total national maize production is also down due to deficit rainfall-related losses). If the MMI is above 95 percent at the end of April no payment is made. The contract is designed such that if the MMI is below the 95 percent threshold the government will receive US$500,000 for every percent point that the MMI is below 95 percent, up to a maximum payout limit of US$20 million. The operation of such a contract is illustrated in Figure 4.

The average payout, or expected loss of the contract, over 48 years is US$1.5 million (Table 2). For entering into this contract and transferring this expected loss to the market and securing the right to access contingency funds of up to US$20 million if there is a drought-related crisis as measured by the MMI, the government must pay an annual premium of approximately US$2.6 million (Table 2).[10] From a donor perspective this is can be viewed as an opportunity to leverage US$2.6 million premium contribution into a US$20 million drought-response contribution in a

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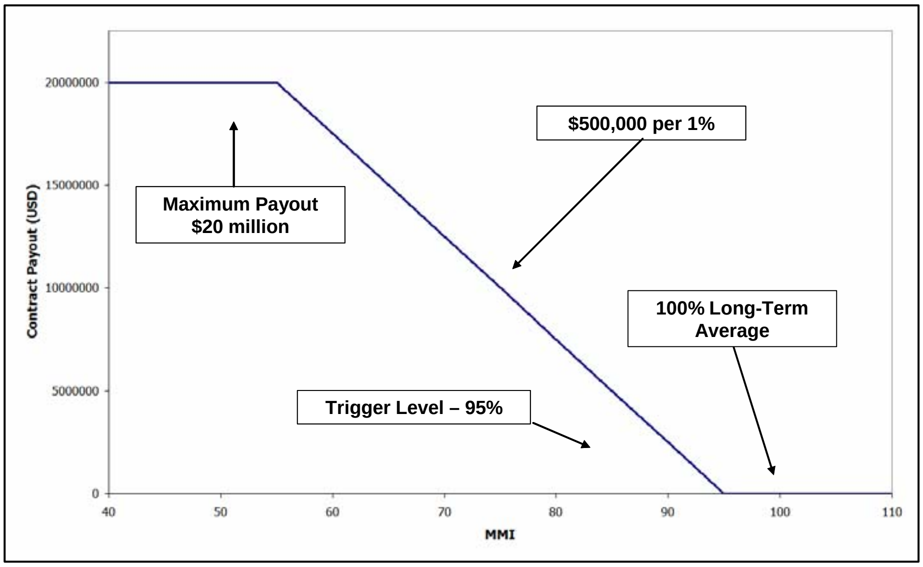
[9] To calculate the indicative premium rates, R, excluding administrative expenses, the following basic equation is used: $R = E(P) + \alpha * (VaR_{99}(P) – E(P))$, where E(P) is the 1962-2009 average payout of the contract, $VaR_{99}(P)$ is an estimate of the VaR at the 99% level of the potential payout – estimated by fitting a best-fit Beta General distribution to the historical MMI data from 1962-2009 – and α is the return-on-VaR risk loading, set at 7% for this illustrative example. In reality market players will take factors such as data length, data quality, trends and forecasts into account when determining the final technical premium rate R and their own risk loading.

[10] This is a simple premium rate estimate. In fact only through a competitive process as part of a risk transfer arrangement can the real market price of Malawian drought risk be discovered.

worst case scenario where a severe shortfall in precipitation has occurred. More importantly, as discussed above, such an *ex-ante* commitment enables the government to build a drought contingency plan well in advance of a drought event around the availability of the contract payout, which will ensure a better planned, more efficient and cost-effective disaster response.[11]

Figure 4: An example of a hypothetical MMI-based weather derivative payout structure, 95 percent trigger level



Had it been in place, a derivative contract based on such an index would have triggered cash payouts to the government most recently in 2005. Going back to 1960, such a contract would have also made payouts in 1995, 1994, 1992, 1980 and 1970 (Figure 5). Such a contract would have paid out US$17.6 million in 1992, US$16.4 million in 1994, US$11.4 million in 1995 and most recently US$2.5 million in 2005 (Figure 5). In all such cases, these payouts could have been used, for example, to finance maize purchases or price risk management instruments to cap the price of maize imports, or other humanitarian interventions.

It is important to note that the premium is always greater than the expected loss; that is, Malawi would always pay more for the insurance than it expects to get back in payouts over the longer term. However the additional value for Malawi of this contract that is not captured in these calculations is the financial savings the government would make by having access to guaranteed funds as early as May, enabling a timely response to a developing crisis and minimizing the potential disruption in grain supply into the country throughout the duration of the emergency response. If these effects of a securing contingent funds through a weather derivative are taken

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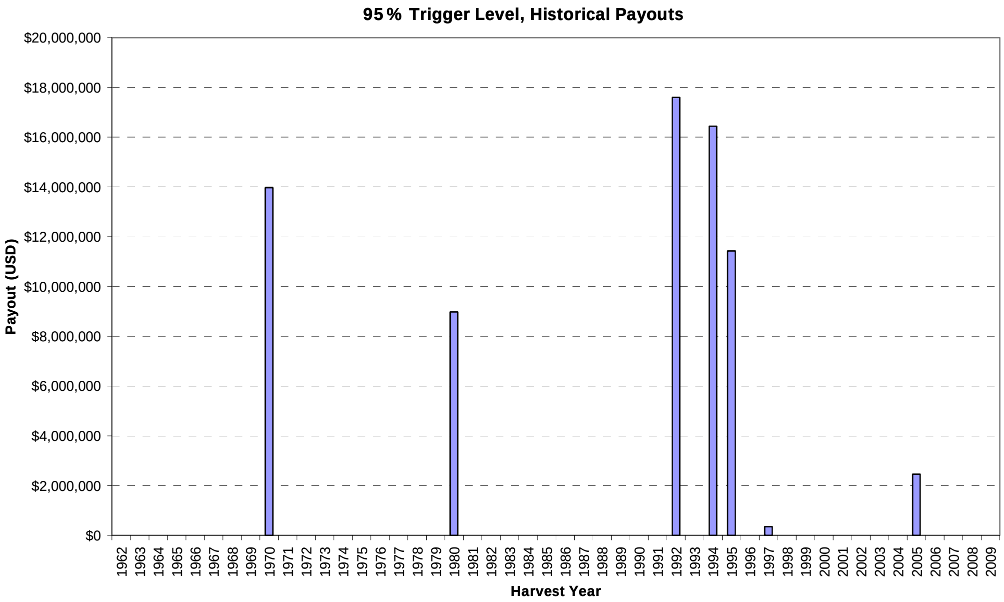
[11] Furthermore the MMI can be monitored throughout the season, as real-time rainfall data is received, and the Government and partners can therefore monitor the likelihood of a payout at the end of April, and assess their operational and financing preparedness.

into account, over the long-term the cost benefit analysis of an annual market premium charge are likely to be significantly more favourable for Malawi[12].

Figure 5: An example of historical payouts at the 95 percent trigger level



5. A pilot transaction for 2008/2009 agricultural season in Malawi

In order to pilot this instrument, the Government of Malawi entered into an initial transaction that provided contingency funding in the event of extreme drought during the 2008/2009 agricultural season. The pilot aimed to test the feasibility and cost of transferring Malawi's drought risk to the international risk markets, and did not aim to cover the entire financial magnitude of a potential drought response in the country. In fact the 2008/2009 pilot only provided about US$5 million in coverage—for comparison, the cost of the 2004/2005 drought response in Malawi was over US$200 million for the government.[13] The trigger level selected by the government was the 90% threshold, targeting a more severe drought than the simple

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[12] For example, following the drought and low harvest in May 2005, Malawi imported between 200,000-300,000 MT of maize into the country for distribution during the lean months that followed in January-March 2006. Much of this maize was purchased on the spot market in South Africa in October-November 2008 and transported into the country for immediate distribution (Slater and Dana, 2006). Had Malawi been in the position to purchase maize in June-July 2005, or ideally to purchase price risk management instruments that capped the maize import price for the months ahead it would have saved approximately US$80-110 per MT imported, using conservative estimates. Assuming similar market dynamics hold in other deficit production years, the saving gains through using a weather derivative payout to secure maize as early possible in deficit years could exceed the additional risk margin charged for the contract in the long-term.

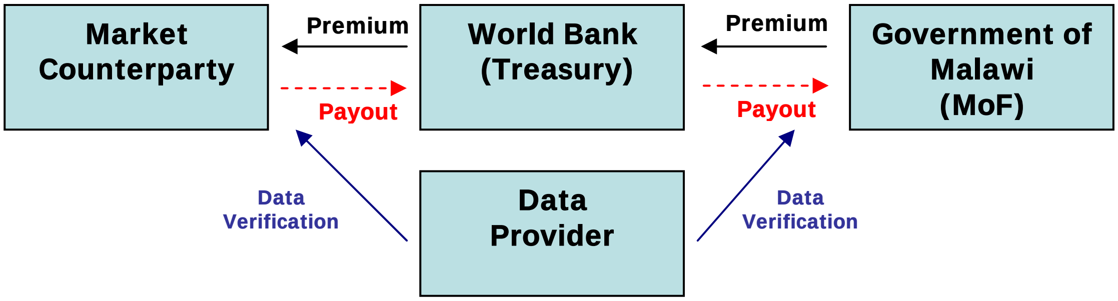
[13] To support the initial pilot for the 2008/2009 agricultural season in Malawi DFID provided the premium to finance the payment of the risk-transfer premium on behalf of the Government. Such a premium secured approximately US$5 million of drought-specific contingency funding. The actual market price of Malawi drought risk was not known until offers were collected from the market for the risk as part of a real transaction.

example given in the previous section and one more appropriate for an index-based risk transfer product.

In addition to secure limited drought financing in a timely and objective manner, the objective of the pilot was to allow the government to establish a market price for its drought risk and to determine the best use for this type of instrument in their food security strategy in conjunction with other available risk management and mitigation tools. In addition, the piloting of this approach also helped define the operational and legal implications for entering into this type of transaction and securing contingency funding not only for Malawi but also for other African governments.

The actual transaction flow is shown in Figure 6. The World Bank acted as intermediary in a national weather derivative transaction to the international market on behalf an International Development Agency (IDA) member country, which in this instance was the Government of Malawi.[14] That is, IDA entered into a derivative transaction with Malawi while simultaneously entering into a mirroring, back-to-back transaction with a market counterpart. The World Bank also facilitated a competitive market process for Malawi's drought risk and provided legal, administrative and technical support to the government for an actual transaction. An independent third-party data verifier, with experience the weather derivative market, was contracted to quality control and clean the data in real-time as it was reported by the Malawi Meteorological Services.

Figure 6: Pilot Transaction Structure



The rationale for World Bank intermediation for this landmark transaction is two-fold. Firstly there is strong market preference for dealing with an experienced and familiar counterparty; this in turn would attract significantly more market players to participate in the tender, leading to more competitive pricing for the government. By being the market face of the transaction increased confidence in the transaction and reduced start-up costs on both sides. Secondly this introductory, market building function for the World Bank was viewed as a necessary investment to overcome market entry barriers for the government. In addition, the government also received World Bank Treasury technical assistance so that it can take full control of the risk transfer

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[14] In June 2008, the World Bank's Board of Executive Directors approved the decision to allow IDA to carry out this type of transactions. The Malawi transaction was carried out in summer 2008, and represents the first time that IDA backed its first-ever weather derivative contract on behalf of a member country.

portion of the program, without World Bank intermediation, after several years of successful risk transfer.[15]

In terms of timing, the derivative itself was purchased in October 2008, following counterparty selection through a competitive process led by the World Bank Treasury in August 2008.[16] Given the small size of the transaction and the other financial risk management strategies available to the government at the time, the weather derivative was designed to secure early maize imports. Timely purchases are essential to avoid huge volatility in grain prices and prevent the dislocation caused by severe shortages, while funds are mobilized to support the full disaster response. In the event of severe drought, a payout would have occurred in early May 2009 which would have been used to purchase a contingent maize import agreement[17] to speed maize into the country in a managed way.[18] In fact, in 2008/2009 the rains were good and no payout was made in May 2009. Nonetheless, this transaction successfully tested the capacity of the Malawi Meteorological Services to transfer rainfall data in real-time to the standards required to the international market, and allowed the government ministries to become familiar with the legal and technical requirements of such agreements.

Several piloting seasons beyond an initial phase will be necessary to fully grasp the role and flexibility of weather risk management instruments within the government's strategy, and operational drought response as its national disaster risk management framework evolves.[19] The first pilot provided a foundation for continuing to manage catastrophic drought risks through insurance mechanisms. In addition, as future investments in the Malawi Meteorological Services and crop modeling are made[20], the risk transfer index itself will improve along with the government's familiarity with the tool.

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[15] This takes the form of training visits from World Bank experts involved with all aspects of the transaction. There is also scope within the new World Bank Agricultural Development Programme Support Project to support training, capacity building and study tours for key Government stakeholders to secure local understanding and ownership of the contracting process.

[16] Swiss Re was selected to be the counterparty to the 2008/2009 transaction. On October 20, 2008, Swiss Re announced that it had entered into a weather derivative contract with the International Development Association (IDA), the arm of the World Bank that helps the world's poorest countries. Under the terms of the contract, Swiss Re would pay out up to US$5 million in the event that Malawi's farmers suffer from a drought-related shortfall in maize production. http://www.swissre.com/pws/media%20centre/news/news%20releases%202008/mi_ida_20081020.html

[17] In September 2005 the Government of Malawi, with technical assistance from the World Bank, piloted the used of a call option linked to the South Africa Future Exchange (SAFEX) white maize prices to cap the price of maize imports from South Africa for 60,000 MT of maize (see Slater and Dana, 2006).

[18] In this context, the World Bank is assisting the Government of Malawi to explicitly link the weather derivative to a broader price risk management strategy, which automatically places the weather derivative contract within the context of a broader risk management program (to strengthen the response of maize markets to production shortfalls).

[19] DFID earmarked funds to continue contributing to premium costs for the next agricultural seasons. Other donor also signaled their interest in supporting the program.

[20] Investments in the observing and measurement infrastructure of Malawi's Department of Climate Change and Meteorological Services (MMS) are necessary to improve the reliability of the index and the Government's early warning system. The Government has made provisions to invest in the MMS's weather observing network and in crop modeling knowledge and capacity in the country through the new Agricultural Development Programme Support Project. Investments in weather stations and their communication have many benefits for Malawi and the region including: better weather forecasting and climate monitoring, enhanced national agricultural and irrigation planning and of course, strengthened national maize early warning system (together with improved crop modeling

6. Conclusions

Climatic shocks are frequent in Malawi and constitute a major impediment to economic growth and poverty reduction. Moreover, global climate change models suggest that future volatility in weather patterns in Sub-Saharan Africa are likely to become even more pronounced. Their impact goes far beyond the initial need for emergency relief, and the resulting macroeconomic instability has presented a major constraint to growth and poverty reduction in Malawi.

This paper describes an innovative financial instrument, namely an index-based drought derivative contract, which could allow the Government of Malawi to transfer the financial risk of severe and catastrophic national drought to the international risk markets. It aims to enable Malawi to manage risks, rather than managing crises. The development of an this risk management instrument will create a new opportunity for the government to financially manage its budgetary exposure to drought and its impact on (maize production) risk using *ex ante* market-based instruments, complementing and enhancing the price and other risk management tools the government already has within its portfolio. Through price discovery it will facilitate government and donor planning and preparedness for drought-related food shortages and, as an additional instrument, it will assist the government in developing a comprehensive and cost effective national food security strategy for each agricultural season. The development of this financial instrument could ultimately enhance the government's response to drought-induced food shortages, and mitigate the impact of weather-related shocks on macroeconomic performance, thereby facilitating investments, economic growth, and poverty reduction.

Such innovative transaction was pioneered in 2008/2009, and was a first for a sovereign entity in Africa. The next step is for the Government of Malawi to build onto the initial pilot transaction and continue to pilot this instrument. In fact, several piloting seasons will be necessary to understand the scope and limitations of weather derivative contract, and its role within the government's evolving strategy, contingency planning and operational drought response framework. The pilots should not aim to cover the entire financial magnitude of such a potential drought response in the country. Rather they should provide coverage for a defined percentage of this risk as part of a broader (maize) risk management program and will test the feasibility and cost of transferring Malawi's drought risk to the international risk markets. The objective of piloting is not only to secure limited drought financing in a timely and objective manner but moreover to establish a price for Malawian drought risk. In the future as more and more transactions of this type occur, as commercial portfolios become more diversified and the market

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by the MMS and Ministry of Agriculture and Food Security). This will facilitate early decision making for superior risk management by Government and ultimately the development of a comprehensive risk management strategy for food security each season. The investments will also further improve the underlying rainfall index for a derivative transaction by: a) expanding the MMS's weather station network so that more stations can be included in the index, increasing its national coverage and therefore accuracy and; b) strengthening the early estimates of national maize production levels by linking the improved quality and timeliness of reported weather data with improved crop modeling. Upgrading will also provide the MMS the required capacity to communicate rainfall data reliably in real-time to the World Meteorological Organization's Global Telecommunications System (GTS). This will help ensure that the Government will be able to access the international markets and benefit from such risk management products.

familiar with such new risk and clients, and as risk mitigation efforts in Malawi improve, it is expected the average cost of risk transfer will also come down.

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