AGRICULTURE GLOBAL PRACTICE TECHNICAL ASSISTANCE PAPER

MALAWI

AGRICULTURAL SECTOR RISK ASSESSMENT

Åsa Giertz, Jorge Caballero, Diana Galperin, Donald Makoka,
Jonathan Olson, and George German

WORLD BANK GROUP REPORT NUMBER 99941-MW

DECEMBER 2015

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ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
ADD	Agricultural Development Division
ADMARC	Agricultural Development and Marketing Cooperation
ARMT	Agricultural Risk Management Team
ASWAp	Agricultural Sector Wide Approach
BBTV	Banana Bunchy Top Virus
CAADP	Comprehensive Africa Agriculture Development Programme
CAB	Congo Air Boundary
CABS	Common Approach to Budgetary Approach
CRED	Centre for Research on the Epidemiology of Disasters
CV	Coefficient of variation
DODMA	Department of Disaster Management
EM-DAT	International Disaster Database
ENSO	El Niño-Southern Oscillation
EU	European Union
FAO	Food and Agriculture Organization (of the UN)
FAOSTAT	FAO Corporate Statistical Database
FISP	Farm Input Subsidy Program
G-8	Group of Eight
GDP	Gross Domestic Product
GRV	Groundnut rosette virus
ha	Hectare
IHS	Integrated Household Survey
IHS2	Integrated Household Survey 2
IHS3	Integrated Household Survey 3
ISOs	Intra-Seasonal Oscillations
ITCZ	Inter-Tropical Convergence Zone
kg	Kilogram
M&E	Monitoring and Evaluation
MAFS	Ministry of Agriculture and Food Security
MDTF	Multi Donor Trust Fund
MGDS	Malawi Growth and Development Strategy
MK	Malawi kwacha
MT	Metric Ton
MVAC	Malawi Vulnerability Assessment Committee
NFRA	National Food Reserve Agency
NGO	Nongovernmental Organization
NSO	National Statistical Office
OPV	Open pollinated variety
QBO	Quasi-Biennial Oscillation
SECO	Swiss Secretariat of Economic Affairs
SGR	Strategic Grain Reserve
SST	Sea surface temperature
TCC	Tobacco Control Commission
USAID	U.S. Agency for International Development
VSL	Village Savings and Loan Group
WDI	World Development Indicators
WFP	World Food Programme

ACKNOWLEDGMENTS

This report was developed by a team led by Åsa Giertz, Agricultural Specialist from the Agricultural Risk Management Team at the World Bank. The activities were supported by the following agricultural specialists: Jorge Caballero, Diana Galperin, Jonathan Olsson, Donald Makoka, George German, Traci Johnson, and Srilatha Shankar. The report was edited by Amy Gautam.

The team is grateful for the leadership and coordination received from Vikas Choudhary and Olivier Durand.

The team would like to extend its appreciation to the Malawi Ministry of Agriculture and Food Security and to the stakeholders from major agricultural supply chains who participated at various moments during the field work and during the workshops to discuss the findings. Their active participation obliged the team to be realistic and practical.

This activity would not have been possible without the generous contributions from USAID, Ministry of Foreign Affairs of the Government of the Netherlands, and State Secretariat for Economic Affairs (SECO) of the Government of Switzerland.

EXECUTIVE SUMMARY

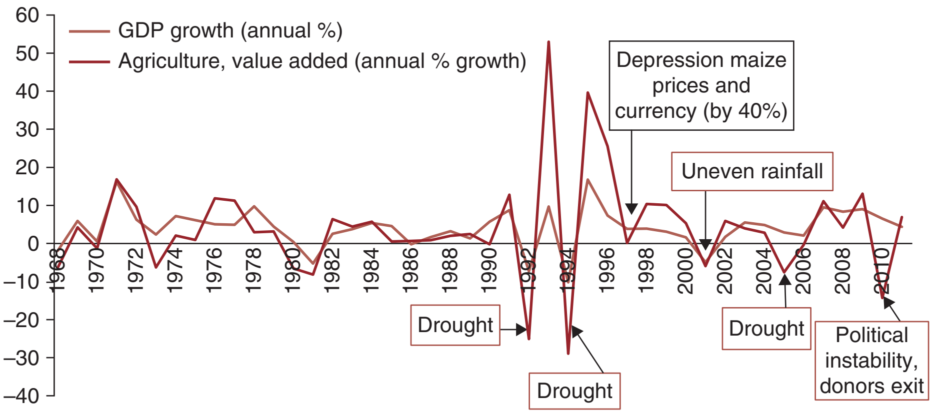
Malawi is among the poorest countries in the world, with limited resources and an economy that relies heavily on agriculture. Per capita gross domestic product (GDP) is US$362 per year[1] (World Development Indicators 2014) and 62 percent of the population lives on less than US$1.25 per day. Malawi is relatively small in size, is densely populated, and has high population growth, all of which put pressure on available land for smallholder farming and on the environment and the natural resource base, notably land and forests. Officially, the population amounts to 15.9 million people, about 80 percent of whom live in rural areas (World Development Indicators, 2010–12 year figures, accessed March 2014).

Agriculture is the backbone of Malawi's economy, contributing 30 percent of total GDP (2011) and 76 percent of total national exports (2012). With 78 percent employed in the sector in 2013 Food and Agriculture Organization of the United Nations (FAO Country Profile, accessed May 2014), agriculture is also a main source of employment and income. Increasing food security is one of the main objectives of Malawi's Agricultural Sector Wide Approach (ASWAp 2010) and a strong focus on increasing maize production since the mid-2000 has resulted in rapidly increasing production. However, production risks continue to result in high losses to the sector, including for maize. Further, price interventions in the sector over the past year have implied greater price risks for producers and traders.

As evident in Malawi, risks can have potentially significant implications on stakeholders, investments, and development in the agriculture sector. Adverse movements in agricultural commodity and input prices together with production-related shocks (for example, from weather, pests, diseases) not only affect farmers and firms active in particular supply chains, but may also put severe strains on a government's finances. Rapid or significant declines in production and/or trade may reduce government tax revenues, affect balance of payments, necessitate compensatory (or recovery) expenditures, and/or otherwise adversely affect a government's fiscal position. The prevalence

[1] Current US$, 2010–11 average.

FIGURE ES.1. GDP AND AGRICULTURAL VALUE ADDED (% GROWTH) IN MALAWI, 1968–2011



Source: World Development Indicators (WDI) 2014.

of "shock-recovery-shock" cycles vastly reduces the ability of many countries to plan for and concentrate on real development issues.

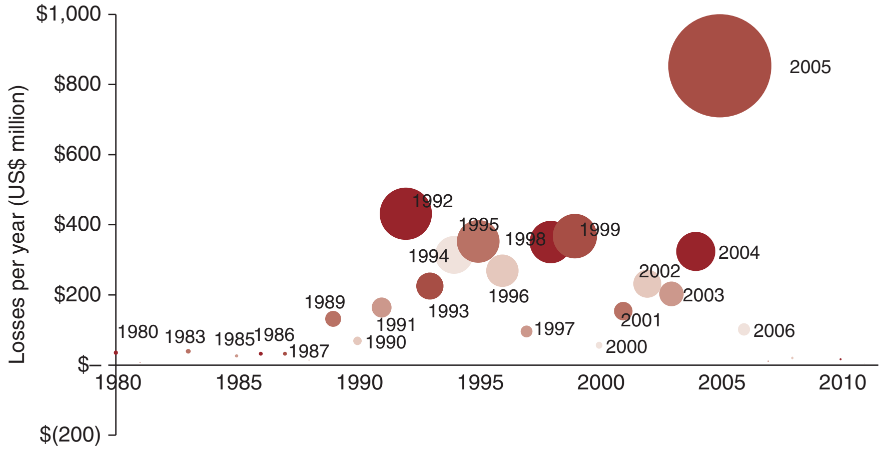
Over the past decades, Malawi has been struck by several severe droughts that have resulted in spikes in food insecurity and prompted the need for humanitarian aid. During the last major drought in 2005, 40 percent of the population was in immediate need of food aid as a result of a poor harvest. Because of the size of the sector in the economy and the importance of agricultural products for export, agricultural growth correlates closely with GDP growth. This means that drops in agricultural growth affect the entire economy, as depicted in figure ES.1—agricultural GDP growth was negative in five years between 1992 and 2010. Further, any drop in agricultural growth in a given year will affect the ASWAp annual growth target of 6 percent that Malawi has committed to under Comprehensive Africa Agriculture Development Programme (CAADP. For individual actors in the sector, these risks reinforce poverty traps by cycles of shock-recovery-shock and result in lower returns on investments in productive assets.

The purpose of this report is to assess existing agricultural risks to the sector, prioritize them according to their frequency and impacts on the sector, and identify areas of risk-management solutions that need deeper specialized attention. Three levels of risks were assessed: production risks, market risks, and enabling environment risks to selected supply chains. To give a sectorwide overview of the impacts of risks, the assessment looks at the largest commodities that jointly account for 80 percent of Malawi's agricultural production value (maize, cassava, potatoes, peas and beans, rice, groundnuts, bananas, tobacco, and sugar) plus tea and cotton because of their export potential. Maize is by far the most important staple crop, accounting for more than 50 percent of the daily calorie intake in Malawi. Tobacco, tea, cotton, and sugar accounted for 67 percent of the total value of national exports of goods in 2012, with tobacco alone accounting for more than 54 percent.

The report takes a quantitative and qualitative approach to assess risks that have occurred in the agriculture sector since 1980. Productions risks are quantified in terms of losses and mapped by different perils. Market and enabling environment risks are analyzed qualitatively. For the purpose of this assessment, "risk" is defined as the possibility that an event will occur and will potentially have a negative impact on the achievement of a farm or firm's performance objectives and/or on successful functioning of the overall supply chain. A broad spectrum of stakeholders was consulted throughout this work, including the Malawi government, farmers, traders, processors, agricultural institutions, and academia. A consultative stakeholder meeting was also held in Lilongwe to obtain feedback on findings and to discuss areas for risk solution interventions for deeper analysis.

Droughts and pests and diseases are cited by stakeholders as the most damaging production risks, especially for food crops. Drought is probably the most visible risk to

FIGURE ES.2. VALUE OF PRODUCTION LOSSES PER YEAR AS A SHARE OF TOTAL AGRICULTURAL PRODUCTION VALUE



Source: FAO Corporate Statistical Database (FAOSTAT); authors' calculations.
Note: These costs constitute only losses, not response costs, which would add to the cost of risks these years.

the sector. Malawi has suffered very bad droughts in the past that had strong fiscal impact and required help from the international community. The damaging impact of pests and diseases is significant but depends on agricultural practices and mitigation activities. The impacts of pests and diseases are at times also exacerbated by adverse weather events. Erratic rainfall and hailstorms are frequent but of moderate or low impact.

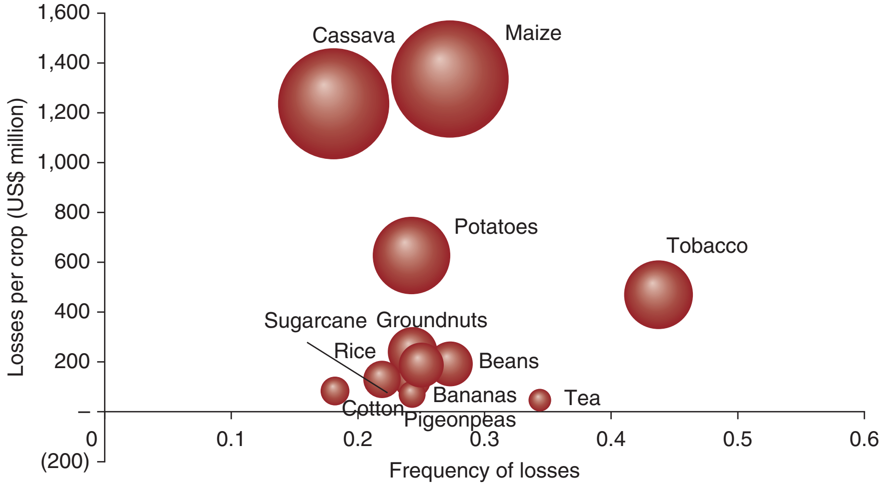
Price volatility is an important market risk in Malawi, particularly in key crops such as maize, tobacco, and cotton. The causes of volatility depend on the crop: cotton prices fluctuate according to world prices, whereas tobacco and maize prices are mainly determined by the domestic market. Maize price volatility is largely a result of enabling environment risks because of unpredictable domestic market interventions and export policies. Regardless of the reason, sudden fluctuations in prices negatively affect farmers, the segment of the supply chain with the least risk-management capacity. Exchange rate volatility and unreliable input markets add to these uncertainties for actors in the export crop sector.

The impacts of individual shocks are at times devastating. Average figures are useful to understand the aggregate costs of production risk yet tend to conceal the catastrophic impact that some shocks have on individuals at the time they occur. Shocks affect household and national food security, have important fiscal repercussions, reduce the availability of foreign exchange, and generally have an overall destabilizing effect on the macroeconomy. For instance, during the 2001 drought, losses amounted to US$161 million, or 4.3 percent of total agricultural production value; in 2005, losses were nearly US$900 million, 24 percent of total agricultural production (2006–08 average). Figure ES.2 shows the magnitude of losses for individual years compared with the general yield trend for assessed crops, where the size of the circle depicts the losses as a share of total agricultural production value.

The losses in normal production value can be extreme for important smallholder crops such as maize and tobacco (for example, 50 percent of maize value was lost in 2005), leading to disastrous impacts on household incomes, food security, and well-being. The magnitude of the losses when shocks occur is much greater for some crops than for others: maize, cassava, potatoes, and tobacco have the highest average annual losses (figure ES.3). However, tobacco and tea incur losses more frequently, meaning that farmers involved in these crops are highly exposed to shocks.

Understanding how risks affect different parts of the country is important for risk-management purposes in an environment with limited resources. Maize yield volatilities

FIGURE ES.3. VALUE AND FREQUENCY OF LOSSES PER CROP IN MALAWI, 1980–2012



are fairly even across Malawi's eight Agricultural Development Divisions (ADDs), with Blantyre experiencing the highest volatility and Kasungu the lowest. The ADDs of Lilongwe and Kasungu, which have the largest extensions of land cultivated to maize (almost 50 percent of the country's total), exhibit relatively similar yield volatilities, significantly lower than that of Blantyre. Cassava shows similar differences in losses between ADDs, although its coefficient of variation (CV) of yield is high in all ADDs (likely due to the discrete jump in cassava yield in early 2000).[2]

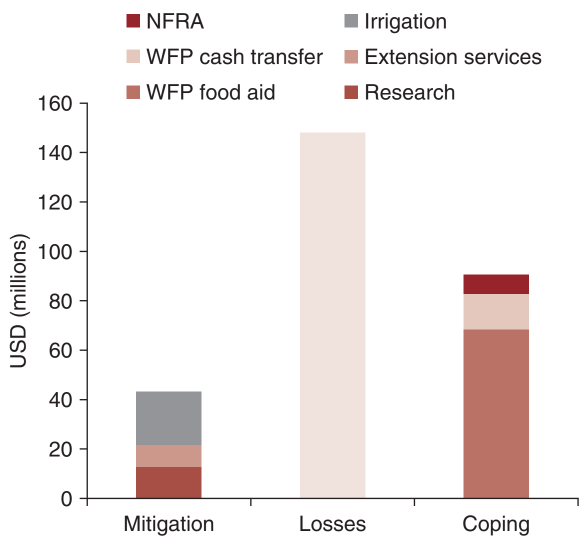
Because of the different level of outputs between ADDs, these variations in yield have different impacts on total production. The eight ADDs produce a total of 2 million metric tons (MT) of maize annually but 70 percent of Malawi's maize production is grown in three ADDs (Blantyre, Lilongwe, and Kasungu), and 90 percent in five ADDs if Machinga and Muzuzu are included. Losses as a share of national production are largest in Kasungu, Lilongwe, Blantyre, and Michnga, which together account for over 9 percent of total production losses annually, and 80 percent of total maize losses in Malawi. Similarly, two regions account for half of Malawi's cassava losses: Blantyre (3 percent of total production) and Mzuzu (1.9 percent). If Salima and Machinga are included, these four regions jointly account for over 80 percent of total annual cassava losses in Malawi.

Risks are costly for Malawi, not just for the private sector but also for the government. Malawi is one of the few countries in Sub-Saharan Africa that adhere to CAADP's goal of allocating 10 percent of the national budget to agriculture, and the country spends about US$250 million on agriculture annually. Although this seems to have mitigated the impacts of risks since the mid-2000s, any losses in subsectors supported by the government imply lost investments. And although the losses are smaller, the government and donors spend large amounts on emergency aid and other coping mechanisms in response to shocks, diverting funds that would otherwise be allocated to long-term development investments.

Figure ES.4 gives an overview of the cost of risks and risk management in Malawi. On the mitigation side are expenditures on activities that could potentially reduce the impacts of identified risks, even though at the moment research and extension are not particularly geared toward risk mitigation but more toward general productivity-enhancing practices. Nevertheless, the figure clearly shows that risk-management expenditures are skewed toward coping mechanisms for ex post risks rather than ex ante risk-mitigating interventions that would decrease

[2] The observed jump in cassava yields and subsequent discussions with Ministry of Agriculture and Food Security (MAFS) officials suggest that there are quality concerns with the cassava yield data. The cassava loss estimates are based on national yield data, and should be adjusted if the national cassava yield data are revised. Total losses excluding cassava amount to US$103.5 million per year.

FIGURE ES.4. COSTS AND GOVERNMENT BUDGETARY EXPENSES FOR ACTIVITIES ASSOCIATED WITH RISK MITIGATION AND RISK COPING VERSUS LOSSES FROM RISKS IN MALAWI, 2008–12



Source: World Bank Ag. Public Expenditure Review 2014; National Food Reserve Agency; authors' calculations.
Note: Losses reflect average annual production losses from 1980–2012 according to the above calculations. Total losses would amount to US$103.5 million if cassava were excluded from the analysis.

the losses from risks. Reallocating funds to risk-mitigating activities thus represents potentially large savings in terms of losses and coping activities.

During the risk-assessment mission, a consultative stakeholder meeting was organized to solicit feedback on the long list of solutions from private and public sector stakeholders. Participating stakeholders were asked to grade the proposed solutions according to their alignment with policy or business objectives; feasibility of implementation in Malawi; affordability for the implementing party (whether public or private); potential for scaling up; and sustainability. The feedback from stakeholders and a gap analysis of already ongoing interventions were then used to narrow the proposed solutions to a short list for a solutions assessment.

Myriad ongoing projects are already studying agricultural risks in Malawi. The goal of the solutions assessment is to identify gaps in broad-based risk-management systems and to advise how these gaps can be bridged to minimize losses and strengthen Malawians' resilience against future shocks. The short list of proposed solutions focuses on areas in which the intervention gaps are currently deemed greatest. It comprises the following four broad areas:

1. **Strengthen agricultural information systems for effective policy development, monitoring, and evaluation.** Successful implementation of any risk-management instrument depends on the ability to monitor the impacts of risks and to evaluate the effectiveness of policies and investments. A solutions assessment in this area would (i) map out measures to strengthen Malawi's agricultural information systems so that they contain reliable data for the development, monitoring, and evaluation of agricultural policies; and (ii) propose measures to strengthen the policy analysis and monitoring and evaluation capacity in the Ministry of Agriculture and Food Security (MAFS). An assessment could comprise the following:
    - » Identification of gaps in the current agricultural information system in terms of collection methods and management of data.
    - » Assessment of existing equipment and information technology and a proposal for potential investments in agricultural information systems to strengthen agricultural policy development and evaluation.
    - » Discussion of the technical skills needed to monitor and evaluate agricultural policies, and areas for strengthening these skills within relevant departments of MAFS.
2. **Implement measures to improve water management for crop production to mitigate current and projected future weather-related risks.** Given the farm structure in Malawi, with its large number of small-scale farmers, water management will in part have to be implemented through small-scale infrastructural investments and improved on-farm practices using a systems approach. Any analysis would have to be conducted with existing land use/ownership structure in mind. An assessment could comprise one or several of the following areas:

» The potential for expanding the use of small-scale irrigation in Malawi and possible models under which small-scale irrigation could be promoted.
» The scope for improving relevant on-farm practices, including conservation agriculture and minimum tillage methods.
» The application of models for investing in on-farm water harvesting infrastructure in the context of Malaw's agriculture sector.

3. Map existing functions and identify measures to **improve coordination between the Strategic Grain Reserve (SGR), Agricultural Development and Marketing Cooperation (ADMARC), and Malawi Vulnerability Assessment Committee (MVAC)** to better target existing coping mechanisms toward their intended beneficiaries, to improve predictability of interventions, and to minimize market distortions. Such work could include the following:
   » An outline of the roles and responsibilities (formal and de facto) of SGR, ADMARC, and MVAC and proposed measures to strengthen their coordination.
   » An assessment of food security policies, including those related to trade, market interventions, and grain subsidies.
   » An analysis of the financial costs and economic impacts of these policies and if relevant, a proposal of alternative policies that can more efficiently achieve the same objectives without market distortions.
4. **Provide opportunities to strengthen farmers' organizations for effective agricultural risk management.** Many of the challenges in the sector that relate to risks (from uptake of inputs and technology to inadequate investments in postharvest infrastructure, price uncertainty, and contractual risks) could potentially be overcome through better organization of farmers. This intervention area is proposed to include the following:
   » An assessment of existing farmers' organizations (formal and informal) in Malawi.
   » A compilation of lessons learned from past and ongoing initiatives to organize farmers in Malawi, successful and unsuccessful, and conclusions about what determines their success.
   » Guidance on how farmers' organizations can implement risk-management mechanisms in practice, focusing on a few specific areas (such as adoption of new technology, price risks, contractual risks, and so on).

Which of these areas will be included in a solutions assessment will be determined together with the government of Malawi. Ideally, the assessments will be conducted in teams including relevant technical staff from the MAFS and other technical bodies to ensure that the analyses and proposed solutions are in line with the priorities and needs of the Ministry and/or relevant institution, and that the knowledge acquired through the assessment remains with relevant staff. Preferably, any work will include gender-disaggregated assessments and proposals.

This activity was requested by the Group of Eight (G-8) and principally financed by the U.S. Agency for International Development and Feed the Futures programs. Contributions were also received by the Multi Donor Trust Fund on risk management, financed by the Dutch Ministry of Foreign Affairs and the Swiss Secretariat of Economic Affairs.

CHAPTER ONE

INTRODUCTION AND CONTEXT

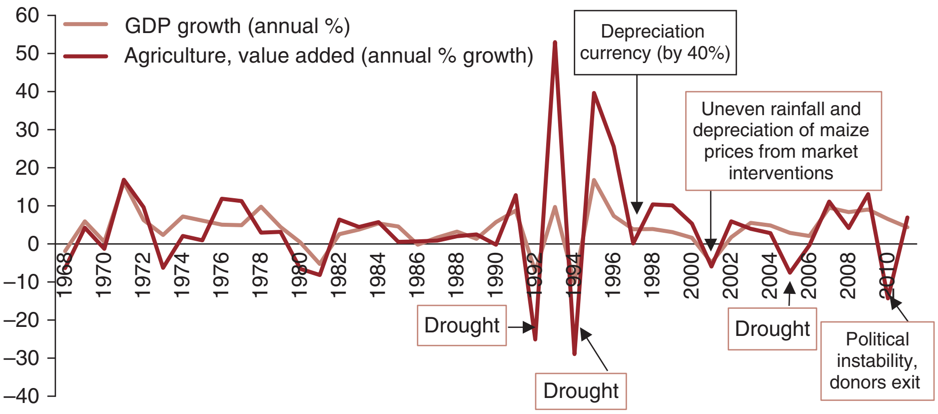
With more than three-quarters of its workforce employed in agriculture, Malawi is highly vulnerable to any adverse events affecting the agriculture sector, and agricultural risks are ever present in the country. Over the past decades, Malawi has been struck by several severe droughts that have resulted in spikes in food insecurity and prompted the need for humanitarian aid. During the last major drought in 2005, 40 percent of the population was in immediate need of food aid as a result of poor harvest.

Increasing food security is indeed one of the main objectives of Malawi's Agricultural Sector Wide Approach (ASWAp 2010), and its strong focus on increasing maize production since the mid-2000s has resulted in rapidly increasing production. However, production risks continue to result in high losses to the sector, including for maize. Further, price interventions in the sector over the past year have induced greater price risks for producers and traders.

Agricultural risks can obstruct development and enforce poverty traps, particularly for a country as reliant on agriculture as Malawi. Because of the size of the sector in the economy and the importance of agricultural products for export, agricultural growth correlates closely with GDP growth. This means that drops in agricultural growth affect the entire economy, as shown in figure 1.1—agricultural value added growth was negative in five years between 1992 and 2010, and the correlation coefficient between agricultural value added and GDP is 78 percent. Further, any drop in agricultural growth in a given year will affect the ASWAp annual growth target of 6 percent that Malawi committed to under Comprehensive Africa Agriculture Development Programme (CAADP). For individual actors in the sector, these risks reinforce poverty traps by cycles of loss-recovery-loss and result in lower returns on investments in productive assets.

Malawi's effort to manage risks and to provide relief in response to adverse events diverts significant resources from longer-term development investments. In recent years, the government and donors have spent US$80–US$100 million annually on coping mechanisms alone (such as food aid). This was in addition to the approximately

FIGURE 1.1. GDP AND AGRICULTURAL VALUE ADDED (% GROWTH) IN MALAWI, 1968–2011



Source: WDI 2014.

US$250 million spent on average annually between 2008 and 2012 on regular government agricultural development programs, including the government's Farm Input Subsidy Program (FISP), which annually distributes inputs worth US$165 million to farmers. Any losses in the sector because of adverse events mean that these investments were wasted.

Improved agricultural risk management is one of the core enabling actions of the G-8's New Alliance for Food Security and Nutrition. To better understand the dynamics of agricultural risks and identify appropriate responses, incorporate an agricultural risk perspective into decision making, and build the capacity of local stakeholders in risk assessment and management, the Agricultural Risk Management Team (ARMT) of the Agriculture and Environment Services Department of the World Bank conducted an agriculture sector risk assessment. This activity was requested by the G-8 and principally financed by USAID and Feed the Futures programs. Contributions were also received by the Multi Donor Trust Fund on risk management, financed by the Dutch Ministry of Foreign Affairs and SECO.

The purpose of this report is therefore to assess existing agricultural risks, prioritize them according to their frequency and impacts on the sector, and identify areas of risk-management solutions that need deeper specialized attention. Three levels of risks were assessed: production risks, market risks, and enabling environment risks to selected supply chains. To give a sectorwide overview of the impacts of risks, the assessment looks at the largest commodities that jointly account for 80 percent of Malawi's agricultural production value:

Food crops: maize, cassava, potatoes, peas and beans, rice, groundnuts, and bananas

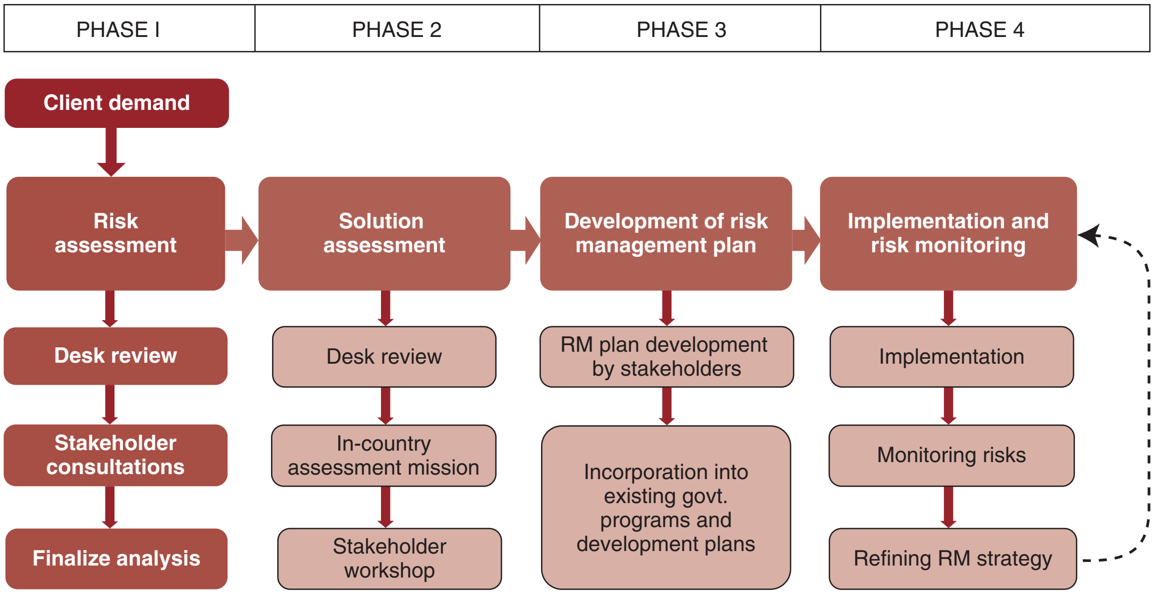
Export/cash crops: tobacco, sugar, tea, and cotton

Maize is by far the most important staple crop, accounting for more than 50 percent of the daily calorie intake in Malawi. Tobacco, tea, cotton, and sugar accounted for 67 percent of the total value of national exports of goods in 2012, with tobacco alone accounting for more than 54 percent. It can be noted that tea and cotton do not belong to the largest crops that fall within the 80 percent threshold, but tea was included in the list of crops prior to the mission because of its contribution to total agricultural export, and cotton because of its potential as an export crop.[3]

The report takes a quantitative and qualitative approach to assessing risk. Productions risks are quantified in terms of value of losses and then mapped by different perils. Market and enabling environment risks are analyzed qualitatively through deskwork and stakeholder consultations. For the purpose of this assessment, risk is defined as the possibility that an event will occur and will potentially

[3] Although the sector in total makes up about 10 percent of total agricultural production value, livestock were not included in the assessment because no single livestock product falls within the top 80 percent production value. Fishing and forestry were not included in the assessment.

FIGURE 1.2. AGRICULTURE SECTOR RISK-MANAGEMENT PROCESS FLOW



have a negative impact on the achievement of a farm or firm's performance objectives and/or on successful functioning of the overall supply chain. A broad spectrum of stakeholders was consulted throughout this work, including the Malawi government, farmers, traders, processors, agricultural institutions, and academia. A consultative stakeholder meeting was also held in Lilongwe to obtain feedback on findings and to discuss areas for risk solution interventions for deeper analysis.

Figure 1.2 provides an overview of the full process the World Bank's ARMT has applied in the past. The Agricultural Sector Risk Assessment constitutes the first phase. Based on its results, a solutions assessment will be conducted under which a few potential risk-management instruments will be further assessed. Under this second phase, ongoing activities in the selected areas will be assessed and gaps mapped to determine activities needed to minimize the impacts of risks on the sector.

This report is structured as follows: Chapter 2 provides an overview of the agriculture sector and the selected crops. Chapter 3 maps the production, market, and enabling environment risks to food crops and export crops. Chapter 4 looks at the adverse impacts of agricultural risks in terms of losses, both at the national level and for different regions. It also discusses the impacts of risks on different stakeholders and identifies particularly vulnerable groups. Finally, chapter 5 prioritizes the risks in terms of their frequency and the severity of their impacts, and discusses solutions based on this prioritization, ongoing risk-management activities, and the feedback from the consultative workshop.

CHAPTER TWO
MALAWI'S AGRICULTURAL SYSTEM

AGRICULTURE SECTOR OVERVIEW AND PERFORMANCE

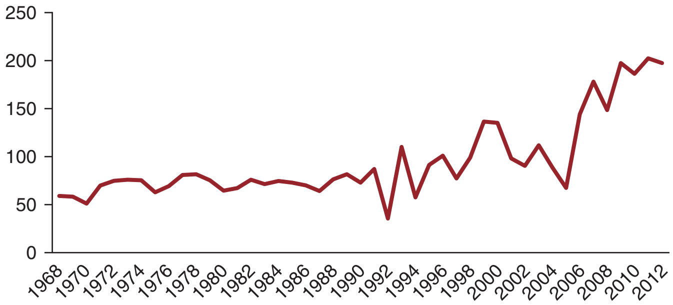
Malawi is among the poorest countries in the world, with limited resources and an economy that relies heavily on agriculture. Per capita GDP is US$362 per year[4] (WDI 2014) and 62 percent of the population lives on less than US$1.25 per day (purchasing power parity [PPP]). Malawi is relatively small in size, is densely populated, and has high population growth, all of which put pressure on land available for smallholder farming and on the environment and the natural resource base, notably land and forests. Officially, the population is 15.9 million people, about 80 percent of whom live in rural areas (World Development Indicators, 2010–12 year figures, accessed March 2014).

Agriculture is the backbone of Malawi's economy, contributing 30 percent of total GDP (2011) and 76 percent of total national exports (2012). With 78 percent of the population employed in the sector in 2013 (FAO Country Profile, accessed May 2014), agriculture is a main source of employment and income. The variability of agriculture has been a determinant of the overall economy's volatility (recall figure 1.1). For example, in years when agriculture suffered significant setbacks because of weather-related or other risk events, GDP growth also experienced an inflexion. In figure 1.1, this can be seen in 1992 and 1994, when severe drought caused significant drops in agricultural production that translated into in negative GDP growth rates. More recently, such correlations occurred in 2001, 2005, and 2010.

In terms of production indexes, the gross cereal production index shows a lot more volatility than do food production and total agricultural production indexes. The cereal production index in figure 2.1 also corresponds with the fluctuations in agricultural value added growth (figure 1.1). This is in line with findings from other studies that Malawi's GDP is strongly correlated with maize production.

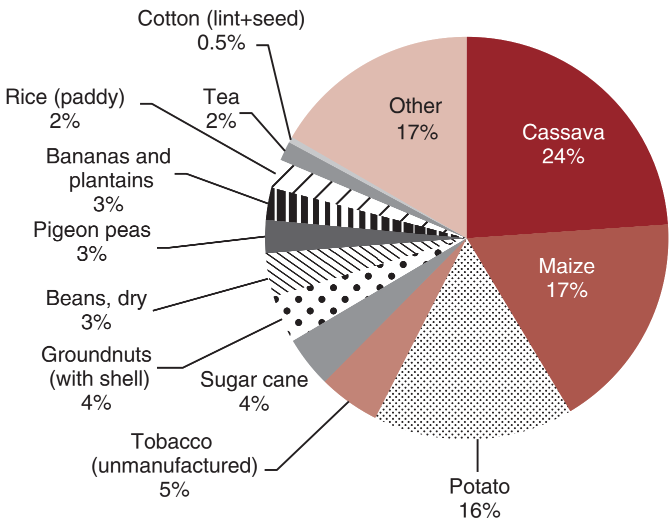
[4] Current US$, 2010–11 average.

FIGURE 2.1. GROSS CEREAL PRODUCTION INDEX (2004–06 = 100) IN MALAWI, 1968–2012



Source: FAOSTAT 2014.

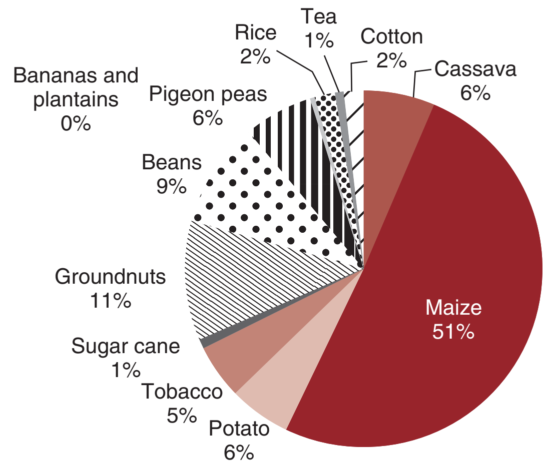
FIGURE 2.2. COMMODITIES THAT MAKE UP THE TOP 80 PERCENT OF GROSS AGRICULTURAL PRODUCTION VALUE (2009–11 AVERAGE)



Source: Calculation of production value based on FAOSTAT data.

Food crops account for the largest proportion of agriculture sector production, and three crops—maize, cassava, and potatoes—contribute over half of the total value. Figures 2.1 and 2.2 show the relative importance of specific agricultural products in terms of production value and harvested area. Maize is the main staple food for most people in rural and urban areas and is cultivated almost everywhere. Most of the other food crops and certainly cash crops have a relatively well-defined geographic production location.

FIGURE 2.3. SHARE OF AREA HARVESTED FOR COMMODITIES THAT MAKE UP THE TOP 80 PERCENT OF GROSS AGRICULTURAL PRODUCTION VALUE (2009–11 AVERAGE)



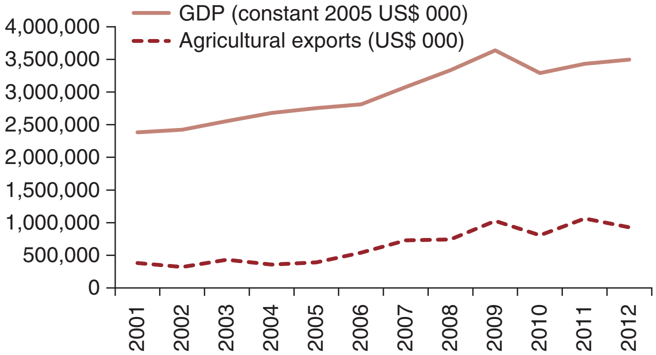
Source: FAOSTAT; cotton area data are from MAFS.

In terms of land area, maize takes up the largest area (more than 1.6 million hectares in 2012), followed by groundnuts and beans (more than 300,000 hectares). Tobacco is the most important export crop in terms of area planted, with about 160,000 hectares (figure 2.3).

Malawi has a dual structure of production whereby the smallholder subsector is the major producer of food crops, especially maize, cassava, potatoes, beans, and peas, whereas large estates specialize in export crops such as tea and sugarcane. Tobacco was formerly in the hands of estates but following the policy reforms during the 1990s, it became a mostly smallholder activity. Other export crops, such as cotton and groundnuts, have traditionally been produced in smallholder farming.

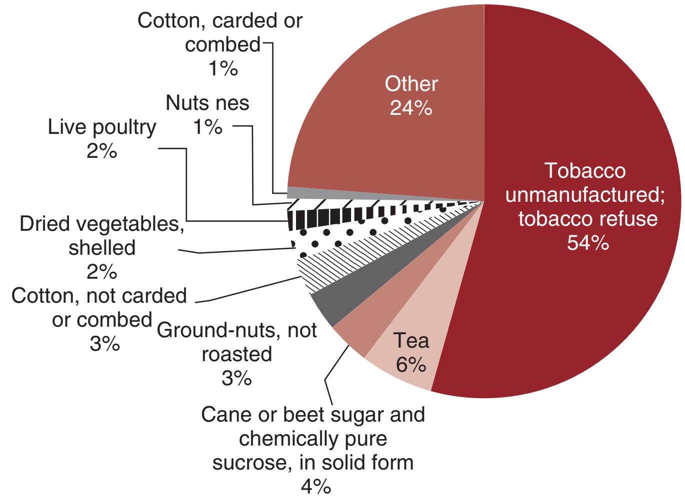
The marketing channels for food crops differ from those of export crops. Food crop markets are for the most part informal and farmers often depend on traders or transporters who come to villages and buy their produce. Farmers are also restricted by limited means of transportation, even though they are aware of better prices at bigger markets around the country. Maize differs from other food crops in that the government-owned ADMARC participates in the market, buying and selling

FIGURE 2.4. AGRICULTURAL EXPORTS AND CONSTANT GDP (US$ '000), 2001–12



Source: World Bank and International Trade Centre.

FIGURE 2.5. AGRICULTURAL EXPORTS FROM MALAWI, 2012



Source: International Trade Centre.

large quantities of maize throughout the season. Cash crops, on the other hand, have more formal supply chains and limited actors after farm gate. The extreme case is the sugar sector, in which only one processor operates in Malawi (Illovo Sugar Malawi Ltd., owned by Associated British Foods, the biggest sugar producer in Africa). The number of purchasers is also relatively small at the tea and tobacco auctions.

Although food crops (mainly maize, cassava, and potatoes) account for the largest proportion of total agricultural production value and cultivated area, export crops have been the main drivers of economic growth. In 2012, agricultural export accounted for 76 percent of total export from Malawi. Figure 2.4 shows GDP and agricultural export trends over the past decade.

However, agricultural export is strongly dominated by a few products, mainly tobacco and tea, followed by sugar, groundnuts, and cotton. Exports of tobacco and tea accounted for 60 percent of total exports in 2012 (figure 2.5). Until May 2012, when the Malawi kwacha (MK) was left to float against the U.S. dollar, exchange rate policy affected the country's export competitiveness because of overvaluation of the local currency.

Malawi is the one of the largest producer of pigeon peas in eastern and southern Africa. Production is concentrated in the southern region where they account for approximately 20 percent of household income. About 35 percent of production is sold on the market, both processed and unprocessed. India is the only export market, where Malawi has captured a high-price window because of seasonal advantage. However, pigeon peas are still not an important export crop.

The maize and tobacco subsectors face the highest levels of government policy intervention. Malawi's main producer support program is the FISP, which subsidizes seeds, fertilizers, and certain chemicals for maize, legume, and cotton (Makoka 2013a; see box 2.1). Additional policy interventions include maize export licensing and maize export bans. The tobacco market is extensively regulated but government intervention is transparent and more predictable than in the maize sector.

AGROCLIMATIC CONDITIONS

Five main landform areas exist in Malawi: the highlands, the escarpments, the plateaus, the lakeshore and Upper Shire Valley, and the Lower Shire Valley. The climate changes from semi-arid in the Lower Shire Valley to semi-arid and subhumid on the plateaus to subhumid in the highlands. Most of the country receives between 763 and 1,143 mm of precipitation per year. Three main areas have precipitation of more than 1,524 mm: Mulanje, Nkhata Bay, and the northern end of Lake Malawi (map 2.1). Almost 90 percent of rainfall occurs between November

BOX 2.1. MALAWI'S FARM INPUT SUBSIDY PROGRAM

In an attempt to boost production and increase food security, Malawi introduced an input subsidy program in 2005. The purpose of FISP is to increase smallholder farmers' access to improved agricultural farm inputs with the objective of achieving food self-sufficiency and increased income for resource-poor households through increased maize and legume production. FISP also subsidizes certain postharvest infrastructure to decrease postharvest losses. FISP has since accounted for more than 50 percent of the Ministry of Agriculture and Food Security's (MAFS) budget. The program subsidizes fertilizers, maize and legume seeds, and, in certain years, cottonseed and chemicals. Under the program, farmers receive vouchers that cover a share of the input cost. The number of vouchers went from 166,000 in 2005/06 to 216,000 in 2008/09 and to 140,000 in 2012. Maize seed subsidized under the program went from 4,524 MT in the 2006/07 season to 8,245 MT in 2011/12.

For fertilizers, the biggest component of FISP, farmers' contribution declined from MK 950 per bag in 2005 to MK 500 per bag in 2012, whereas the value of the voucher increased from MK 1,750 per bag to MK 6,536 per bag in the same period.

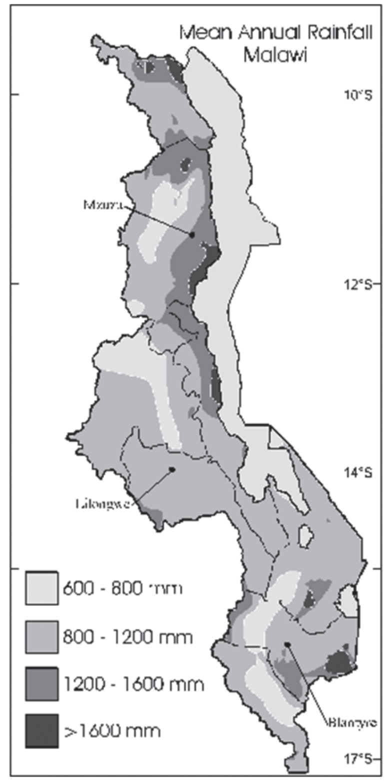
The actual results of the program are mixed. According to a recent World Bank evaluation of the program, FISP has had only a moderate impact on yields, prices, and agricultural wages. One possible reason is that maize in Malawi has low response rates to fertilizer is relatively low. Other reasons are that fertilizers are shared and therefore not optimally applied, and vouchers are resold and therefore do not have the intended effect on targeted farm households. Consequently, impacts among higher-income farmers can be linked to FISP. Nevertheless, many farmers have the perception that FISP contributes positively to the well-being of their households.

Sources: Makoka 2013a; World Bank 2013.

and March, with no rain at all between May and October over most of the country. Mean annual temperatures vary with altitude, ranging from 25°C in the Lower Shire Valley to 13°C on the Nyika Plateau. Frost occasionally occurs in lower lying land on the plateaus.

Forty percent of the total land area in Malawi is suitable for agriculture, as shown in table 2.1 (based on data for 2000).

MAP 2.1. AVERAGE ANNUAL PRECIPITATION (mm) IN MALAWI



Source: Moriniere and Chimwaza 1996.

TABLE 2.1. LAND USE IN MALAWI (km^2)

Total Land Area (km^2)	**94,281**	**% of Total**
Agricultural land (km^2)	**55,720**	**59**
Arable	21,174	38
Forested	18,945	34
Permanent crops	557	1
Permanent pastures	11,144	20
Other	3,900	7

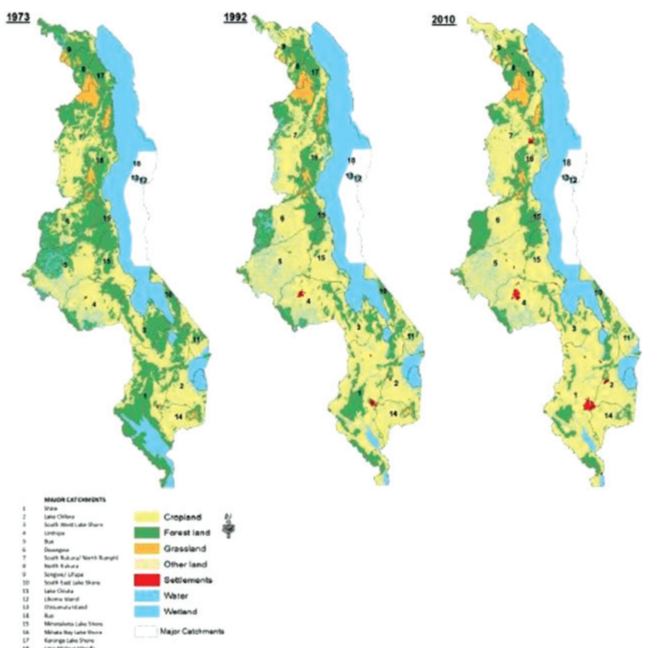
Source: FAO/WDI.

Map 2.2 shows the land cover in Malawi and its evolution over the past 30 years. Forestland has reduced extensively whereas the area dedicated to agricultural crops has increased. This change is certainly connected to Malawi's high population growth and density, and is a main contributor to increased production risks and reduced human resilience. As such, it is a key long-term issue for public policy.

PRODUCTION AND MARKET TRENDS

The yields of Malawi's main crops have followed very different trends, depending on public policies and market developments over the past 30 years. Maize yields have increased, though at a very modest rate and with great drops due to droughts (for example, in 2001 and 2005). The long-term increase is attributed to government interventions through programs such as the Agricultural Productivity Investment Program (APIP), the Starter Pack Scheme, the Targeted Inputs Program (TIP), and the FISP. In any case, actual maize yields remain below potential yield. Tobacco yields have also increased over the years, peaking at almost 1,400 kilograms (kg)/hectare (ha) in 1997. Yields then declined and leveled off, with year-to-year variations affected by weather and farmers' access to fertilizer. Other main food crops cropped by smallholders, such as groundnuts and beans, which have the largest cultivated area after maize, experienced a slow decline in yield, most likely associated with the low availability of fertilizer and other inputs (figure 2.6).

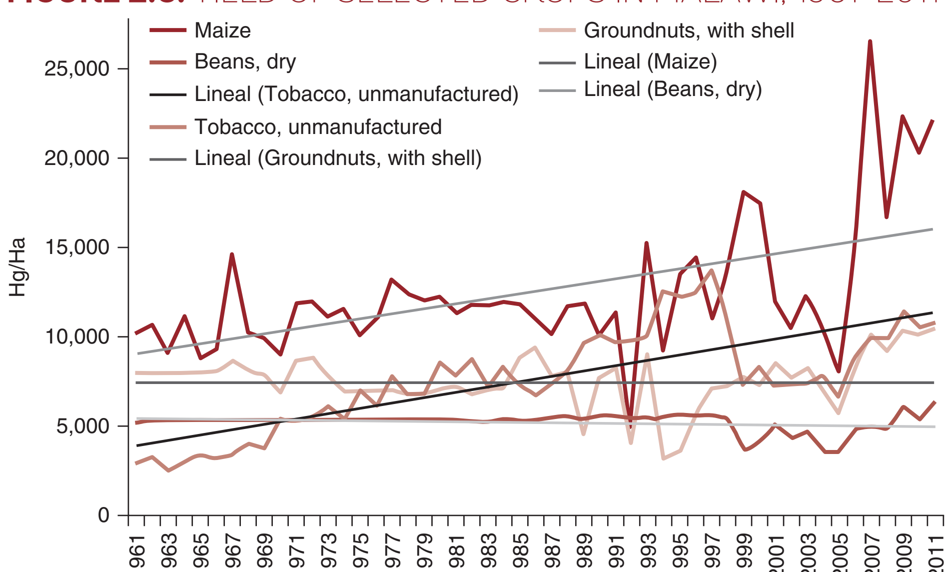
MAP 2.2. EVOLUTION OF LAND COVER IN MALAWI, 1973–2010



Source: LTS International 2013.

In terms of market trends, some crops, such as cotton and maize, are marked by intense price volatility. Maize has a relatively thin and poorly functioning market, a major cause of high seasonal variation. Interannual price variation is mostly connected to uncertain public policies and irregular access to modern production inputs, which in turn have led to limited productivity growth. Cotton price volatility is connected to international market volatility. A crop such as tobacco, which has a relatively well-developed internal market and a relatively efficient technology transmission mechanism, is less exposed to production risks but is very sensitive to domestic supply and demand variation. These issues are discussed in chapter 3 within each supply chain's market risk assessment.

FIGURE 2.6. YIELD OF SELECTED CROPS IN MALAWI, 1961–2011



Source: FAOSTAT 2014.

CHAPTER THREE

AGRICULTURE SECTOR RISKS

Droughts and pests and diseases are cited by Malawian stakeholders as the most damaging production risks, especially for food crops. Droughts are probably the most visible risk to the sector; very bad droughts in the past have had a strong fiscal impact on Malawi, necessitating help from the international community. The damaging impact of pests and diseases is significant but the extent of damage depends on agricultural practices and mitigation activities. The effects of pests and diseases are at times exacerbated by adverse weather events. Erratic rainfall and hailstorms are frequent but of moderate or low impact.

Price volatility is an important market risk in Malawi, particularly in key crops such as maize, tobacco, and cotton. Causes for these volatilities depend on the crop: cotton prices fluctuate according to world prices, whereas tobacco and maize prices are mainly determined by the domestic market. Maize price volatilities are largely a result of enabling environment risks due to unpredictable domestic market interventions and export bans. Regardless of the reason, sudden fluctuations in prices negatively affect farmers, the segment of the supply chain with the least risk-management capacity.

This chapter presents findings regarding the production, market, and enabling environment risks for selected food and export crops. The impact of adverse events on different stakeholders is discussed in chapter 4.

FOOD CROPS—PRODUCTION RISKS

WEATHER-RELATED RISKS

Weather-related risks such as droughts, dry spells, and erratic rains constitute some of the most important risks to the sector, although they are more predictable than they might seem at first glance. Drought in Malawi happens in a number of different ways, notably in shortened rainy seasons (because of late starts, early cessation, or both) and/or dry spells during the rainy season. Although these weather events often come as a shock to producers, there are certain patterns in their occurrence. The short cycles or waves of weather patterns are affected by so-called teleconnections, especially El Niño and La Niña. Teleconnections are linkages between weather variations or anomalies in widely separate locations of the world that bring about temporary changes over a one- to two-year time frame. El Niño events are strongly connected with drought in Malawi, whereas La Niña is associated with unusually wet years. If there is an El Niño event, the following growing season in Malawi is highly likely to experience a significant drought.[5] Other teleconnections also affect Malawi's weather patterns.

Further, in the medium term, analyses of rainfall data have shown that Malawi goes through different multiyear cycles of wet and dry periods. The climate in Malawi alters between 11.1-year cycles with precipitation above average and precipitation below average (Mwafulirwa 1999). One theory is that this longer oscillation is related to regular changes in sunspot activity, but this has yet to be confirmed. Some stakeholders were of the opinion that weather has become more unpredictable over the past two decades, with drought events more frequent and intense and with more frequent floods with more severe impacts in certain parts of the country. (More information on weather cycles and climate change can be found in appendix A.)

Despite this, most food crops grown in Malawi are not particularly drought tolerant and are therefore sensitive to dry spells and erratic rains. Irish potatoes, groundnuts, beans, and bananas are all susceptible to dry spells. For groundnuts, farmers reported losing more than half their harvest in a dry season in 2012. Drought-tolerant varieties exist for groundnuts, but are not widely adopted by farmers, in part because of limited access and in part because of the timing of harvest, which overlaps the harvest of other crops, making sufficient labor unavailable. Few drought-resilient varieties exist for potatoes. Although banana plants are also sensitive to drought, the banana-growing zones are located in areas with higher annual rainfall and with more rainy days than elsewhere in the country; further, banana farming is often conducted close to rivers and streams, so bananas tend to be fairly drought resistant. Cassava is relatively drought tolerant, but interviewed farmers reported losses of more than 50 percent of cassava in dry years. In addition, cassava loses quality during rainy periods, and has a lower market price if harvested then. Predictability of the rainy season is thus important for cassava producers.

The impact of shorter rainy seasons and extended dry spells on maize depends on the maize variety. Broadly, three different maize varieties are currently used in Malawi: traditional, hybrid, and composite. Hybrids and composites are being promoted by the government and donors. Traditional varieties are particularly susceptible to shortened rainy seasons because they require a long growing season. Hybrids are considered drought tolerant because they have shorter growing seasons, and thus can still produce normal yields even if the rainy season is shorter than normal. However, because they are less able to absorb soil moisture, these types of drought-tolerant varieties are typically sensitive to prolonged dry spells. They also don't cope well with high temperatures, as they have been developed for other climates. Another challenge with hybrids is that they require fertilizer, which farmers often find prohibitively expensive. The drought resilience of composites is not clear, although some studies report that they are the most drought tolerant of the three varieties. However, although composites possess some of the traits of hybrids, the seeds can be recycled and are therefore popular among farmers in Malawi. The traditional varieties cope better during extended dry spells and with higher temperatures because they have adapted to local conditions over time. However, traditional maize varieties require a full growing season and are therefore not considered drought tolerant. Hence, the effect of drought on maize depends on the type of drought (that is, extended dry spell, less rainfall, or shorter than normal growing season), and the variety planted. Chapter 4 shows that the impacts of production risks are incurred significantly differently across regions in Malawi.

Table 3.1 shows the main droughts experienced in Malawi during the past 30 years. Figures 3.1–3.5 show how these droughts affected different food crops. As can be seen, maize and groundnuts show great fluctuations in yield as a result of drought.

Bananas show a more stable yield trend, which is partly in line with the above discussion. However, this stable yield can also be questioned on the grounds of data quality, particularly given the sharp jump in yield between 1998

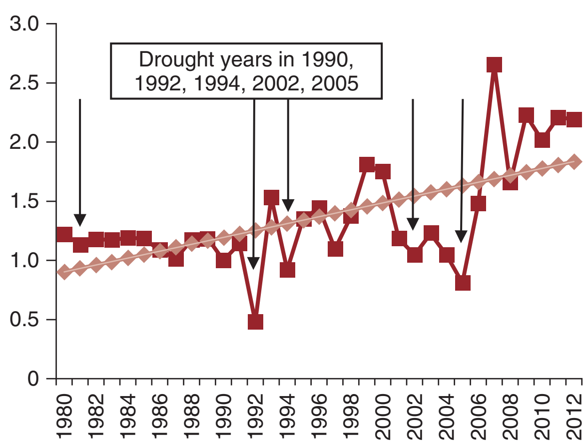
[5] According to Mwafulirwa (1999), the likelihood is 80–90 percent.

TABLE 3.1. MAJOR DROUGHT INCIDENTS IN MALAWI, 1980–2012

Year	Start Month	Total # of People Affected	November–March Rainfall (mm)	Region(s) Affected	Crops Affected According to Yield Trends
1991	Information not available	No data	696	8 total: 2 in north, 3 in central, 3 in south	Maize Potatoes
1992[a]	April		490	21 total: 5 in north, 6 in central, and 10 in south	Groundnuts Maize
1994	Information not available	7,000,000	583	17 total: 5 in north, 3 in central, and 9 in south	Groundnuts Maize Potatoes
1995	Information not available		585	17 total: 4 in north, 3 in central, and 10 in south	Groundnuts Potatoes
2002[a]	February	2,829,435	No data	Information not available	Beans Maize
2005–06[a]	October through March	5,100,000	754 (for 2005 event)	11 total: 4 in north, 2 in central, and 5 in south	Beans Groundnuts Maize Potatoes
2012	August	1,900,000	No data	Information not available	Information not available

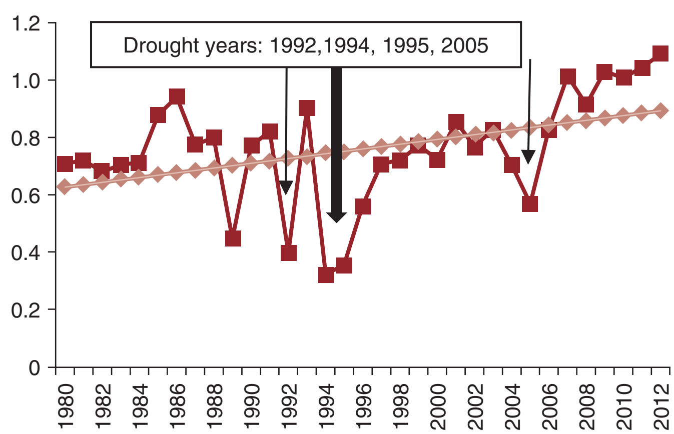
Sources: EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters-CRED (http://www.emdat.be/search-details-disaster-list), RMSI, World Bank 2009; and appendix A of this report.

FIGURE 3.1. MAIZE YIELDS (MT/ha), 1980–2012



Source: FAOSTAT 2013.

FIGURE 3.2. GROUNDNUT YIELDS (MT/ha), 1980–2012

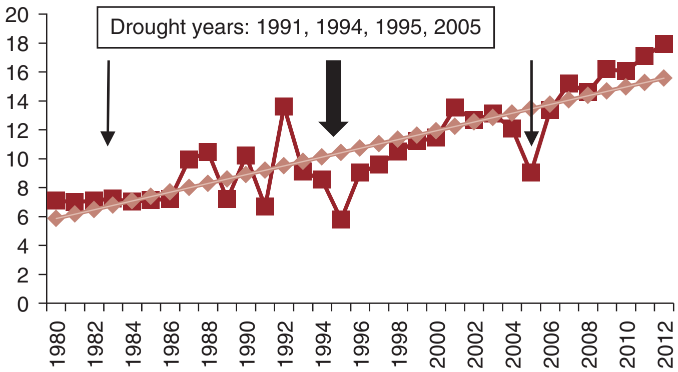


Source: FAOSTAT 2013.

and 1999. Because improved productivity cannot explain this jump, it is reasonable to assume that there was a correction in the data. For the purpose of this report, banana yields are given two trend lines because a single line would give the illusion of losses over seven years. In reality, and as the dual trend lines show, yield remained flat both prior to and after 1998/99. As the regional analysis will show, national yield data do not capture the full picture of banana production in Malawi.

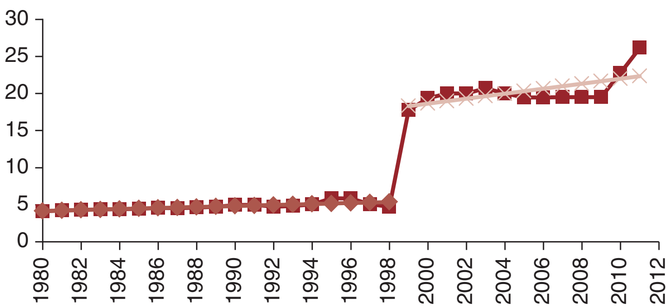
Beans show essentially no variation in yield up to the late 1990s, when volatility increased. Based on the remarkably

FIGURE 3.3. POTATO YIELDS (MT/ha), 1980–2012



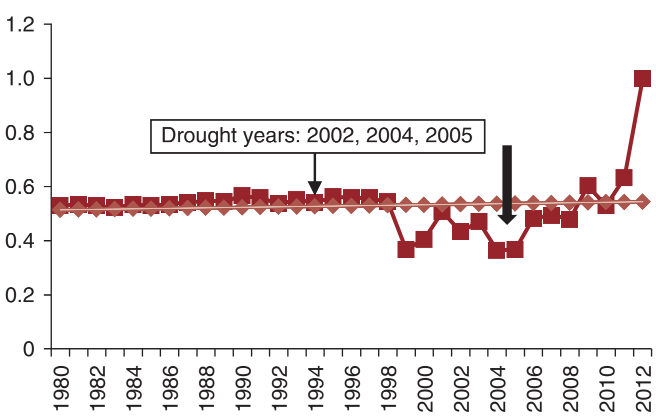
Source: FAOSTAT 2013.

FIGURE 3.4. BANANA YIELDS (MT/ha), 1980–2012



Source: FAOSTAT 2013.

FIGURE 3.5. BEAN YIELDS (MT/ha), 1980–2012



Source: FAOSTAT 2013.

stable yield from 1980 to 1998, it is reasonable to assume that yield data from this period were based on assumptions rather than on actual yields. Nevertheless, three of the drops in yield in the 2000s coincide with three main drought years in Malawi.

BOX 3.1. GLOSSARY OF DROUGHT EVENTS

The word "drought" is commonly used when referring to a deficiency in precipitation in a certain period, but the way in which this event occurs determines the impact. Three such ways include the following:

Dry spell: A cessation in rainfall in a normally rainy season. Dry spells can be short or long, and their length will determine the impact on the crops. They are especially problematic for crops with poor ability to absorb moisture in the soil. Similarly, the time at which they occur in the growing cycle of the crop will also determine the damage because crops are differentially vulnerable in different stages of maturity. Dry spells are also sometimes referred to as erratic rains.

Late onset or early cessation of the rainy season: The rainy season starts later than normal or ends earlier than normal, which affects the overall length of the rainy season. Traditional crops are normally adapted to the normal local rainy season and therefore do not have time to mature in this event.

High temperatures: Normal rainfall but temperature is higher than normal. Global climate change models project that temperature will increase in Malawi, and thus incidents of high temperature will be more frequent in the future. High temperature is problematic for crops with low stress tolerance.

Table 3.1 provides an overview of the main droughts in Malawi in terms of the number of affected people and the impacts on various crops' production. However, droughts can be measured according to different variables and their impacts depend on when in the season they occur, as this can affect agriculture differentially. Table 3.1 is therefore not an exhaustive list of all droughts but reflects the reported droughts' impacts on the agriculture sector. (For a discussion of the various concepts associated with the term "drought" in Malawi, see box 3.1.)

PESTS AND DISEASES

Pests and diseases are an important problem in Malawi and although the exact figure is not known, a significant share of food crops is lost annually as a result. The Ministry of Agriculture and Food Security maps outbreaks to a certain extent, but it does not capture the full impact of pests and diseases on the sector. Also, pests and diseases

TABLE 3.2. PESTS AND DISEASES IN MALAWI FOR ANALYZED FOOD CROPS, IN FIELD AND POSTHARVEST

	In the Field		
	Pests	**Diseases**	**Postharvest**
Maize	• Stalk borers • Maize weevils • Larger grain borers • *Striga* • Whitegrubs • Wireworms • Termites	• Maize streak virus • Gray leaf spot • Rust • Southern leaf blight	
Cassava	• Cassava green mite • Cassava mealy bug • Termites	• Cassava mosaic virus disease • Cassava bacterial blight • Cassava brown streak virus disease	
Potatoes	• Weevils	• Aphids • Nematodes • Bacterial wilt • Late blight	
Bananas	• Banana weevils • Nematodes	• Banana bunchy top virus • Fusarium wilt (Panama disease) • Black Sigatoka • Yellow Sigatoka	
Groundnuts	• Whitegrubs • Groundnut hoppers • Termites	• Rosette • Early leaf spot disease • Late leaf spot disease	• Bruchids • Pod-sucking bugs
Beans	• Aphids • Beanflies • Leaf beetles	• Bacterial blight • Angular leaf spot • Bacterial brown spot • Halo blight • Anthracnose, rust • Bean common mosaic virus	
Pigeon peas	• Nematodes • Pod borer *Helicoverpa armigera* • Pod sucker *Nezara viridula* • Termites	• Fusarium wilt (Panama disease)	

Sources: Monyo et al. 2012; Mih and Atirib 2003; Ngwira and Khonje 2005; and Authors' interviews with stakeholders.

are often closely tied to adverse weather events that exacerbate the impacts, which can make it difficult to attribute losses to the different risks. Nevertheless, research and interviews with farmers show that pest and disease outbreaks are regular occurrences in Malawi and that farmers lose about 20–30 percent in the event of an outbreak. In the worst cases, farmers can lose an entire harvest, as from rosette diseases for groundnuts and the banana bunchy top virus (BBTV).

Pests and diseases are a problem for essentially all food crops. Table 3.2 provides an overview of the plant pests and diseases in existence in Malawi. As can be seen, virtually all food crops are subject to a variety of pests and diseases although some are more common than others. For example, a combination of bacteria and pests has spread between potato producers across Malawi and it is estimated that in some areas, up to 60 percent of potatoes are contaminated. Similarly, it is estimated that about 60 percent of Cavendish banana plants are infected by BBTV. Certain pests and diseases are also more localized than others. For maize, for example, southern leaf blight, rust, and stalk borers tend to be problematic in middle elevation areas, whereas maize streak virus is more of a problem at low elevations. Termites pose a problem to maize and pigeon peas as they will feed on plant residue.

Agricultural practices significantly affect the occurrence of pests and diseases in Malawi. For example, plant diseases are commonly transferred from harvest to harvest in vegetatively propagated crops such as cassava and potatoes, as farmers cannot afford to buy new and/or certified seeds. Instead of culling diseased potato plants from their fields to mitigate the effect of potato diseases, farmers respond by harvesting potatoes earlier to avoid the rot spots that develop with the diseases and present toward the end of the growing season. However, this results in lower yields because there are smaller potatoes, which are priced less in the market. And the main reason for the spread of BBT is poor farmer practices, as farmers do not immediately remove infected banana plants when identified. Although diseases are generally not a problem for pigeon pea producers, a high incidence of Fusarium wilt occurs when farmers grow pigeon peas in the same plot year after year. Finally, the improved bean varieties were all bred to be resistant to one or more bean diseases, but farmers opt not to replace their seeds with new varieties.

Pests and diseases also pose a risk postharvest. Inadequate infrastructural capacity along with lack of knowledge of preventative storage methods result in stored grain being subject to pest infestations. For maize, for example, postharvest losses from large grain borers and maize weevils can be as high as 30 percent. Hybrid varieties are more pest prone during storage than other maize varieties, complicating farmers' possibilities to mitigate the effects of drought.

FLOODS

Floods are relatively frequent and problematic on a local level, but do not constitute a structural risk to agricultural production. Floods are frequently mentioned in monitoring documents related to risk and disasters mainly because they often involve damaged infrastructure and buildings, loss of livestock, and sometimes even loss of human life. However, floods in Malawi are usually limited to a narrow geographic area and tend to not have any visible impacts even on a regional level. Since 2007, only three flood events in Malawi have affected more than 1,000 households. Farmers and other stakeholders interviewed about major risks to agricultural production did not mention floods. The main exception is around the Shire River and in other areas around rivers. Land scarcity and the greater fertility of land on river banks have encouraged farmers to cultivate areas close to rivers, where flooding frequently occurs. However, because this flooding can be expected (indeed, authorities discourage farmers from taking this land under cultivation), it should not be seen as a risk.

ANIMALS

Elephants and hippos frequently damage harvests in the field. This is especially problematic for farmers close to national parks. Animals either cross fields and trample the crops in their paths or they enter fields to eat the crops. For example, in 1999, 369 households in the T.A. Chimwala area had their crop damaged by elephants and became malnourished as a result. In 2005, elephants destroyed the crops of 142 families in Machinga. Farmers in Mchinji estimate that about 10 percent of their crops are lost as a result of animals; they have limited options for protecting their crops, although farmers did report some cooperation with the park services. However, although this is a problem for individual farmers, it cannot be considered a structural risk.

FOOD CROPS—MARKET RISKS

THE PRODUCTION OF OTHER CROPS

Because of substitution effects, cassava prices tend to be affected by maize prices. Some cassava is milled into flour, which is a cheaper substitute for wheat and maize flour, and sometimes it is mixed in with maize flour. As such, when maize production is high and its price declines, so does the market price for cassava. When there is a shortfall in maize production and its price rises, so too does the price for cassava rise as its demand also increases.

Malawi is overdependent on a single export market—India—for pigeon peas. Experience has shown that this is risky. Malawi's pigeon peas have on occasion been rejected due to poor quality and Malawi frequently fails to meet the Indian demand even though in theory its production is sufficient. As India's annual demand depends on its own domestic production, it is difficult to predict for Malawian producers—a risk that the existence of alternative markets would somewhat mitigate.

UNPREDICTABLE TRANSPORTATION COSTS

Transportation costs are not predictable, which is problematic especially for potato and banana producers. Transportation costs are negotiated on an ad hoc basis, and total transportation cost is dependent on the ultimate path from point of sale by farmers to final market destination. Prices often depend on truckers' ability to backhaul and cobble together multiple segments to reach their final destination. For these reasons, truckers sometimes also change the price during transportation.

AFLATOXINS

Aflatoxins are a serious problem in Malawi (see box 3.2), especially for groundnuts and maize, in some cases posing a risk to the entire sector as well as to consumers. For groundnuts, aflatoxin poses the biggest marketing risk, as experienced by Malawi in the 1990s when the United Kingdom banned all groundnuts imported from Malawi after detecting aflatoxins above permissible levels in shipments. Malawi is currently exporting to neighboring countries and although they currently do not test for aflatoxins in shipments, they are likely to close their markets if and when new testing routines are introduced. Serious public health concerns are associated with the consumption of contaminated groundnuts, both domestically and in export markets. It has also been estimated that as much as 30 percent of all maize is contaminated with aflatoxin. Although contamination levels are not as severe as those for groundnuts, maize's pronounced role in the national diet makes aflatoxin contamination a major health hazard for Malawi. Insufficient awareness and the lack of preventive measures, along with the prohibitive cost of testing, result in unacceptably high levels of aflatoxin contamination.

BOX 3.2. AFLATOXINS

Aflatoxins are chemicals produced by fungi (in the case of Malawi, *Aspergillus flavus*) that live in the soil and flourish particularly well under humid conditions. Aflatoxin contamination can take place before and during harvest and/or during storage. Although aflatoxins flourish in humid conditions, crops are also vulnerable to contamination during droughts. Host crops include maize, groundnuts, and sorghum.

Aflatoxins are carcinogenic, mutagenic, teratogenic, and immunosuppressive, and have other serious health implications, reasons that strict trade regulations related to aflatoxins are in place.

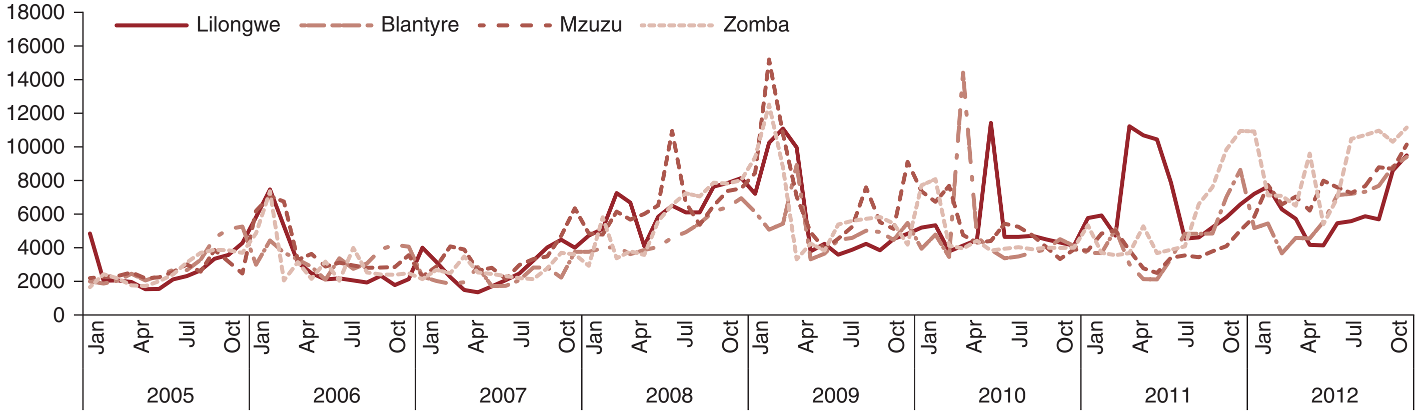
In a recent survey, 30 percent of groundnuts sampled in Malawi were contaminated with unsafe levels of aflatoxin. In general, improved varieties of groundnuts tend to have lower rates of aflatoxin contamination because they are resistant to drought, pests, or diseases that can make groundnuts more susceptible to aflatoxin contamination. But because most of groundnut production comes from smallholders, it is difficult to institute improved handling and management practices and/or increase the use of improved varieties that would decrease the risk of contamination. A number of nongovernmental organizations (NGOs), donor, and government schemes intend to introduce improved varieties, but the high recycling rate self-limits farmers' access to them.

Sources: Monyo et al. 2012; Ngwira and Khonje 2005.

FOOD CROPS—ENABLING ENVIRONMENT RISKS

The most serious enabling environment risk in Malawi is unpredictable and opaque government interference. Currently, this is of particular concern in the maize sector, which over the past years has been subject to market interventions, price interference, and erratic policy bans. Figure 3.6 shows maize prices in Malawi from 2005 to 2012. In a normal year, prices should be lowest in May–June, immediately after harvest, and should show a marked increase toward November–December, only to remain high or increase further during the lean season until the next harvest. In years of poor harvest, prices should be higher than in other years, although imports and food aid may put downward pressure on prices. However, these cycles also depend on government interventions.

FIGURE 3.6. MONTHLY MAIZE PRICES IN LILONGWE, BLANTYRE, MZUZU, AND ZOMBA (TAMBALA/kg), 2005–2012



Source: National Statistics Office (NSO) 2014.

BOX 3.3. NATIONAL FOOD RESERVE AGENCY (NFRA)

The National Food Reserve Agency has been in existence since the early 1980s and is subordinated in the MAFS. The NFRA consists of seven branches around the country and employs 120 persons. Its mandate is to keep maize for the government to support vulnerable groups:

» In a normal year
» For a humanitarian crisis
» For vulnerable groups in different parts of the country

The annual budget allocation is in part based on the previous year's consumption and on production estimates made by MAFS. Additional allocation is sometimes made over the year depending on domestic food security.

To the extent possible, maize is procured domestically but imports of maize do take place. NFRA does not buy, sell, or distribute maize directly. ADMARC procures in part through public tenders and in part through direct procurement from traders, and sells maize on the market. Incomes from sales are used as revolving funds for maize procurement. Other outlets for the maize stored in the NFRA are the World Food Programme (WFP) (both emergency relief and school feeding programs) and the Department of Disaster Management (DODMA).

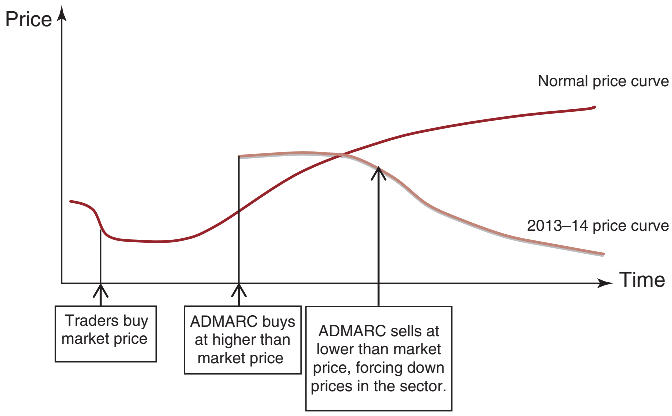
Source: Interview with NFRA in March 2014.

As a result of government policy, maize prices over past seasons have proved to be a significant risk to maize sector participants. Especially since 2012, the government has developed a heavy interventionist policy in the maize sector that, with the help from the NFRA (see box 3.3), has significantly decreased maize prices in the lean season, when prices are normally higher than postharvest. Based on information from NFRA, traders, and farmers, the chain of events has been as shown in figure 3.7.

These market interventions have distorted prices, leading to abnormal patterns in maize price development. Figure 3.8 describes the how the policy carried out in 2013 altered the normal price pattern over the season. Because of the timing of the intervention, farmers were not particularly affected this year. Rather, traders bought at normal levels from farmers, expecting to make a profit later in the season. In part because of the government budget cycle, ADMARC did not initiate procurement of maize until after the new budget year had started in July. At that time, ADMARC procured maize at MK 125–145/kg, above the normal market price. The plan for 2013–14 was to buy 120,000 MT and by early March, about 90,000 MT had been procured through two official tenders. Purchases later in the season were done without public tenders, but instead through a network of traders in the interest of time. In early 2014, the price offered was MK 130–160/kg. By November 2013, ADMARC started selling maize from the NFRA at MK 80/kg, much lower than the initial purchasing price and the price normally seen at that time. The price intervention by NFRA and ADMARC and the accompanying export ban has meant that traders have had to sell their stock at a loss, which the interviewed traders signaled will be transferred to farmers next year.

FIGURE 3.7. MAIZE INTERVENTIONS IN MALAWI SINCE 2012

FIGURE 3.8. MARKET INTERVENTIONS AND PRICE DISTORTIONS IN MALAWI'S MAIZE MARKET



The main enabling environment risk is changes in export regulations without any prior announcements, which interviews with private and public sector actors indicated are a problem for both producers and traders. Although trade policies de facto have been relatively stable over the past years (table 3.3), frequent announcements about changes in trade policies are reportedly being made, generating uncertainty for participants in the sector.

For other food crops, enabling environment risks are less of a problem, mainly due to the lack of government intervention. The main exception is for beans, where export bans make trade uncertain and limit the potential for returns for producers. Much of the Malawian bean belt lies near the border with Mozambique.

THEFT

Theft is a problem for certain food crop producers and contributes to other issues for the sector. Concerns over theft limit maize farmers' interest in storing maize in simple, raised silos. Instead, farmers store the maize inside their homes. Onions and potatoes are also stolen, sometimes directly from fields. For potato traders, theft is a problem at "break of bulk points" (where goods are offloaded and reloaded) during transport of potatoes to final market destinations.

EXPORT CROPS OVERVIEW

Export crops differ from food crops in that most risks to the commodities are further down the supply chain. In general, the supply chains for the four export crops analyzed (tobacco, cotton, sugar, and tea) are better organized than for food crops. This means better access to inputs for farmers, and more incentives among processors to support producers to minimize risks and losses at farm level (and indeed throughout the chain). However, export commodities are by nature more exposed to exogenous risk, such as foreign trade regulations and exchange rate fluctuations. With a wider range of actors involved and more value added throughout the chain, marketing and enabling environment risks tend to be more pronounced. The interviews with small-scale maize traders in box 3.4 give insights to some of the concerns facing actors in the sector.

Risks are much more crop-specific for export crops than for food crops in Malawi. When analyzing the risks among export commodities, it is notable that the risks differ between the supply chains and that the four subsectors analyzed face different challenges. Whereas for all seven food crops analyzed the main risks were drought, erratic rainfall, and pests and diseases, risks to individual export commodities differ to a greater extent because of more complicated supply chains and markets.

TABLE 3.3. TRADE BANS AND LIFTS IN MALAWI SINCE 2008

Date	Commodity	Trade Ban	Description
2008	25 assorted commodities	Restricted imports and exports	Scarcity of products within Malawi prompted the restriction. Export restriction included maize.
July 23, 2008	Roundwood timber	Total trade ban on roundwood timber exports	Roundwood timber exports generated less revenue than processed timber, resulting in high foreign exchange losses.
May 28, 2012	Cottonseed and seed cotton	Restricted ban on export of cottonseed and seed cotton	Scarcity of cottonseed during the planting season prompted the restriction.
June 21, 2012	Soybeans	Total trade ban on export of soybeans	High levels of malnutrition among children under five in Malawi led to a total ban on soybean export to boost domestic consumption of protein.
June 20, 2013	Export commodities	Export ban lifted on 15 commodities. Scrapped some commodities, reducing the list from 25 to 10	Government lifted both total and restricted bans on some commodities, reducing the list from 25 to 10. Maize remains on the list of restricted export products.

Source: Authors, based on GOV press releases.

BOX 3.4. INTERVIEWS WITH SMALL-SCALE MAIZE TRADERS

This box summarizes interviews with a single-owner, family-run, maize-trading operation and with a single maize trader.

Maize-Trading Operation. The two men interviewed work for the maize-trading operation owned by their elder brother. At least three other brothers with bicycles were out collecting maize from farmers and bringing it to this site for sale. The fact that they go to the farm gate, or at least to the farmers' village center, is a critical success factor in their estimation. The range of their operation is roughly 10 km from their trading post. Their peak period of activity is April–May, but they are open for business year-round. They typically hold back 60 to 75 50 kg bags of maize for sale later in the year. Their method of minimizing storage costs is ingenious: they own no warehouse or silo, instead renting two to three empty rooms per year in occupied houses to store their maize reserve. They lay mats down in the room, and put what they refer to as *chemicals* on the maize that act as a preservative. In addition to paying rent, they pay a small stipend to the homeowner to guard the maize from theft.

At the time of the interview, the brothers paid an effective rate of MK 5,500 per 50 kg bag and sold at an effective rate of MK 6,000 per 50 kg bag. They don't see ADMARC as a particularly compelling competitor, because when ADMARC comes to town it only opens depots to which farmers have to bring their produce. They feel this gives them a comparative advantage, as they are collectors (that is, they go to the farmer). Everyone in the outfit has a second job. The owner is a gas station attendant and the younger brothers all sell used shoes.

During the interview, the brothers did relate that random bans on trading maize were somewhat of a problem, particularly when a ban is announced when they have a lot of capital tied up in inventory. However, they did not see bans as a particularly large risk, stating, "We know we can always sell [the maize] eventually."

Single-Person Trader. The gentleman interviewed is currently a full-time driver. However, several years ago, he augmented his driving income by trading. He raised the capital to start trading by selling the output from three acres of hybrid maize plus some savings. His modus operandi was to rent a truck, drive to farmers outside of Lilongwe, and then sell the maize he bought from them in downtown Lilongwe. He stopped doing this when he encountered a problem fatal to his operation. When the current president came to office, she instituted a combination of policies and programs that had the net effect of dropping the market price of maize, which effectively wiped out his profit margin relative to his transportation costs. The price of maize has now risen sufficiently that he is considering reentering the trading game next year. If he does, he will not give up driving.

Source: Authors, based on interviews with stakeholders, March 2014.

EXPORT CROPS—PRODUCTION RISKS

WEATHER-RELATED RISKS

Droughts, dry spells, erratic rains, and unpredictable weather patterns are problematic for export crops, although they are affected differently. Tea yields are affected by irregular precipitation because the quantity of rainfall determines the frequency at which the plants can be plucked (twice a month during the rainy season and just once off season). One estate reported that this caused yields to drop 25 percent in 2013. For tobacco producers, dry spells are generally a problem, but so is late onset of rain because the seedlings' root-balls become too large for the tobacco to transplant well to the field, which means replanting. However, late onsets of rain do not affect production on a large scale in Malawi.

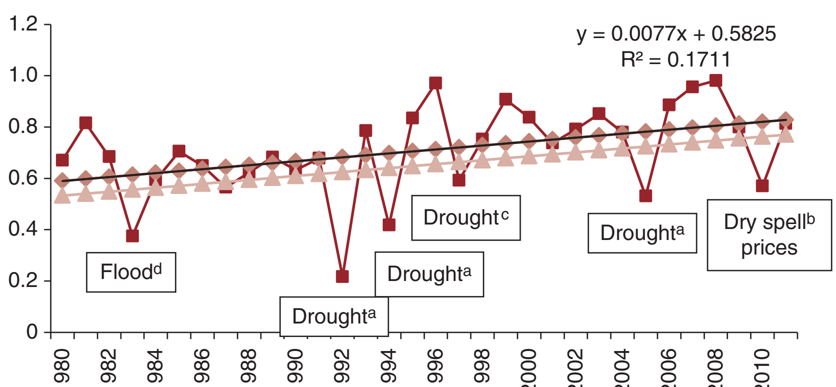
For cotton production, dry spells are common and may be damaging if they occur between the first and fourteenth week. The losses in the affected areas can be on the order of 10–50 percent. Figure 3.9 shows drops in cotton yields since 1980 and their causes.

Rainfall is not a risk for sugarcane because sugar production in Malawi is irrigated for both estates and outgrowers. Fluctuations in sugar yields can be seen prior to the mid-1990s, with a big drop in 1993. After 1997, fluctuations in yields essentially disappear as irrigation for sugar production was largely developed by Illovo when the company established in Malawi in 1997 (figure 3.10). But excess rainfall during harvest is a challenge, not because it affects yield, but because it complicates the extraction of cane from the field (trucks get stuck) and as the cane gets wet, additional power is needed at the plant to dry it, thus increasing processing cost.

PESTS AND DISEASES

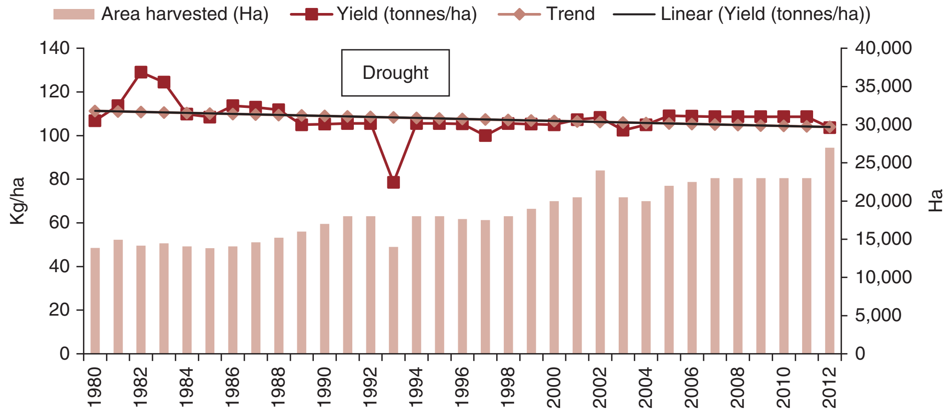
Pests and diseases are less of a problem for export crops than they are for food crops; the main pests are ballworms and aphids. Although pests and diseases exist for the four export crops, they are controlled with chemicals and at times through handpicking. For example, even small-scale sugar outgrowers who have a pest problem do not experience losses higher than 10 percent. Exceptions exist, of course: Satemwa Tea Estate claims that in 2013 a pest attack during the dry season caused the complete cessation of plucking for three months in the affected areas. This risk is considered frequent but of low impact because pests are mitigated for with small amounts of pesticides. As with food crops, the occurrence and losses of export crops also depend on agricultural practices, including the removal of infected plants, the handling of chemicals, and the use of different varieties.

FIGURE 3.9. COTTONSEED AND COTTON LINT YIELDS AND MAJOR DROUGHT EVENTS IN MALAWI, 1980–2012



a National-level droughts according to RMSI 2009; *b* Reserve Bank of Malawi. Owing to low prices in preceding years, farmers were hesitant to plant cotton; *c* Kachule 2011; *d* National-level floods, according to RMSI 2009. These floods particularly affected the southern part of the country.

FIGURE 3.10. SUGARCANE YIELDS (KG/ha) AND AREA HARVESTED (HA) IN MALAWI, 1980–2012



Source: FAOSTAT; authors' calculations.

BOX 3.5. CASE STUDY: MARY MWASE, MAIZE, AND TOBACCO FARMER MADISI

Mary Mwase has 3 acres of land on which, together with her husband, she cultivates 1 acre of tobacco, 1.5 acres of maize, and 0.5 acres of soybeans. Like many other women farmers in Madisi, Mary is engaged in other income-generating activities, such as baking doughnuts and selling cooked cassava and sweet potatoes at Madisi Main Market. When sales are good, Mary earns a gross of MK 2,250 (US$5) in 3–4 selling days. For their tobacco production, Mary and her husband received an in-kind loan of fertilizer, seed, and pesticides from Limbe Leaf Tobacco Company (LLTC—a tobacco leaf–buying company) through contract farming. For maize, they highly depend on farm inputs provided by the government under FISP. Their gross income comes mainly from tobacco sales (MK 500,000) and to a lesser extent from maize and soybean sales (MK 10,500 and MK 9,600, respectively).

At the production stage, the major risk Mary and her husband face is erratic rains, which take different forms such as early ending of rains, late onset of rains, and dry spells in the midst of the cropping season (see the accompanying table). Mary believes changes in rainfall are due to poor management of the local vegetation, which has resulted in careless cutting down of trees in the area. She recalls that when she was a girl, the area had a lot of trees and vegetation, and rainfall was not a problem, unlike now. Because her maize, tobacco, and soybeans are rain fed, the changing rainfall patterns have negatively affected her crops' output. Mary also mentioned pests, and especially armyworms, as serious production risks for many crops in Madisi.

Mary lamented the insufficient provision of farm inputs from FISP; the prices for farm inputs, especially fertilizer that she uses, have varied widely over the past 10 years. For example, fertilizer prices oscillated from MK 4,000 per 50 kg bag in 2008 to MK 15,500 in 2013, making it difficult for her to use sufficient amounts. She also wondered why fertilizer and other inputs for tobacco production are not subsidized. Mary said she is happy with the way the maize industry is regulated, especially by ADMARC, because whenever she runs short of food (maize) during the lean months (December to March), she is able to buy maize from ADMARC at a lower price than from vendors.

TABLE B3.5.1. RISK EVENTS IN ORDER OF IMPORTANCE ACCORDING TO MARY

	Affected Crop	Frequency	Impact
Late onset of rains	Maize Tobacco	Frequent	20%–30% crop loss
Farm inputs' price volatility	Maize Tobacco	Frequent	40%–70% yield loss
Early ending of rains	Maize Tobacco Soybeans	Frequent	20%–30% crop loss
Pests and diseases	Maize Tobacco Soybeans	Occasionally	5%–10 % crop loss

The major risk-management strategies adopted by Mary and her husband include mitigation through contract farming with LLTC, use of early maturing varieties especially in maize production, and chemical applications to control pests and diseases. Mary had no strategies to cope with erratic rains.

Source: Author interview with Mary Mwase.

HAILSTORMS

Hailstorms are a problem for tobacco producers, but although they tend to be devastating where they strike, they are highly localized. They damage a limited number of hectares of crop rather than a region or even a village. The interview with farmer Mary Mwase in box 3.5 exemplifies some of the production risks facing small-scale producers in Malawi and practices used to mitigate for these risks.

EXPORT CROPS—MARKET RISKS

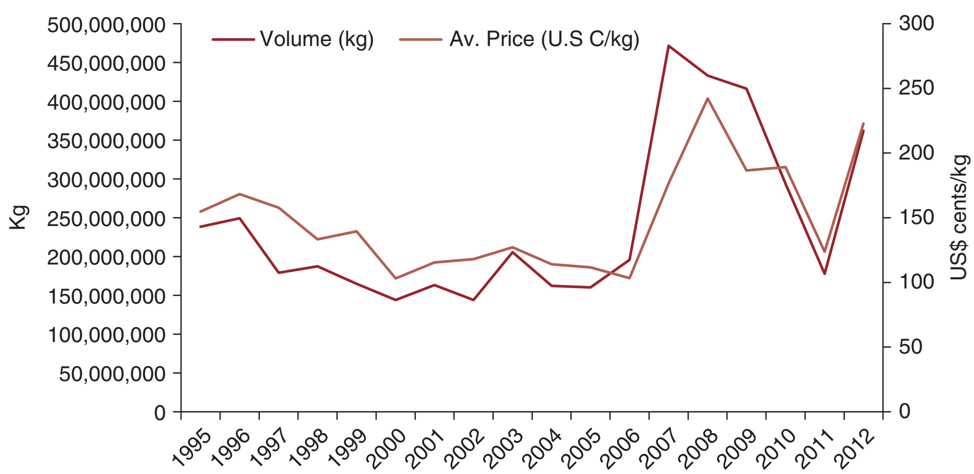
PRICE VOLATILITY

Price volatility is an important market risk throughout the tobacco supply chain and although prices to a certain extent follow international price trends, price volatility is largely a result of changes in domestic supply. Farmers tend to take production decisions on the basis of the prices obtained at auction in the previous year, allocating more or less land to tobacco at the expense or advantage of other cash and food crops. High prices the year before drive an increase in production and supply at the auction, whereas prices perceived as low the previous year cause farmers to restrain tobacco production. Because demand, in turn, tends to be far more stable from one year to the next, the result is continuing price and production volatility. Figure 3.11 shows the clear relationship between tobacco sales in the auction and the previous year's auction price—the correlation coefficient is 84 percent. In addition, due to the great importance of tobacco production to so many smallholder farmers, these decisions affect the performance of other crops' markets.

A reserve (minimum) price is fixed every year just before the start of the buying season, posing a risk to farmers who have already made their production decisions. In theory, the reserve prices are fixed at a level that covers the farming cost and allows for a 50 percent profit margin. However, farmers complain that this minimum price is announced too late, when they have already made production decisions and incurred most production costs. In sum, late reserve price announcements do not contribute to stabilizing prices and supply.

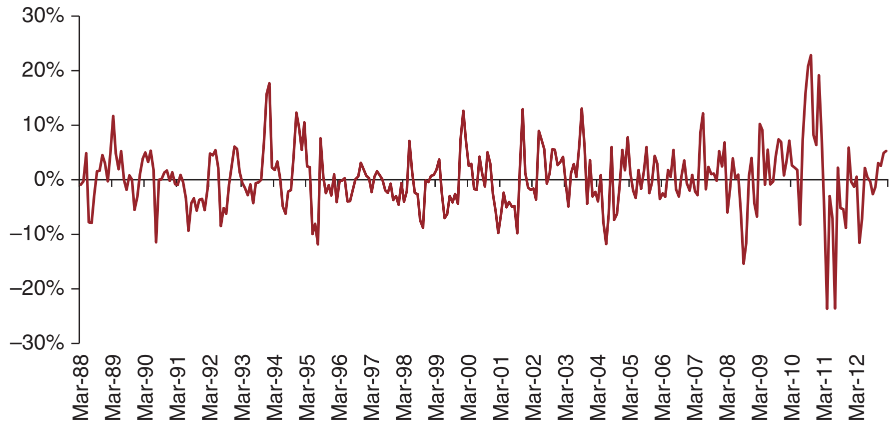
Price volatility is also very high in cotton, affecting both ginners and farmers. Figure 3.12 shows international cotton price changes. A minimum procurement price is fixed before harvest in an agreement between ginners, farmers' associations, and the government to facilitate transactions between farmers and ginners and to assure returns that recover farmers' production costs. Drops in international prices (export prices for ginners) may result in significant disturbance of the domestic market, reduce demand from ginners at the minimum price, incentivize farmers to side-sell, and even cause some ginners to stop buying. According to the Reserve Bank of Malawi, in addition to

FIGURE 3.11. AVERAGE AUCTION PRICE (U.S. CENTS/kg) AND VOLUME (kg) OF TOBACCO SOLD, LAGGED ONE YEAR, 1995–2012



Source: Tobacco Control Commission (TCC).

FIGURE 3.12. ANNUAL COTTON PRICE CHANGE (%) IN MALAWI, 1988–2012



Source: http://www.cotlook.com.
Note: Cotton, Cotlook "A Index," Middling 1-3/32 inch staple, CFR Far Eastern ports, U.S. cents/lb.

the dry spell, the decline [of cotton production in 2010] is attributed to lower prices offered in the preceding season that resulted in the pulling out of a lot of farmers from growing the crop. Farmers would like to have a guaranteed price at planting but this is not consistent with the high volatility of international prices.

An effect of this is increased side-selling to ginners that have lower operating costs and are willing to pay higher prices. Traditionally, a few ginners with large processing facilities have dominated Malawi's cotton market. These ginners both supplied inputs and provided extension services to cotton producers. Extension services were offered for "free," the cost recovered through the price offered to farmers. Recently, new ginners have entered the market that do not provide services to producers and therefore can offer higher prices for cotton. With the government providing cotton inputs, fewer ties exist between producers and the three traditional ginners. This presents a risk for them because they no longer have reliable sources of cotton and therefore risk working at lower than optimal capacity. It is noted that since 2005, the government has supplied inputs to the cotton sector in 2007/08, 2008/09, 2011/12, 2012/13, and 2013/14, an unpredictable event for stakeholders in the past.

Limited buyers at the Blantyre tea auction make tea prices unpredictable and volatile. The auction in Blantyre is run by two brokers and usually there are not more than five active buyers (multinational companies). At times, there are as few as two buyers, resulting in limited competition and high price volatilities at the auction. Because of this, estates prefer to make direct contracts with buyers in the consuming countries, which in general means not only more stable but also higher prices. The proportion of direct sales versus auction sales varies between estates, and thus their exposure to price risks does too. For example, Eastern Produce sells most of its produce through contracts all over the world, whereas Satemwa, a small estate, sells 80 percent of its produce at the Blantyre auction.

Uncertainty about selling prices is the most important risk for smallholder sugar farmers associated in trusts. The price at which the trusts start selling to Illovo is decided at the beginning of the marketing season but is continuously adjusted according to variation in the exchange rate, inflation rate, and interest rate (box 3.6). The function used to make the price adjustments on the basis of those variables is seemingly unknown to stakeholders, including the farmers' organization (trust) interviewed for this analysis (Kasinthula). The leaders of the farmers' organization would like to see greater transparency and participation in the pricing process.

For tea outgrowers, the price volatility risk is especially related to exchange rate volatility (see box 3.7). In fact, the outgrowers' selling price is agreed with the estates on the basis of negotiations between the tea growers' association and the estates' association, but very often the "agreed" price does not meet farmers' expectations. At

BOX 3.6. SUGAR PRICES

Farmers are paid every month 85 percent of the amount due resulting from the average of the current and previous month's prices. This average price at which the trust submits its production to Illovo varies greatly from month to month and, at the end of the marketing year, is calculated as the average over all months (the marketing year average). This is the price used for finally settling the bill for the sales of the entire marketing year. The trust, in turn, pays a fixed monthly amount to the member farmers (MK 34,000 currently or a different amount depending on the arrangements regarding the repayment of each farm's development loans) and a final bonus at the end of the year.

The Kasinthula Cane Growers Ltd., the trust interviewed by the mission, has distributed benefits in only one year since it was created in 1997. This bonus (15 percent) could even be negative if the final price is lower than the accumulated monthly payments. All costs (transportation, inputs, and so on) are deducted from farmers' final payment, so the exchange rate is a relevant risk.

FIGURE B3.6.1. ANNUAL PRICES SUGAR AND SUCROSE (2006–14)

present, the base price is fixed at US$0.13/kg of green leaf, paid to farmers in Malawi kwachas. Then the estates pay a bonus twice a year calculated on the basis of the final selling price and the industrial costs. At the time of the interview (March 2014), the most recent price was MK 17/kg. The exchange rate variation is a risk for farmers as it affects both their returns and the cost of inputs supplied by estates, which are also denominated in foreign currency.

EXPORT CROPS—ENABLING ENVIRONMENT RISKS

The macroeconomic environment constitutes a constant risk to the export sector. Malawi faced serious macroeconomic challenges in 2011 and 2012 as a result of policies that led to a growing fiscal deficit, rising inflation, and the depletion of international gross reserves in the context of an overvalued exchange rate. The government that came to power in April 2012 has instituted macroeconomic policy adjustments to address the imbalances (see box 3.7), including devaluation of the Malawi kwacha and a move toward a flexible exchange rate regime. The immediate result was a period of great exchange rate volatility and a sense of financial instability among farmers and other actors in the tobacco and other supply chains.

Although there are signs that these reforms have started yielding results, economic recovery is fragile and the exchange rate may take time to stabilize given the excess demand for foreign exchange. As long as instability continues to fuel shocks (input-product price imbalances), financial risk will exist along the agricultural supply chains, caused by the variable exchange rate. In effect, the exchange rate has been very volatile since mid-2012 when the kwacha was devaluated.

GOVERNMENT INPUT DISTRIBUTION

Delays in the supply and insufficient quantities of government-provided inputs are an important enabling environment risk for cotton producers. Cotton inputs (seeds and chemicals) have been supplied by the government for a few years now.[6] Cotton inputs used to be provided by ginneries on a loan basis—a system that provided incentives for both ginners and farmers to be efficient in distributing and using inputs, as ginners were interested in obtaining as much raw material as possible and farmers had to attain levels of production compatible with the loan repayment needs. Moreover, that system stimulated loyalty between buyers and farmers and therefore promised to establish longer-term agreements. The success of the government input supply program depends upon the government's logistics for assuring the timely arrival of inputs (seeds in particular), the ginners' distributing capacity, and sufficient quantities of chemicals for each farmer. Farmers interviewed for this report declared that they preferred the previous system (input sales by ginners) as distribution was more effective and timely. When inputs, particularly seeds, do not arrive on time, farmers

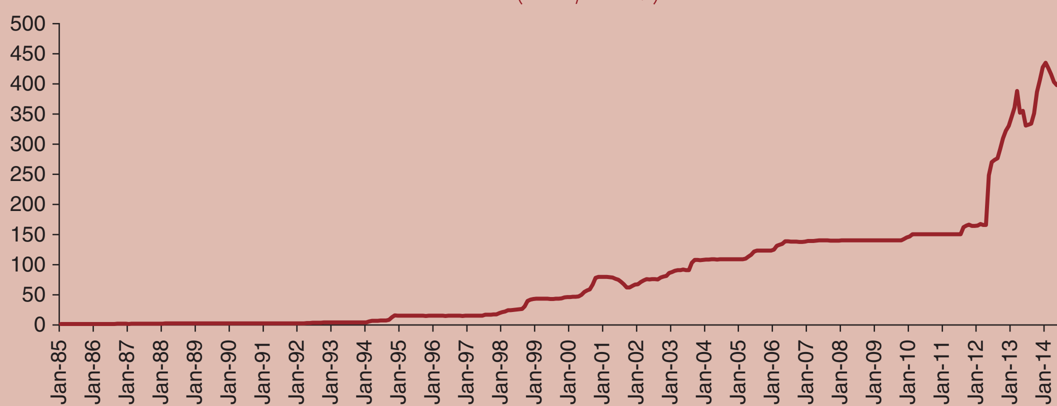
[6] Under the FISP, the government provided cottonseed and chemicals in the 2007–08 and 2008–09 seasons, and since 2011.

BOX 3.7. RECENT MACROECONOMIC REFORMS

During the period 2006–10, Malawi experienced strong economic growth averaging 7.1 percent. Since 2009, however, the economic situation has worsened as a result of inappropriate macroeconomic policies, including rising budget deficits in an environment where the exchange rate was overvalued. These policy distortions contributed to a severe shortage of foreign exchange, which affected the availability of basic goods and production inputs, including fuel, and higher inflation (see accompanying figures).

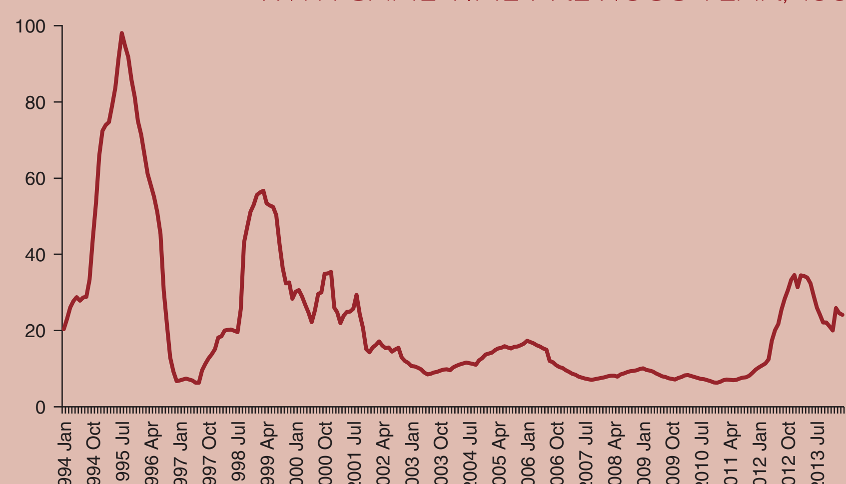
Since April 2012, the new government has undertaken significant economic and governance reforms to address Malawi's macroeconomic imbalances and resumption of donor support. In May 2012, for example, the kwacha was devalued by 49 percent (from MK 167 to MK 250 to the U.S. dollar) and subsequently floated. A tight monetary and fiscal policy was imposed. Other reform measures included: removal of subsidies on fuel; cancellation of requirements for prior approval and pre-vetting of all imports in excess of US$50,000; and the reversal of surrender requirements on tobacco dollars, according to African Development Bank (AfDB 2013). The high cost of finance remains a major obstacle to doing business in Malawi as the Reserve Bank's key bank rate is very high. At the time of the study, the macroeconomic conditions seemed to be worsening as the revelation of massive looting of public funds in 2013 is making continuation of general budgetary support by donors difficult. About 40 percent of the national budget is financed by donors, under the Common Approach to Budgetary Support (CABS), which includes the AfDB, European Union (EU), Germany, Norway, the United Kingdom, and the World Bank.

FIGURE B3.7.1. EXCHANGE RATE (MK/US$) BY MONTH, 1985–2014



Source: Reserve Bank of Malawi.

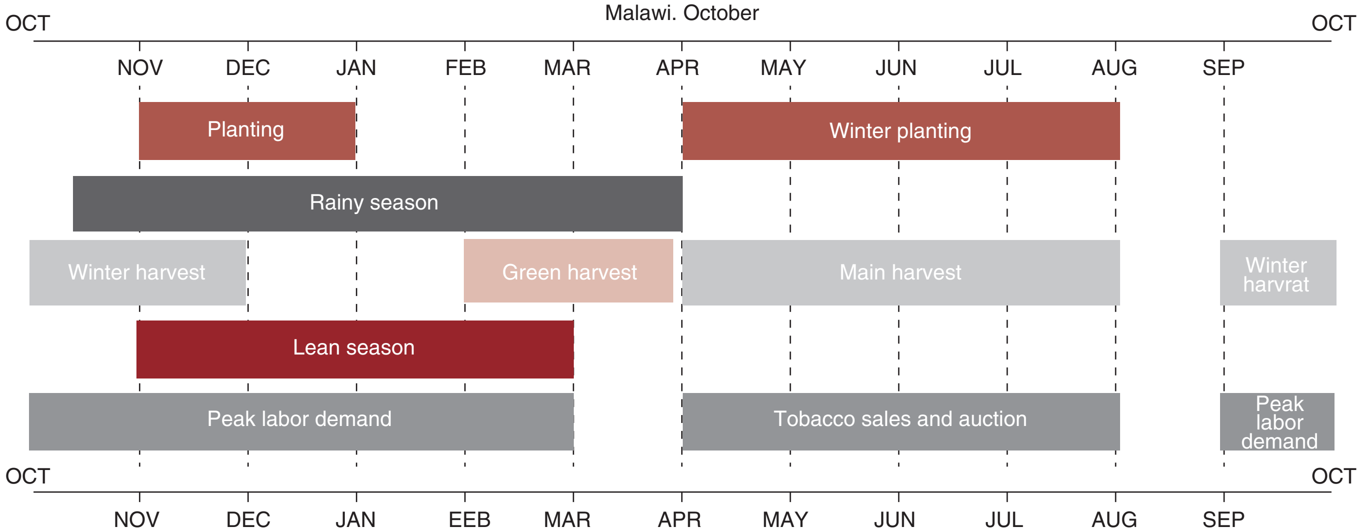
FIGURE B3.7.2. CHANGES IN CONSUMER PRICES COMPARED WITH SAME TIME PREVIOUS YEAR, 1994–2013



Source: IMF, International Financial Statistics, accessed June 13, 2014.

Sources: AfDB 2013; Reserve Bank of Malawi 2014.

FIGURE 3.13. CROP CALENDAR FOR MALAWI



Source: USAID 2013.

tend to shift to other crops. In addition, if farmers don't get the quantities of chemicals required for the actual planted area, they may lose part of the harvest to pests. Under the current government distribution program, quantities distributed should be determined according to plot size but this is not usually the case and farmers often get less than they need. This is a risk for both farmers and ginners.

POWER OUTAGES

Especially for tea and sugar production, power outages are a problem. For sugar outgrowers, the problem is interrupted irrigation, which eventually leads to yield losses. For Illovo, this is less of a problem as the company has its own power generating plant. Power outages also affect the functioning of tea-processing plants and can seriously damage sensitive tea. It was reported that power outages occur two or three times a week and sometimes last up to 12 hours. The tea-processing plants have their own power generators but their use represents a considerable increase in the cost of tea processing.

THEFT

Just as for food crops, theft is a problem for tea and sugar producers. This happens both on the processing sites and during transportation. Illovo reported that as much as 3,000 tons were lost last year and managers from Eastern Produce Malawi Ltd. reported that a tea shipment of 13 containers was stolen on its way to the Port of Beira in Mozambique in 2013. The cost is not only that of the lost products but also the increased costs for security arrangements.

REJECTED SHIPMENTS

Although rare, tobacco shipments are sometimes rejected because they are contaminated with banned substances. To ensure that no pesticide residue is found in the tobacco bought, a sampling analysis of tobacco sold in the auction is conducted. However, at times the samples do not reflect the quality of the full batch of tobacco and residue is found upon the tobacco's arrival at the importer, so the shipment is returned to Malawi. According to the Tobacco Control Commission, a regulatory body, this is not common, but when it happens it has devastating consequences for the exporters.

WEATHER-YIELD ANALYSIS

To determine whether and the extent to which yield is affected by climatic events, a study was conducted on the relationship that several climatic events have on different crops' yield for Malawi. Daily weather data from 1961 to 2011 from 23 weather stations across Malawi were used, correlated with disaggregate yield data for cassava and maize for 1984–2012. To understand the impact of weather volatilities in different periods on yield, the crop calendars for maize and cassava were used (figure 3.13).

Precipitation in Malawi follows a very clear pattern, with one rainy season from November to March and one dry season from May to September. All regions within the country follow this pattern, with few variations. Over the year, each crop goes through sowing, growing, and harvesting phases.

Two different rainfall parameters were estimated for each of the three phases:

» **Cumulative rainfall:** the sum of daily precipitation in mm for each phase; and
» **Number of rainy events:** the number of days in the phase in which rainfall is greater than 5 mm.

Maize: The relationship between cumulative rainfall and number of rainy events and maize yield is not significant, except in the Salima region, where the number of rainy events for the harvesting phase explains 25 percent of yield variability. However, because most of the determination coefficients are very small, a multiple linear model was also run. According to the results, cumulative rainfall significantly explained variability ($R^2 > 20\%$) in maize yield only for Salima and Shire Valley. In Salima, rainy events indexes help explain yield, whereas in the Shire Valley, cumulative rainfall through the three phases best explains yield.

Except in the Salima and Shire Valley regions, there is no linear yield trend for maize but rather two different yield levels with a cutoff point after year 2005. The fact that yields are almost twice as high from 2006 and onward (yield went from 1.1 MT/ha before 2005 to 1.95 MT/ha the year after) may explain why rainfall is not correlated much with the variability of maize yield in the period examined. To test for this, yields were kept constant. Indeed, these results show that rain explains a certain amount of variability in yield. Particularly worth noting is that both cumulative rainfall and rainy events during the harvesting phase help explain more yield variance in almost all regions. The exceptions are Blantyre, Karonga, and Kasungu, where the proportion of variance explained is less than 15 percent.

Similar to maize, cassava experienced a jump in yield, as the mean yield went from 3.8 MT/ha to 16.7 MT/ha at the turn of the century. Thus, yields were also standardized for cassava, but the result is less clear than for maize; rainfall explains very little of the variability in cassava yield. The cumulative rainfall in the three phases helps explain about 30 percent of yield variability in Blantyre, and indicates that the more rain, the better the yield in this region. It is clear that the best production years were the most humid ones, whereas the worst years had the least rainfall. The three driest years, 2004–05, 1994–95, and 1991–92 (when about 600 mm fell throughout the whole seven month period), match some of the lowest production years, so drought can be considered the main threat in this region. But for the other regions, the relationship between rainfall and cassava yield is not as strong.

In summary, drought during the harvesting phase (March–April) helps explain most of the variability in maize yield, particularly during the shock years of 1991–92, 1993–94, and 2004–05. This applies for most of the country. However, applying rainfall data and rainy event information on the three phases in cassava production does not significantly explain cassava yield variability over the period studied (that is, 1984–2011). Nevertheless, it was found that the droughts during 1991–92, 1993–94, and 2004–05 were the cause of low cassava yield, particularly in the Shire Valley.

CHAPTER FOUR
ADVERSE IMPACT OF AGRICULTURAL RISK

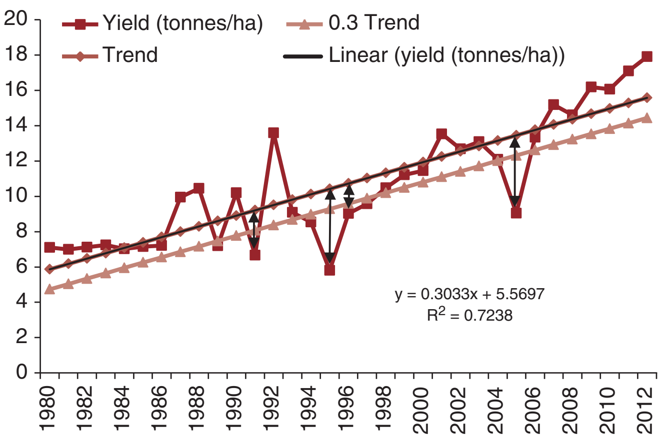
OVERALL AGRICULTURAL LOSSES

Although the previous chapter provides a good overview of the types of risks present in Malawi, for policy purposes it is important to understand their impacts in terms of the magnitude of losses, geographic occurrence, and stakeholders affected. Without knowing how much the impacts of risks cost, where they occur, or whom they affect, it is difficult to target often limited resources in a manner that effectively minimizes the impacts. This chapter attempts to quantify losses in the sector that are larger than what could be considered as normal, to compare production and losses between regions, and to map how this affects different stakeholders in the agriculture sector.

The quantification of losses captures production risks such as drought and pest and disease outbreaks. The indicative value of agricultural output lost for particular years (when yields are below one-third of the standard deviation of the long-term trend) is calculated as the deviation of the actual yield from a historic yield trend multiplied by the actual area that year. The production value is then multiplied with current producer prices and converted into US dollars at the prevalent exchange rate. Indicative loss values are also compared with agricultural GDP to provide a relative measure of the loss. Figure 4.1 shows the basis for estimating indicative losses. The dark red curve is the yield, the lighter red dotted line is the long-term trend, and the pink line with triangular shapes marks one-third of the standard deviation. Losses are measured in years where they fall below this point (denoted by the arrows in the figure).

Table 4.1 shows the average annual losses from production risks for selected crops. The annual risk-related losses amount to US$149 million on average, or 3.98 percent of the total annual agricultural production value in Malawi. Almost 30 percent of losses is from maize, which suggests the great impact of agricultural production risks on smallholder households' food security. Similarly, cassava and potatoes account for 26 percent and 13 percent, respectively, of total annual losses. Tobacco also forms an important part of the agricultural economy and many smallholders have a significant part of their cash income compromised as a result of tobacco production losses, which account for 10 percent of total agricultural losses. These figures do not take into account losses caused postharvest, by price volatility, for example.

FIGURE 4.1. EXAMPLE OF HOW INDICATIVE LOSSES ARE CALCULATED



Although the average annual losses are high, the impacts of the individual shocks are even more devastating. Average figures are useful to understand the aggregate costs of production risk, yet they tend to conceal the catastrophic impact that some shocks have on participants in the sector at the time they occur. Shocks have an impact on household and national food security, have important fiscal repercussions, reduce the availability of foreign exchange, and have an overall macroeconomic destabilizing effect. Chapter 2 showed the high correlation between agricultural and national GDP. For instance, during the 2001 drought, losses amounted to US$161 million, or 4.3 percent of total agricultural production value, and in 2005 to nearly US$900 million, 24 percent of total agricultural production (2006–08 average). Figure 4.2 shows the magnitude of losses for individual years, where the size of the circle depicts the losses as a share of total agricultural production value.

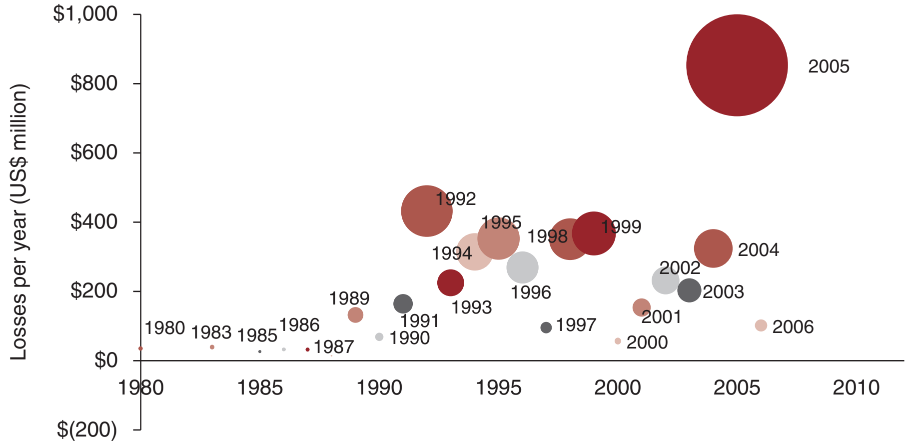
The losses in terms of the normal production value were extreme for important smallholder crops such as maize and tobacco (50 percent in maize in 2005), which means disastrous impacts on household incomes, food security, and well-being. Because of the contribution to

TABLE 4.1. LOSSES FROM AGRICULTURAL PRODUCTION RISKS, 1980–2012

Crop	Average Annual Losses (MT)	Average Annual Losses (US$)	Annual % Loss of Ag. Production (2006–08 Prices)	Total Losses (MT)	Total Losses (US$)
Cassava	147,719	45,010,044	1.21	4,874,734	1,485,331,478
Maize	183,711	40,545,037	1.09	6,062,465	1,337,986,237
Potatoes	52,047	19,062,320	0.51	1,717,541	629,056,577
Sugarcane	27,956	3,628,714	0.10	922,548	119,747,574
Beans, dry	5,941	5,739,877	0.15	196,069	189,415,972
Rice, paddy	3,038	2,522,431	0.07	100,257	83,240,235
Tobacco	8,431	14,672,960	0.39	269,779	469,534,740
Pigeon peas	4,771	2,225,235	0.06	157,459	73,432,773
Groundnuts, with shells	7,612	7,295,940	0.20	251,203	240,766,028.02
Bananas	5,456	1,842,499	0.05	174,579	58,959,956
Tea	1,760	2,074,786	0.06	56,327	66,393,164
Cotton	2,851	4,090,601	0.11	91,241	130,899,241
TOTAL	**451,294**	**148,710,449**	**3.98**	**14,874,205**	**4,884,763,980**

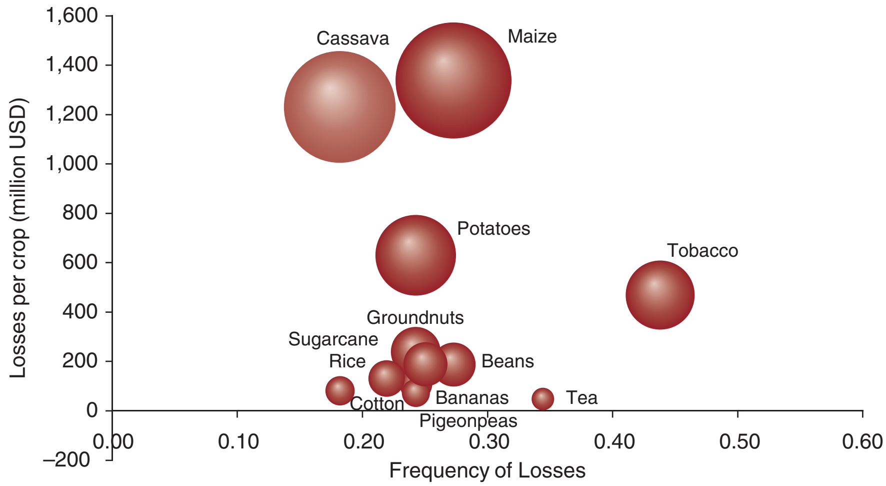
Source: FAOSTAT; authors' calculation.

FIGURE 4.2. VALUE OF PRODUCTION LOSSES PER YEAR AS A SHARE OF TOTAL AGRICULTURAL PRODUCTION VALUE



Source: FAOSTAT; authors' calculations.

FIGURE 4.3. VALUE AND FREQUENCY OF LOSSES PER CROP, 1980–2012



agricultural production value, the magnitude of the losses when shocks occur is much greater for some crops than others. Thus, maize, cassava, potatoes, and tobacco have the highest average annual losses (figure 4.3).[7] However, tobacco and tea incur losses the most frequently, meaning that farmers involved in these sectors are highly exposed to shocks.

[7] The cassava loss estimates are based on national yield data and should be adjusted if the national cassava yield data from 1980 to 2012 are revised.

PRODUCTION VOLATILITY BY REGION

The relative production volatility among different regions is measured using the coefficient of variation[8] (CV) of yield. Because of the limited available data for other crops, only maize and cassava were analyzed.

[8] Calculated as the standard deviation divided by the series arithmetic media. It shows the extent of variability relative to the population mean: the higher the CV, the higher the variability.

MAP 4.1. MALAWI'S EIGHT AGRICULTURAL DEVELOPMENT DIVISIONS

Source: USAID.

Malawi's eight ADDs were used to analyze the differences in production volatility. The demarcation is shown in map 4.1.

Maize production volatilities are fairly even across ADDs. Blantyre showed the highest variation, with a CV of 48 percent, and Kasungu the lowest, with 31 percent (table 4.2). The ADDs of Lilongwe and Kasungu, which have the largest extensions of land cultivated to maize (almost 50 percent of the country's total), exhibit relatively similar production volatility (CVs of 36 percent and 31 percent, respectively).

However, owing to the different output levels produced in each region, these variations have different impacts on total production. The ADDs produce a total of 2,016,170 MT of maize annually, but yield and area harvested vary significantly between ADDs (table 4.2). Seventy percent of Malawi's maize production is grown in three ADDs, Blantyre, Lilongwe, and Kasungu, and 90 percent in five ADDs if Machinga and Muzuzu are included. Losses as a share of national production are largest in Kasungu, Lilongwe, Blantyre, and Michnga, which together account for over 9 percent of total production losses annually, and 80 percent of total maize losses in Malawi.

TABLE 4.2. MAIZE PRODUCTION BY AGRICULTURAL DEVELOPMENT DIVISION IN MALAWI, 1983–2013

ADD	Share of Production (% of Total, 2009–12)	Area Harvested (% of Total, 2009–12)	Yield 2009–12 Average (MT/ha)	Average Annual Losses (MT)	Average Annual Losses as % of Total National Production	CV of Yield (%)
Blantyre	14.5	16	1.9	36,955	1.8	48
Karonga	4.2	3	2.7	5,798	0.3	44
Salima	4.5	4	2.5	13,905	0.7	41
Lilongwe	25.5	24	2.3	53,734	2.7	36
Mzuzu	9.5	9	2.2	18,303	0.9	34
Machinga	10	16	1.3	26,469	1.3	34
Shire Valley	1.9	4	1.1	6,476	0.3	34
Kasungu	29.9	24	2.7	67,967	3.4	31
Total	**100**	**100**	**–**	**229,607**	**11.4**	**–**

Source: Data from MAFS 2013 Annual Statistical Bulletin.

TABLE 4.3. CASSAVA PRODUCTION BY AGRICULTURAL DEVELOPMENT DIVISION IN MALAWI, 1983–2013

ADD	Share of Production (% of Total, 2009–12)	Area Harvested (% of Total, 2009–12)	Yield 2009–12 Average (MT/ha)	Average Annual Losses (MT)	Average Annual Losses as % of Total National Production	CV of Yield (%)
Karonga	25.3	18.7	9.923	13,136	0.9	80.6
Mzuzu	19.2	20.9	12.609	26,965	1.9	82.6
Kasungu	17.8	16.8	8.750	6,068	0.4	80.6
Lilongwe	8.9	13	7.427	5,846	0.4	77.7
Salima	9.2	9.6	10.788	20,138	1.4	78.6
Machinga	7.5	8.5	7.032	14,997	1.1	76.2
Blantyre	11. 7	11.7	7.397	42,874	3.0	89.7
Shire Valley	0.5	0.8	7.195	1,554	0.1	69.4
Total	**100**	**100**	**–**	**131,577**	**9.2**	**–**

Cassava shows similar differences in losses between ADDs although the CVs are high in all of them (table 4.3). The high CVs are likely due to the great jump in cassava yields in early 2000. Total annual cassava production is 1,421,327 MT and four ADDs account for about three-quarters of the production: Karonga, Mzuzu, Kasungu, and Blantyre. However, two regions alone account for half of national losses: Blantyre (3 percent of total production) and Mzuzu (1.9 percent). If Salima and Machinga are included, these four regions jointly account for over 80 percent of total annual cassava losses in Malawi. This despite the fact that neither Salima nor Machinga belong to the top cassava-producing ADDs in Malawi.

THE IMPACTS OF AGRICULTURAL RISKS ON DIFFERENT STAKEHOLDERS

How the losses are distributed among stakeholders along the supply chains is, to a great extent, a function of supply chain governance and stakeholders' capability and opportunities for risk management. Smallholder farmers are the most vulnerable segment in the supply chains. Their production and price risk-management strategies, usually based on low-risk and low-yield strategies, tend to result in poor capital buildup and below-potential production levels. Primary farmers' organizations (clubs, trusts, cooperatives) are also a very weak segment in the supply chain. Great product price variations (cotton), multipayment systems (sugarcane), and variable input costs expose them to recurrent financial losses. They tend to have fragile financial structures (sugarcane trusts, for instance) and sometimes rely on credit to finance their operations, thereby increasing their long-term commitments and risks. Estates, exporters, millers, and large trading companies are in general less directly exposed to production risks and are able to hedge prices globally. Table 4.4 summarizes stakeholders' risk profile and their current management patterns.

VULNERABLE GROUPS

Vulnerability to agricultural risk is high across Malawi.[9] Throughout the country, the main source of food is own crop production. Both cash and food crops are important sources of cash for households, which is important because home food production is often supplemented by food purchased from local markets. Poor households also

[9] The term "vulnerability" is used here to describe exposure to hazards and shocks. Literature highlights the fact that vulnerability is a product of two components: exposure to a hazard (a shock) and resilience (the ability to manage the hazard) (Devereux et al. 2007).

TABLE 4.4. STAKEHOLDER RISK PROFILES FOR FOOD AND EXPORT CROP SUPPLY CHAINS

Stakeholder	Most Common Risks	Significance of Risk	Current Risk Management
Smallholder farmers	Weather risks (erratic rains, drought, and so on)	Weather is a major risk for smallholders. It mostly affects food production. Cash/export crops are generally cultivated in appropriate agroecological zones and sometimes protected by irrigation (sugarcane) contract farming arrangements that assure drought-tolerant varieties and other best practices (tea, partially).	Appropriate drought-tolerant varieties and crop diversification to drought-tolerant crops (such as sorghum) are the most common, though not widespread, risk-management strategies.
Smallholder farmers	Pests and diseases	Pests and diseases can be controlled, and therefore risks are limited, if technological knowledge and resources are available. This is especially problematic for food crop producers, as cash crop producers have better access to mitigating instruments.	Mitigation capacity is higher among export crop producers under the umbrella of contract farming.
Smallholder farmers' organizations (clubs, trusts, cooperatives)	Same risks as smallholder farmers (above) plus a financial risk	Production, price, and exchange rate risks have financial repercussions on the organizations' finances and may jeopardize their existence.	Farmers' organizations provide production and marketing services (technical assistance, input financing, and so on) that tend to reduce farmers' risks, mostly production risks, but increase their exposure to financial risk.
Grain traders	Price risks Trade bans	Artificial price stabilization mechanisms derail prices from their normal pattern, which results in an unpredictable investment climate and potential losses on investments. Unforeseen and/or erratic trade policies add to this because they close any alternative markets when prices are low as a result of price interventions.	Traders try to recuperate losses by pushing down farm gate prices the following season; hence farmers bear the cost of the risk in the long run.
Ginners (cotton)	Side-selling Price volatility	Ginners that are well established and have long-term contract farming arrangements (the few), including provision of production support services to farmers and price negotiation, are more exposed to side-selling risks at moments of great price drops. More speculative ginners manage to profit from price fluctuations.	Ginners need to establish long-term commitments with farmers. This is becoming difficult under the government's free and untargeted input distribution.
Estates (tea, sugar) and exporters	Market-related, particularly export price risks	By diversifying sales into export and domestic markets (sugar), auctions and direct sales (tea), hedging, and so on, estates minimize the incidence of risks.	High management capacity.

often sell their household labor (locally known as "*ganyu*") in exchange for food.[10]

This heavy reliance on agriculture and the fact that the majority of the population is dependent on rain-fed agriculture, whereas precipitation is frequently insufficient to support rain-fed food production, makes households vulnerable to shock.[11] Further, households' reliance on *ganyu* is conditional on rainfall because the *ganyu* is usually provision of farm labor. In 2007, 95 percent of the sampled households reported experiencing at least one shock in

[10] The household economy approach distinguishes the source of food mainly into "purchase," "own crops," and "*ganyu*."

[11] Shocks are defined as adverse events that lead to a loss of household welfare, such as a reduction in consumption, income, and/or a loss of productive assets (Dercon 2005).

TABLE 4.5. DISTRIBUTION OF POVERTY IN MALAWI

	Poverty Rate (% Below National Poverty Line)
National average	**50.7**
Group	
Urban	17.3
Rural	56.6
Male-headed household	49
Female-headed household	57
Geographic location	
North	54.3
Central	44.5
South	55.5
Highest: Chikwawa	81.6
Lowest: Nkhotakota	32.1

Source: Malawi Integrated Household Survey (IHS) 3 (IHS3) of 2011.

the past five years. More than 75 percent of rural households reported encountering four or more shocks in the past five years World Bank 2007).

Poor households that experience shocks are more likely to experience a decline in well-being than nonpoor households who experience the same number of shocks (Devereux et al. 2006). Studies have shown that households are vulnerable to food insecurity because of their poverty situation (Makoka and Kumwenda 2013). In particular, poverty makes them susceptible to any food-related shock because they do not have the capacity to prevent the food-insecurity shock or to manage its effects when it occurs. Table 4.5 shows the distribution of poverty in Malawi. (More details on vulnerable groups can be found in appendix C.)

Productive assets, including livestock, are an important source of livelihood, especially in the face of shocks. In some livelihood zones, such as Western Rumphi and Mzimba, Mzimba Self-Sufficient, and Lower Shire Valley, households depend on livestock as a source of food and cash. They are able to respond to shocks by increasing the sale of their livestock, and thus cushion themselves against a range of shocks. Nevertheless, most farmers lack this option and therefore remain vulnerable after a shock occurs (Christiaensen and Subbarao 2004; Dercon 2001; Makoka 2008).

GENDER STRUCTURES ADD AN ADDITIONAL LAYER OF VULNERABILITY

Women make up 70 percent of the agricultural labor force but earn less for salaried work and own fewer assets than do men. The value of assets owned by male-headed households is more than double that of female-headed households and male-headed households are more likely to own agricultural assets. Women's rate of pay for *ganyu* is likely to be only two-thirds the rate paid to men. In 2005, female-headed households had 14 percent less consumption per capita than male-headed households, making them more vulnerable to adverse impacts on production and incomes (Hay and Phiri 2008). Because of their limited possession of assets, and hence collateral, women face more difficulties than men in accessing credit, an additional obstacle to mitigating risks and recuperating from shocks. A good example is cotton production, which is heavily reliant on chemicals that in general are too expensive for women to acquire. But even in subsectors where female-headed households participate to a greater extent, gender biases against risk-mitigating investments pose a problem. This also applies to the FISP—women are reportedly subject to long queues, sometimes lasting as long as two days, before they can buy fertilizer because priority is usually given to men (Mvula 2011).

Table 4.6 shows structural differences in the type of agricultural activities performed by men and women. Ten percent of the total plots managed by men are allocated to tobacco, compared with 3 percent of plots managed by women. Reportedly, women are less likely to engage in cash crop production due to labor and time constraints; thus female-headed households allocate larger portions of their plots to local maize and pigeon peas than their male counterparts. This means that shocks to the tobacco sector disproportionately affect male-headed households, whereas shocks to maize and pigeon pea production and markets disproportionately affect female-headed households.

Equally, women often rely on vendors who come to their doorsteps because they have difficulty transporting their produce to more favorable markets. In many cases, better

TABLE 4.6. PROPORTION OF PLOTS BY TYPE OF CROP CULTIVATED AND AS A SHARE OF TOTAL CROPS, 2011

Share of Total by Crop	Local Maize (%)	OPV/ Hybrid Maize (%)	Pigeon Peas (%)	Ground-nuts (%)	Tobacco (%)	Beans (%)	Sorghum (%)	Composite Maize (%)	Rice (%)
Male	31.8	32.2	14.7	15.1	10.4	5.5	4.3	4.0	2.7
Female	45.3	29.7	21.3	17.0	3.3	6.2	6.4	3.9	3.1
Malawi	35.3	31.6	16.4	15.6	8.5	5.7	4.9	4.0	2.8
Share of crop									
Male	41	52	41	47	76	47	40	51	47
Female	59	48	59	53	24	53	60	49	53
Malawi	100	100	100	100	100	100	100	100	100

Source: Malawi IHS3 Report 2012; authors' calculations.
Note: OPV = Open pollinated variety

prices are offered at district centers, which are often far away, but women do not have the time or resources to transport their produce there. Reportedly, women also often fall prey to unreliable weighing scales in transactions with vendors.

IMPACT ON HOUSEHOLD FOOD SECURITY

For many households in Malawi, coping with shocks means changing household dietary patterns. In its study of 4,908 households in 2009, WFP (2010) reported that the most common coping strategy for various shocks was a reduction in food portion size (reported by 57 percent) followed by a reduction in the number of meals (55 percent). The Malawi government and the World Bank (2007) reported that consuming less food was the first coping strategy for about 14 percent of all households that reported experiencing a shock.

More details on vulnerability in Malawi as it relates to agricultural risks can be found in appendix C.

CHAPTER FIVE

RISK PRIORITIZATION AND MANAGEMENT

To better utilize scarce resources, it is important to understand which risks cause major shocks to the sector in terms of losses and to observe the frequency at which they occur. This chapter summarizes the risks faced by the agriculture sector and the possible solutions, as identified by the mission and validated and prioritized with stakeholders at different levels and at a workshop with MAFS in Lilongwe.

RISK PRIORITIZATION

Table 5.1 summarizes stakeholders' opinions regarding agricultural risk prioritization, defined on the basis of the probability of the event and its expected impact, for food and export crops. The darkest area of the table lists the most significant risks based on their potential to cause the greatest losses to the agriculture sector as a whole and the frequency of their occurrence for any of the crops affected.

From the risk prioritization exercise, and based on the frequency of realized risk events, their capacity to cause losses, and stakeholders' ability to manage the risks, the following emerged as the most important risks to Malawi's agriculture sector:

- Drought events
- Price volatilities and government market interventions
- Pests and diseases

PRIORITY RISK-MANAGEMENT MEASURES

The drought and diseases/pests hazards challenging Malawi confront it on a continuum of scales (for example, small, medium, and large). The vulnerability of Malawi's food crop sector to these risks is largely a result of the often-poor performance by its stakeholders, institutions, and infrastructure. Low yields, inadequate infrastructure, underfunded and low-performing supporting institutions, and unstructured markets all leave those engaged in the agriculture sector with minimal incomes and the barest capacity to cope with hazards.

The fact that Malawi's climate patterns are somewhat predictable (particularly episodes of drought at intra-seasonal, seasonal, and decadal time scales) opens up pathways

TABLE 5.1. RISK PRIORITIZATION

Likelihood \ Impact	Low	Moderate	High
Highly probable (1 in 3)	• Hailstorms • Untimely distribution of inputs (cotton) • Theft (sugarcane, tea, food crops) • Damage from wild animals • Power outage (sugarcane, tea) • Exchange rate (risk mainly for smallholders)	• Pests and diseases (food and export crops) • Price volatility and/or uncertainty (tobacco, tea, cotton, sugar) • Unpredictable regulatory environment for traders	• Drought events, including: – False start of, or shorter than normal, rainy season – Extended dry spells – Higher than average temperatures
Probable (1 in 5)	• Side-selling (cotton) • Excess rainfall, increasing harvesting and processing cost (tea, sugar) • Floods (food crops)		• Unpredictable maize market interventions causing price volatilities in the maize market (recent)
Occasional (1 in 10)		• Export shipments rejected (tobacco)	

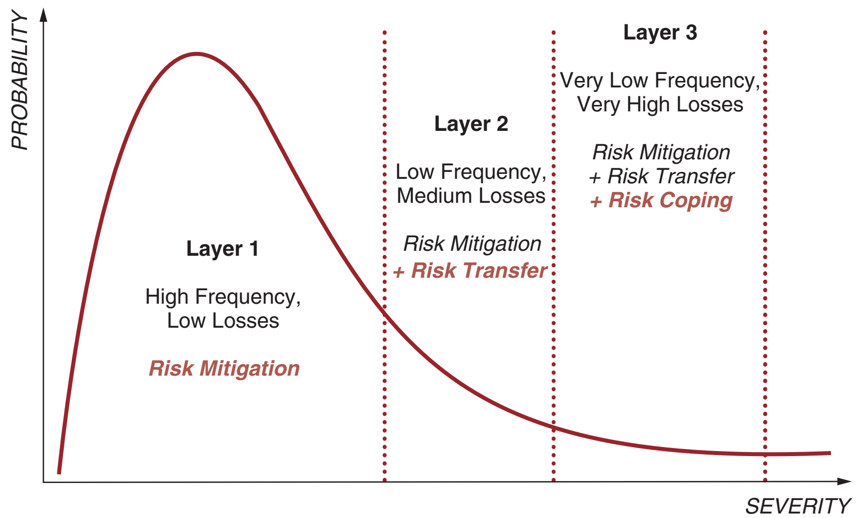
for reducing the impacts of some hazards through better use of forecasting information. Being able to predict late onset of the rainy season has allowed Malawi to institute a response farming program. The ability to reliably forecast major droughts six to seven months in advance allows the government, NGOs, and donors to reallocate resources and make plans and preparations for a response. Understanding that annual variations from climate norms and their parameters are expected can better inform risk-mitigation strategies and the design of associated investments in the future (for example, strategies around plant breeding programs, or assessment of the value proposition behind infrastructure investments such as irrigation).

The Long List of Solutions. The potential solutions identified during field interviews as well as suggested in various government and nongovernmental documents are presented in this section (table 5.2). Risk strategies are usually a combination of risk-mitigation, risk-transfer, and risk-coping instruments. Risk mitigation refers to actions taken to eliminate or reduce events from occurring or to reduce the severity of losses (for example, water-draining infrastructure, crop diversification, extension); risk transfer refers to mechanisms to transfer the risk to a willing third party at a cost (for example, insurance, re-insurance, financial hedging tools); and, risk-coping refers to actions that help cope with the losses caused by a risk event (for example, government assistance to farmers, debt restructuring). How instruments are applied for a given risk will likely depend on the probability of the risk and the severity of its impacts (figure 5.1).

ONGOING INTERVENTIONS

Juxtaposed with high production losses, costly market uncertainties, and ever-present enabling environment risks in the agriculture sector, significant financial resources are allocated to the agriculture sector under regular government programs. Malawi is one of the few countries that adhere to the commitment under the CAADP to allocate at least 10 percent of its budget to the agriculture sector. Most of this (67 percent) goes to FISP in direct input support (seeds and fertilizers). Between 2008 and 2012, the government spent on average US$12.6 million on agricultural research, US$9.1 million on extension services, and US$37.5 million on the crop production program for enhanced food security under Pillar 1 of ASWAp and US$21.5 million on irrigation under Pillar 3. Although all of these investments do not automatically mitigate risks, research, extension, and irrigation especially have the potential to do so if designed through a risk lens. because risk-mitigating practices are often win-win investments (that is, while mitigating risks they increase productivity), much of the support under FISP could also have risk-mitigating impacts depending on how the support is designed, what varieties are grown, and how fertilizers are applied.

FIGURE 5.1. STRATEGIC RISK INSTRUMENTS ACCORDING TO RISK LAYERS



Source: World Bank ARMT.

Despite all these efforts, as shown in the previous chapter, the impacts of risks remain high and significant resources are therefore allocated to coping mechanisms. In the case of disasters, such as the droughts in 2005 (when about 5 million Malawians received food aid) and in 2012 (when more than 1.63 million people received aid), coping mechanisms financed by both government and donors provide a vital safety net for people. But because of the impacts of risks on a regional and district level, the allocation of resources to ex post risk-coping mechanisms is also high in normal years when agricultural losses are reportedly low at the national level. Over the past six years, DODMA and WFP have distributed grain worth US$22.1 million, procured by the NFRA for the SGR. And since 2012, ADMARC has released subsidized grain worth US$16.5 million via the reserve. This does not include other ongoing donor projects that support coping mechanisms, which have amounted to over US$16 million annually on average over the past 10 years. Nor does it include food support provided by WFP that is not procured through the SGR. (In 2013/14, support provided by WFP reportedly amounted to about US$92 million). Minimizing the losses from agricultural risks would, thus, free up resources for other longer-term development objectives.

In addition to the government's efforts in the sector, a large number of donor-financed agricultural projects relate to risk reduction. Between 2004 and early 2013, more than 60 projects above US$1 million supported activities that could potentially have risk-reducing effects in Malawi and cover the focus crops in this report. In total, these projects amounted to some US$765 million, or about US$85 million per year. Of these, 15 projects totaling US$165 million were oriented toward coping; that is, they supported postrisk interventions. In addition, hundreds of similar projects worth less than US$1 million exist in Malawi that cover crops other than those focused on in this report.

To better understand how resources to agriculture are allocated under these projects, the categories listed in table 5.3 were investigated.

The amounts spent on mitigation and coping together with the losses from risks are not just costly, but also represent lost development opportunities: losses due to risks are lost returns on investments and productive assets for actors in the sector—money that could have reduced poverty and generated multiplier effects in the economy; instead, resources spent by the government and donors on coping mechanisms are diverted from longer-term development investments in and outside the sector.

Figure 5.2 shows the amount spent annually from the regular government budget on risk-mitigating and risk-coping mechanisms versus the amount lost due to risks on average between 2008 and 2012. Risk-management expenditures are clearly skewed toward coping mechanisms for ex post risks rather than toward ex ante, risk-mitigating

TABLE 5.2. LONG LIST OF AGRICULTURAL RISK-MANAGEMENT SOLUTIONS IDENTIFIED FOR MALAWI

Risk	Mitigation	Transfer	Coping
Food crops			
Production	Improve resilience of production to mitigate for droughts, pests, and diseases, including the following: • Strengthen ag. research for more resilient varieties • Strengthen the capacity of ag. extension services to more effectively promote and improve adoption of risk-mitigation practices among farmers • Improve water management through increased investment in infrastructure (for example, irrigation, water harvesting) • Improve access/timeliness/reliability of inputs • Introduce conservation agriculture (that is, minimum tillage) • Strengthen weather early warning systems • Introduce response farming • Use FISP to better mitigate risks • Support crop diversification / geographic optimization • Increase storage Mitigate the effects of floods: • Support reforestation and grass reclamation • Invest in water control (for example, dams, drainage infrastructure) Strengthen farmers' organizations, traders' associations, and trucking sector to bring more structure to markets and capture economies of scale Implement rural roads program to improve the quality of rural roads and reduce transportation costs	Insurance: • Macrolevel insurance • Farmer-level crop insurance through banks	• Strengthen available information and analytical capacity in relevant institutions (for example, MVAC, DODMA) to improve timeliness and effectiveness of responses through better targeting • Use improved information to plan responses more effectively and thereby improve possibilities for price hedging, budget planning, and so on for response programs • Improve management of the Strategic Grain Reserve (SGR) and ADMARC to improve predictability of interventions • Design rural food-for-work programs so that they improve or build agricultural infrastructure
Market	Minimize market interventions to eliminate market and price distortions through improved management of the SGR, including adopting transparent and predictable purchases and releases of grain Strengthen market incentives for farmers to invest in risk-mitigation practices that result in increased production and productivity Introduce warehouse receipt system		

TABLE 5.2. *continued*

Risk	Mitigation	Transfer	Coping
Food crops			
Enabling environment	Stabilize export policies (and related communication) so that market actors can operate in a predictable business environment		
Export crops			
High volatility of tobacco prices and production	Pursue production and price stability strategy, including enforcement of crop production planning, anticipated announcement of reserve prices, intensification of crop diversification program, and strengthening of contract farming arrangements (for example, reinforcement of integrated production system).	Insurance system development could be an option to production volatility, mostly if contract farming is further strengthened.	
Cotton price volatility and untimely availability of inputs	Strengthen cotton contract farming arrangements between ginners and farmers, including inputs, technical assistance, marketing, and so on. Follow a loan-based system.		
Outgrowers' price uncertainty along the extensive period of sugarcane harvesting and selling (April–November)	Support greater pricing transparency and crop and income diversification, strengthening the contract farming arrangements between Illovo and the production trusts.		
Exchange rate volatility	Continue policy reforms that address macroeconomic imbalances.		

interventions that would decrease the losses from risks. Thus potentially large savings exist in terms of avoided losses and expenditures saved on coping activities by reallocating funds to risk-mitigating activities.

The Short List of Solutions. During the risk-assessment mission, a consultative stakeholder meeting was organized to solicit feedback on the long list of solutions from private and public sector stakeholders. Participating stakeholders were asked to grade each proposed solution according to its alignment with policy or business objectives; feasibility for implementation in Malawi; affordability for the implementing party (whether public or private); potential to be scaled up; and sustainability. The feedback from stakeholders was then used with the above gap analysis to narrow the proposed solutions to a short list for a solutions assessment. Because the emphasis is placed on the more vulnerable segments of the supply chains, the proposed solutions would have a direct positive impact on reducing poverty.

As discussed above, myriad ongoing projects relate to risk in Malawi. In brief, the short list of proposed solution areas comprises the following:

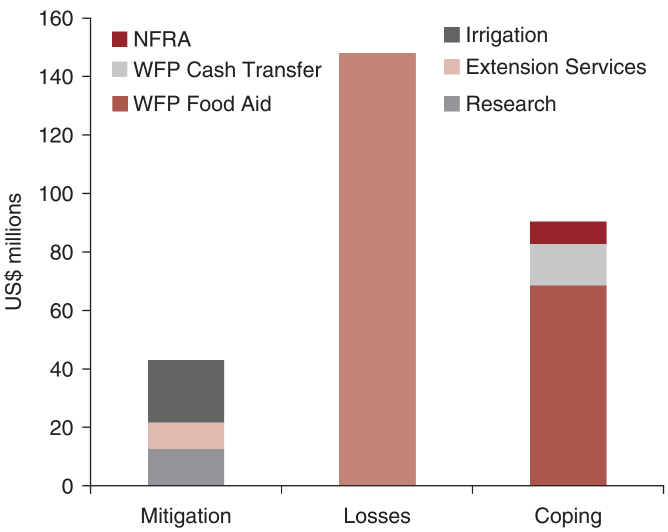
1. Map out measures to strengthen agricultural information systems so that they contain reliable data useful for the development, monitoring, and evaluation of policies, and strengthen policy analysis and monitoring and evaluation (M&E) capacity

TABLE 5.3. VALUE OF DONOR-FINANCED AGRICULTURAL PROJECTS BY TYPE OF ACTIVITY, 2004–13

Type of Mitigation Project	Value of Project (US$ Million)	Type of Coping Project	Value of Project (US$, Millions)
Irrigation	207.3	Drought and flood response	30.0
FISP	164.2	Emergency relief	78.1
Research	33.4	Grain storage	44.4
Natural resource management	25.5	Emergency preparation	4.2
Extension services	15.7	Coping and strategy support	12.0
Reforestation	4.1		
Inputs	64.4		
Production	74.9		
Adaptation	10.7		
Total	**600.1**	**Total**	**165.7**

Source: GOM Donor Database.
Note: This table captures relevant donor-funded activities (grants and loans); some of these activities are incorporated under the government's regular programs and are thus accounted for under MAFS's budget.

FIGURE 5.2. GOVERNMENT BUDGETARY EXPENSES FOR RISK-MITIGATING AND RISK-COPING INTERVENTIONS VERSUS LOSSES FROM RISKS



Source: World Bank Ag. PER 2014.
Note: Mitigation is calculated using an annual average of government expenditures from 2008–12. Losses are an annual average from 1980–2012. Coping is an annual average of NFRA expenses to the WFP, DODMA, and ADMARC, as well as the amount spent in 2014 (the only year for which information was available) for WFP food aid and cash transfer expenses.

in MAFS. Successful implementation of any risk-management instruments will depend on the ability to monitor the impacts of risks and to evaluate the effectiveness of policies and investments. An assessment could comprise the following:

» Identification of gaps in the current agricultural information system in terms of collection methods and the management of data.
» Assessment of existing equipment and information technology and a proposal for potential investments in agricultural information systems to strengthen agricultural policy development and evaluation.
» Discussion of the technical skills needed for M&E of policy and a proposal for areas for strengthening these skills within relevant departments.

2. Assess measures to improve water management for crop production to mitigate current and projected future weather-related risks. Any analysis would have to be conducted with existing land use/ownership structures in mind. An assessment could comprise one or several of the following areas:
   » The potential for expanding the use of small-scale irrigation in Malawi and possible models

under which small-scale irrigation could be promoted.
   - The scope for improving on-farm practices, including conservation agriculture and minimum tillage methods.
   - Models for investing in on-farm water harvesting infrastructure that would be applicable in the context of Malawi's agriculture sector.
3. Map existing functions and identify measures to improve the coordination between the SRG, ADMARC, and MVAC to better target existing coping mechanisms toward their intended beneficiaries, to improve predictability of interventions, and to minimize market distortions. Such work could include the following:
   - An outline of the roles and responsibilities (formal and de facto) of SGR, ADMARC, and MVAC, and proposed measures to strengthen their coordination.
   - An assessment of related food security policies, including those of trade, market interventions, and grain subsidies.
   - An analysis of the financial costs and economic impacts of these policies and if relevant, proposed alternative policies that can more efficiently achieve the same objectives without market distortions.
4. Assess opportunities for strengthening farmers' organizations for effective agricultural risk management. Many of the challenges in the sector that relate to risks, from uptake of inputs and technology to inadequate investments in postharvest infrastructure, price uncertainty, and contractual risks, could potentially be overcome through better organization of farmers. This assessment is proposed to include the following:
   - An assessment of existing farmers' organizations (formal and informal) in Malawi.
   - A compilation of lessons from initiatives to organize farmers in Malawi, successful and unsuccessful, and conclusions regarding the determinants of their success.
   - Proposals on how farmers' organizations can implement risk-management mechanisms in practice, focusing on a few specific areas such as adoption of new technology, price risks, contractual risks, and so on.

Which of these areas will be included in a solutions assessment will be determined together with the government of Malawi. Ideally, the assessments will be conducted in teams including relevant technical staff from MAFS and other technical bodies to ensure that the analyses and proposed solutions are in line with the priorities and needs of MAFS and/or other relevant institutions, and that the knowledge acquired through the assessment remains with relevant staff. Preferably, any work will include gender-disaggregated assessments and proposals.

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APPENDIX A
WEATHER-YIELD ANALYSIS

MALAWI'S POLITICAL DISTRICTS

To determine whether and the extent to which yield is affected by climatic events, a study was conducted on the relationship between several climatic events and different crops' yield for Malawi. Malawi is divided into 28 political districts, as shown in map A.1.

WEATHER INFORMATION IN MALAWI

The Malawi Meteorological Services Department's database of 23 weather stations has daily data from 1961–2011, or about 50 years of data from most of the stations. Map A.2 provides the geographic location of each weather station (red dots).

DISTRIBUTION OF MONTHLY RAINFALL IN MALAWI

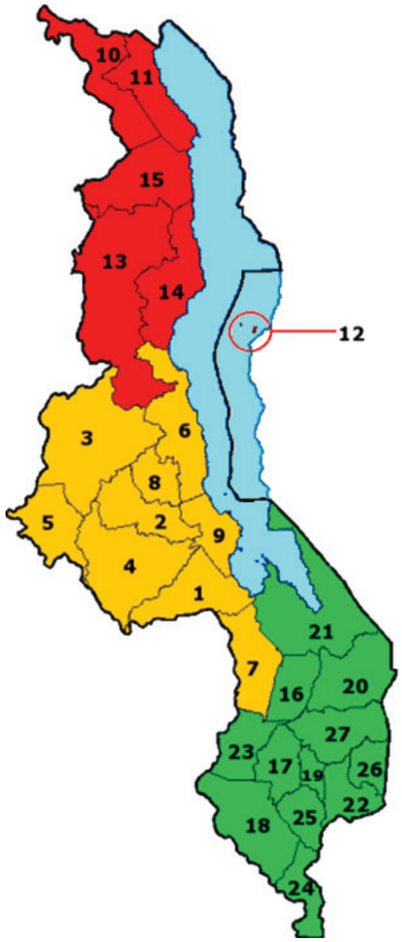
Rain in Malawi follows a clear seasonal pattern throughout the year: most of the rain falls from November to March, with the months of May–September being generally dry. The period from January to March is usually the most humid across the entire country. All regions within the country follow this pattern with few variations. Figure A.1 shows the average monthly distribution of rain for several weather stations:

The pattern is evident in all stations: most of the rain falls from November to March, with approximately 200 mm falling per month; even though the period from May to September is generally dry, some stations receive almost no rain at all during these months.

DROUGHT AND EXCESS RAINFALL ANALYSIS

Once the yearly rainfall pattern has been established, it is useful to determine the annual variability in rainfall. To determine whether a year was dry or wet, the

MAP A.1. POLITICAL DISTRICTS IN MALAWI



Source: Wikimedia Commons.
Note: Districts: 1 = Dedza, 2 = Dowa, 3 = Kasungu, 4 = Lilongwe, 5 = Mchinji, 6 = Nkhotakota, 7 = Ntcheu, 8 = Ntchisi, 9 = Salima, 10 = Chitipa, 11 = Karonga, 12 = Likoma, 13 = Mzimba, 14 = Nkhata Bay, 15 = Rumphi, 16 = Balaka, 17 = Blantyre, 18 = Chikwawa, 19 = Chiradzulu, 20 = Machinga, 21 = Mangochi, 22 = Mulanje, 23 = Mwanza, 24 = Nsanje, 25 = Thyolo, 26 = Phalombe, 27 = Zomba, 28 = Neno.

standardized cumulative rainfall was calculated for each station, according to the following formula:

$$StdRain_i = \frac{(Prec_i - \mu_i)}{\sigma_i}$$

Where

StdRain, Standardized cumulative rainfall
Prec, yearly rainfall
μ, mean yearly rainfall
σ, standard deviation of yearly rainfall
i, year

Using the standardized cumulative rainfall, drought and excess rainfall years are more clearly identified. Table A.1 shows the standardized cumulative rainfall by year and station; red blocks mean an extreme drought event (*StdRain* <−2); orange means a drought event (*StdRain* <−1); light blue means a light excess rainfall event (*StdRain* >1); and navy blue indicates an excess rainfall event (*StdRain* >2).

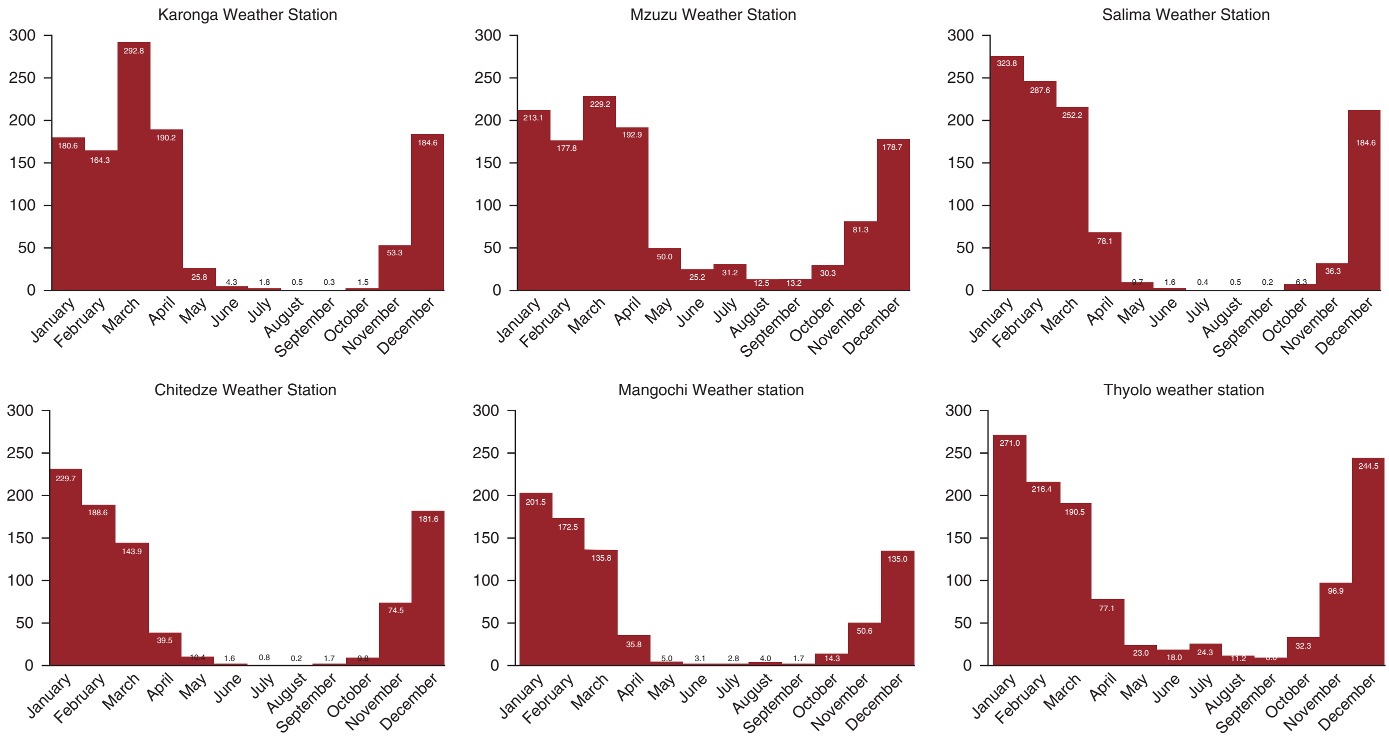
Drought years were experienced in 1966, 1973, 1975, 1983, 1987, 1990, 1992, 1994, 1995, 1998, and 2005. During these 11 years, rain was more than one standard deviation below average at least five stations. The most extreme years were 1992, 1994, and 2005, when more than 10 stations were dry. The most extreme dry year was 1992, when 17 stations received less than 1 standard deviation less rain than average. The Mimosa, Mzuzu, Chitedze, and Makoka stations experienced the most severe droughts. The most recent dry year occurred in 2005, with most stations (18) having a negative anomaly of rainfall.

Excess rainfall years were experienced in: 1961, 1962, 1963, 1974, 1976, 1978, 1979, 1980, 1984, 1985, 1986, 1989, 1996, 1997, 1999, and 2001. During these 16 years, rainfall was more than one standard deviation above average for at least five stations, meaning that rainfall was generally plenty during these years. The most severe years were 1974, 1976, 1978, 1989, and 1997. From 1974 to 1980, there was plenty of rainfall, because five of those seven years were extremely wet. The most severe year in terms of excess rainfall was 1989, when 13 stations had a positive anomaly, 6 of them extremely high. Mzimba, Chileka, Kasungu, KIA, Dedza, and Tembwe stations experienced the most rain in 1989.

RAINFALL—YIELD REGRESSIONS

A database of historical crop production information for maize and cassava was provided by the MAFS statistical bulletin. The database has 30 years of production and

FIGURE A.1. MONTHLY RAINFALL PATTERN FOR SEVERAL WEATHER STATIONS



Source: Authors, based on info from Malawi Meteorological Services Department.

surface information for eight "regions": Karonga, Mzuzu, Kasungu, Lilongwe, Salima, Machinga, Blantyre, and Shire Valley.

Because the geographic resolution of the crop data is not the same as the rainfall information, the following convention was assumed: all weather stations close to the region were used to determine a rainfall index for each region. Thus, the average of the available stations within a region were used as a proxy for each region's rainfall. Table A.2 shows which stations were used for each region.

Figure A.2 shows Malawi's sowing calendar, which corresponds to the November–March rains. Thus, three stages were used to determine the relationship between rainfall and yield: a first stage from late October to December for the sowing season; a second stage from January to February for the growing season; and a third stage from March to April for the harvesting season.

Two different rainfall parameters were estimated for each crop season (sowing, growing, and harvesting):

» *Cumulative rainfall (CumRain)*—the sum of daily precipitation in millimeters (mm) for each of the seasons described above; and
» *Number of rainy events (Events)*—the number of days in each season in which rainfall is greater than 5 mm.

To determine the relationship between yield and rain, linear regression models were run using both rain parameters during each stage of the crop cycle as the explanatory variable for yield. The main objective of the regression analysis is to calculate the determination coefficient (R^2) for each variable. The determination coefficient is a measure of the proportion of the variability in yield explained by each rainfall variable. Therefore, a high R^2 is a good indication that the particular rain parameter and yield are related. The results of the regression analysis for each crop and region follow.

TABLE A.1. RAINFALL ANOMALIES FOR MALAWI'S 23 WEATHER STATIONS

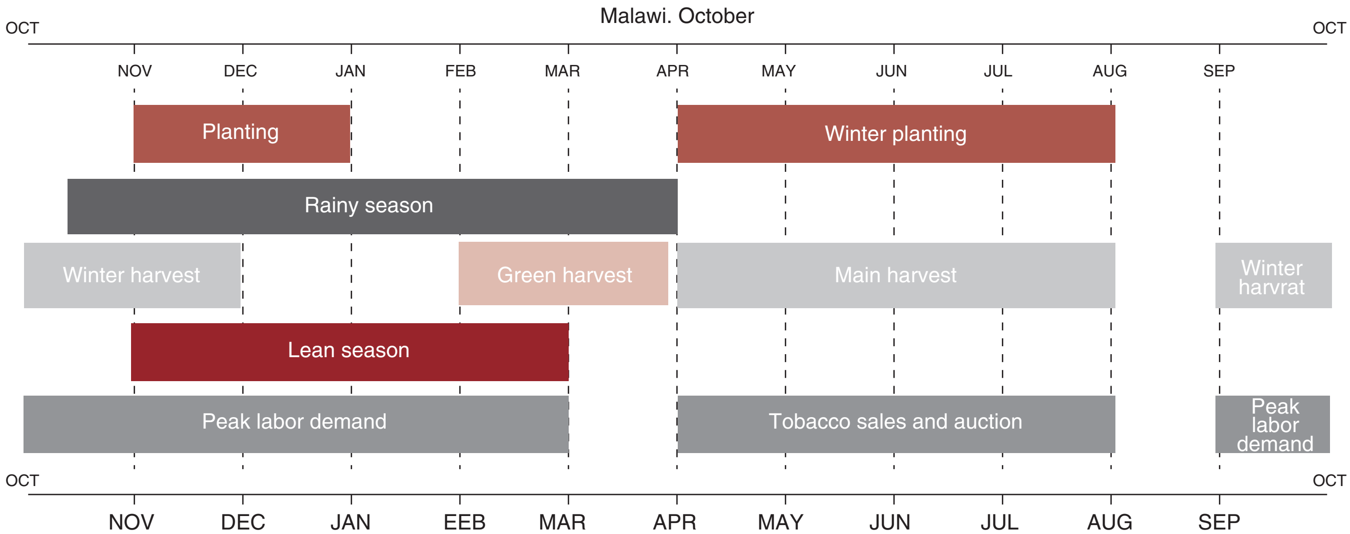
Year	Chitipa	Mzimba	NkhataB	Salima	Chileka	Mimosa	Ngabu	Karonga	Mzuzu	Kasungu	KIA	Chitedze	Nkhota	Dedza
1957	−0.84	0.02	1.34	0.40	−0.67									
1958	−1.42	−0.88	−1.33	−0.59	−0.82	−0.73								
1959	0.40	−0.33	−1.22	0.18	−1.09	−0.37								
1960	0.07	−0.32	0.27	−0.95	−0.28	−0.22	−0.45							
1961	1.25	0.58	1.38	1.55	0.02	0.98	−1.52	1.86	2.71	0.22	0.22	1.59	1.53	1.40
1962	1.18	−1.38	1.24	−0.04	0.79	0.76	0.94	1.75	0.72	0.78	1.36	0.73	0.46	0.49
1963	0.46	0.10	−0.12	0.21	0.00	1.67	−0.11	2.31	1.20	0.24	−1.49	−0.55	1.10	0.96
1964	0.75	−0.54	−0.10	−0.63	−0.40	−1.12	−0.46	−0.53	−0.47	−0.44	−1.13	−0.59	−0.81	−0.71
1965	0.94	1.24	−0.60	−0.07	−0.92	0.04	−0.57	1.43	−0.07	−0.17	0.66	−0.45	0.90	0.36
1966	−0.81	−0.69	−1.01	−1.38	0.49	−0.80	−1.03	0.48	0.40	−0.35	−1.23	−1.56	−0.69	−1.52
1967	1.29	−0.56		−0.85	−0.12	0.35	−0.61	2.15	1.57	−0.10	−1.09	−0.80	0.68	−0.59
1968	1.50	−0.37	0.58	−0.40	−1.07	−0.66	−0.27	0.11	−0.03	−0.18	0.41	0.06		0.02
1969	−0.03	−1.44	−0.06	0.61	0.87	1.55	0.22	−0.33	−0.34	−1.11	−0.01	−0.21	0.53	−0.72
1970	1.58	−0.89	−0.53	0.26	−0.83	−0.75	−0.89	−0.29	−0.74	−0.69	0.12	0.53	0.23	−0.46
1971	0.67	2.32	−0.49	0.51	−0.26	−0.70	−0.70	−0.51	0.08	0.36	0.18	0.48	0.10	0.07
1972	−0.78	−0.91	0.09	−0.43	0.19	−0.96	−0.32	−0.35	−0.65	−1.73	−0.35	0.01	1.58	−0.78
1973	−1.31	−0.62	−0.66	−0.95	−0.87	−0.37	0.26	0.05	−0.93	−0.74	−1.86	−1.29	0.31	−1.20
1974	−0.74	1.69	0.36	1.31	2.11	1.59	0.45	1.83	0.18	0.78	1.96	1.92	0.96	0.65
1975	0.14	0.03	−0.30	−1.07	−1.90	−1.34	−0.24	0.16	1.21	−1.07	−0.44	0.51	−0.31	−0.21
1976	−0.56	1.56	1.95	1.62	1.21	1.10	0.75	−0.39	0.73	−0.04	0.43	0.42	1.72	0.42
1977	0.12	−0.61	−0.66	0.54	−0.07	−0.92	−0.62	0.56	−0.68	−1.02	1.17	1.25	0.59	0.24
1978	1.77	1.77	1.64	2.66	1.67	1.22	1.61	0.49	0.88	1.52	0.89	0.46	1.82	1.51
1979	1.30	0.13	1.16	−0.16	0.91	−0.34	−0.50	2.28	0.30	−0.50	1.02	−0.51	1.17	0.62
1980	−0.10	1.17	−0.08	0.57	−0.05	0.20	−0.79	−0.50	0.02	2.63	−0.25	−0.15	2.12	0.40
1981	−2.06	−0.33	0.31	−0.69	−0.81	0.40	−0.67	−0.61	−0.90	0.13	0.38	−0.08	−1.16	−0.37
1982	0.19	0.95	−0.22	−1.17	−0.30	0.11	0.66	−1.17	0.39	−0.23	−0.55	0.52	1.11	1.07
1983	−0.52	−0.19	−1.74	−0.52	−1.29	−1.14	−0.11	0.51	−0.59	−0.27	−0.76	−1.12	−1.12	−0.32
1984	2.24	0.55	−1.29	−0.95	0.95	0.78	1.32	0.45	1.37	−0.38	0.29	−0.06	−1.23	0.22
1985	0.58	0.10	−0.20	−0.21	2.42	0.71	1.09	−0.80	0.49	0.72	0.92	0.76	0.17	−0.02
1986	2.13	0.69	−0.69	0.04	1.04	0.73	0.40	−0.02	−0.01	1.11	−0.55	1.00	1.27	−0.17
1987	−0.78	−0.85	−1.81	−0.77	−0.56	−1.68	−1.76	−0.74	−1.24	−0.52	−1.43	0.33	−1.04	0.19
1988	−0.42	−0.65	0.14	2.15	0.28	0.83	1.39	−0.61	0.64	−0.07	−0.67	−0.16	−0.55	−0.06
1989	−0.01	3.13	0.65	0.85	2.13	1.88	1.49	−0.96	0.47	2.95	2.47	1.31	1.09	2.98
1990	−0.73	−0.33	0.29	−0.92	−1.45	−0.64	−1.17	−1.22	−0.99	−1.30	−0.97	−0.24	−0.40	−1.14
1991	−0.23	−0.35	0.44	−0.30	0.14	−0.41	−0.01	−0.55	0.78	0.22	0.36	−0.54	−1.15	1.92
1992	−0.16	−0.55	−1.52	−0.09	−1.22	−3.12	−1.55	−0.19	−2.18	−1.78	−0.30	−2.49	−1.19	−1.26
1993	−0.85	−1.75	−0.88	−0.57	−0.34	0.77	0.35	−1.32	−1.58	−0.43	−0.32	0.89	−0.64	0.81
1994	−1.39	−0.37	−0.89	−1.05	−1.36	−0.90	−1.62	−1.33	−0.92	−0.32	0.28	−0.78	−1.44	−0.98
1995	−0.46	0.39	0.38	−2.34	−0.26	−1.14	−0.04	−0.32	−0.84	−0.95	−1.16	−3.09	−1.17	−1.56
1996	−0.60	−0.19	1.52	0.04	0.54	0.83	0.08	−1.21	0.23	1.34	2.59	0.34	−0.65	0.47
1997	−0.25	−0.74	0.91	1.57	1.70	0.62	1.88	−0.33	−0.27	0.88	0.14	1.08	−0.22	0.99
1998	0.72	−1.54	−0.04	−0.45	−0.55	0.33	−0.21	0.13	−1.16	0.12	−0.69	0.34	−1.41	−1.92
1999	−0.39	0.72	2.44	−0.52	0.48	0.71	0.31	−0.78	2.01	−0.71	0.06	1.63	−0.46	−0.78
2000	−0.87	0.61	−0.96	−0.43	0.85	0.51	1.33	−0.01	−0.53	−0.88	−0.66	−1.19	−0.69	0.21
2001	−1.40	0.54	−0.31	1.64	0.52	1.24	2.29	−0.37	−0.85	−0.13	0.41	0.60	−0.74	−0.74
2002	0.02	0.12	1.63	0.41	−0.43	0.24	−1.19	0.77	1.71	−0.25	0.60	−0.44	0.16	−0.09
2003	−0.58	0.49	0.08	0.45	−1.02	−0.56	−0.59	−0.87	0.15	1.59	1.51	0.04	−1.07	1.36
2004	0.60	1.01	0.40	0.41	−0.03		0.24	1.18	0.09	1.60	0.24	0.83	−0.18	−0.94
2005	−1.18	−1.75	−1.77	−1.83	−1.52		−0.74	−0.78	−1.53	−0.81	−1.65	−1.42	−1.09	−1.56
2006	1.21	−0.48	0.54	1.34	0.99	0.00	−0.75	0.39	−0.21	−0.20	−0.33	−0.32	−0.15	0.96
2007	−0.34	−0.32	−0.59	0.71	0.28	−0.88	2.23	−1.26	0.57	0.91	−0.35	0.55		−0.22
2008	−1.32	0.00	0.35	0.31	−0.09	−0.39	0.18	−0.54	−1.17	−0.72	−0.44	−0.13	−0.06	
ExtDro	1	0	0	1	0	1	0	0	1	0	0	2	0	0
Drought	7	5	8	6	9	6	7	6	6	6	8	7	11	7
Normal	35	39	34	38	36	36	33	34	35	35	33	34	25	34
Excess	10	8	9	8	7	7	9	8	7	7	7	7	10	6
Ext Exc	2	2	1	2	3	0	2	3	2	2	2	0	1	1
Prob Dry	13%	10%	16%	12%	17%	12%	14%	13%	13%	13%	17%	15%	24%	15%
Prob Normal	67%	75%	67%	73%	69%	73%	67%	71%	73%	73%	69%	71%	54%	72%
Prob Exc	19%	15%	18%	15%	13%	14%	18%	17%	15%	15%	15%	15%	22%	13%

Mangochi	Bvumbwe	Bolero	Thyolo	Makoka	Chichri	Tembwe	Balaka	Monkey	ExtDry	Drought	Normal	Excess	ExtExc	Conclusion
									0	0	4	1	0	Normal
									0	2	4	0	0	Normal
									0	2	4	0	0	Normal
									0	0	7	0	0	Normal
0.48	0.16								0	1	6	8	1	Excess
0.47	0.39	1.49	1.16						0	1	11	6	0	Excess
1.15	1.23	1.17	0.54						0	1	9	7	1	Excess
−0.51	0.05	−1.05	−0.24						0	3	15	0	0	Normal
−0.37	−0.35	3.85	0.20	−0.31					0	0	15	3	1	Normal
0.21	−1.57	−0.72	−0.79	−0.46	−0.82	−1.01			0	8	13	0	0	Drought
1.01	0.24	−0.41	−0.25	−0.06	−0.09	0.43			0	1	14	4	1	Normal
−0.18	−0.76	0.09	−0.17	−0.73	−1.20	−0.64			0	2	17	1	0	Normal
−0.77	0.84	−0.42	1.24	−0.65	1.82	−0.24			0	2	16	3	0	Normal
−0.10	−0.52	0.08	−0.64	1.01	−0.63	−0.29			0	0	19	2	0	Normal
−0.45	−0.94	0.69	−0.47	1.29	−0.68	0.27			0	0	18	2	1	Normal
−0.74	−0.19	−0.64	−0.59	0.47	−0.19	−0.28			0	1	19	1	0	Normal
−0.64	−0.36	−0.69	−0.74	−1.08	−0.52	−1.37			0	6	15	0	0	Drought
0.73	1.84	0.13	1.82	0.44	1.19	0.57			0	0	10	10	1	Ext Exc
0.64	−0.90	0.77	−1.25	−1.05	−0.91	−1.17			0	7	13	1	0	Drought
1.79	1.54	0.71	1.65	−0.99	1.57	2.51	0.00		0	0	10	11	1	Ext Exc
−0.14	−1.47	0.11	−0.81	−0.01	−0.08	0.48	0.10		0	2	18	2	0	Normal
2.36	0.75	−0.25	0.92	0.48	0.94	2.68	1.29		0	0	6	13	3	Ext Exc
0.86	−1.32	0.34	−1.57	0.15	−0.30	0.01	−0.64		0	2	14	5	1	Excess
−0.20	−0.47	1.12	−0.79	−1.69	−0.47	−0.54	−1.21	1.62	0	2	14	5	2	Excess
−0.50	−0.62	−0.99	−0.56	0.07	−0.92	−0.53	−1.17	−0.56	1	3	19	0	0	Normal
0.04	0.26	−0.05	−0.06	−0.63	0.54	0.44	0.14	0.20	0	2	19	2	0	Normal
−1.27	−0.65	−0.09	−1.32	−0.09	−1.44	−0.14	−0.08	−0.67	0	8	15	0	0	Drought
0.24	0.32	1.33	0.36	0.96	1.33	−0.09	−0.10	0.86	0	2	15	5	1	Excess
−0.92	1.76	0.53	1.83	1.55	0.88	1.17	0.95	0.28	0	0	16	6	1	Excess
−0.36	0.18	−0.02	0.30	1.64	1.14	0.92	1.24	−1.20	0	1	13	8	1	Excess
−1.14	−0.90	−0.85	−1.06	−0.85	−0.77	−1.02	−0.26	−0.90	0	9	14	0	0	Drought
−1.04	−0.40	−0.51	−0.29	0.84	0.16	0.11	−0.90	0.23	0	1	19	2	1	Normal
0.19	1.18	0.46	0.89	1.44	0.71	2.16	0.12	1.52	0	0	4	13	6	Ext Exc
−0.76	−0.68	−1.76	−1.37	0.04	−1.60	−0.06	−0.88	0.03	0	8	15	0	0	Drought
0.66	−0.28	−0.24	0.19	0.54	−0.51	−0.58	0.38	−0.04	0	1	21	1	0	Normal
−1.42	−1.50	−0.36	−1.59	−2.22	−1.46	−1.34	−1.90	−1.76	4	17	2	0	0	ExtDry
−0.15	−0.05	−1.12	−0.23	−0.58	0.24	0.25	−0.42	−0.95	0	4	19	0	0	Normal
−2.31	−1.50	−0.04	−1.31	−2.47	−1.26	−1.41	−0.43	−1.36	2	13	8	0	0	ExtDry
−1.35	−0.64	−0.39	−0.49	−0.98	−0.19	−1.07	0.24	−1.78	2	9	12	0	0	Drought
0.13	1.06	0.08	0.12	0.58	−0.57	1.08	−0.08	0.94	0	1	16	5	1	Excess
1.67	2.90	0.16	1.88	2.34	1.68	−0.87	3.47	0.61	0	0	10	10	3	Ext Exc
−1.42	−0.08	−1.61	−0.28	0.10	−0.54	−0.90	−1.00	−0.68	0	7	16	0	0	Drought
−0.69	1.10	−0.95	1.33	0.10	1.48	1.16	1.00	−0.78	0	0	13	8	2	Excess
1.02	0.99	−0.62	0.28	−0.09	0.12	0.40	0.26	0.30	0	1	20	2	0	Normal
1.07	1.46	−0.80	2.03	0.48	0.61	0.73	0.20	1.95	0	1	13	7	2	Excess
0.19	−0.64	1.59	0.28	−0.96	2.10	−0.52	−0.90	0.83	0	1	17	4	1	Normal
0.74	−0.81	−0.38	−0.13	−0.47	−0.78	0.61	0.53	0.35	0	2	18	3	0	Normal
0.10	0.06	1.51	0.57	0.16	−0.27	−0.42	0.96	0.36	0	0	18	4	0	Normal
−1.35	−1.23	−1.68	−1.49	−0.42	−1.46	−1.54	−1.13	−1.31	0	18	4	0	0	ExtDry
2.12	0.28	−0.07	0.84	0.72	0.94	0.67	0.89	0.47	0	0	19	3	1	Normal
1.19	0.53	0.61	0.84	1.36	0.64	−0.07	0.05	0.66	0	1	17	3	1	Normal
−0.31	−0.27	−0.11	−0.78	0.01	−0.42	−0.57	−0.70	0.78	0	2	20	0	0	Normal
1	0	0	0	2	0	0	0	0						
8	6	5	8	5	6	8	5	5					ExtDry	3
31	33	35	31	32	29	29	24	21					Drought	8
9	9	7	8	7	8	6	4	3					Normal	25
2	1	1	1	1	1	3	1	0					Excess	11
17%	13%	11%	17%	11%	14%	19%	15%	17%					Ext Exc	5
65%	69%	74%	66%	73%	67%	67%	73%	72%						
19%	19%	15%	17%	16%	19%	14%	12%	10%						

TABLE A.2. WEATHER STATIONS USED IN EACH MAFS REGION

Region	Number	Station 1	Station 2	Station 3	Station 4
Blantyre	1	Chileka	Chichiri	Bvumbwe	
Karonga	2	Chitipa	Karonga		
Kasungu	3	Kasungu	Nkhota Kota		
Lilongwe	4	KIA	Chitedze	Tembwe	
Machinga	5	Makoka	Balaka		
Mzuzu	6	Bolero	Mzimba	Mzuzu	Nkhata Bay
Salima	7	Salima	Dedza	Mangochi	Monkey Bay
Shire Valley	8	Mimosa	Thyolo	Ngabu	

FIGURE A.2. MALAWI'S CROP CALENDAR



Source: USAID 2013.

MAIZE

Table A.3 summarizes the regression determination coefficient (R^2) for each rain parameter by region. It shows that the relationship between cumulative rainfall and number of rainy events and maize yield is not significant, except in the Salima region, where the number of rainy events for the harvesting season explains 25 percent of yield variability. Because most of the determination coefficients are very small, a multiple linear model was also run using each set of the three variables combined as regressors. Table A.4 illustrates the results of these models.

Table A.4 shows that only for the Salima and Shire Valley regions do the two rain indexes barely significantly explain variability in maize yield ($R^2 > 20\%$). In Salima, the combined rainy events indexes help explain yield, whereas in the Shire Valley, the combined cumulative rainfall indexes help explain yield best (24%).

Figure A.3 illustrates the yield of maize for all regions over time. It shows that except in the Salima and Shire Valley regions, where rainfall better explains the variability in yield, there seem to be two different levels of yield. There is not a linear upward trend, but rather two different levels of production, with a break point after 2005, when the level of production is clearly higher.

Table A.5 illustrates the mean yield from 1984–2005 versus 2006–13 for each region. It shows that yield has been

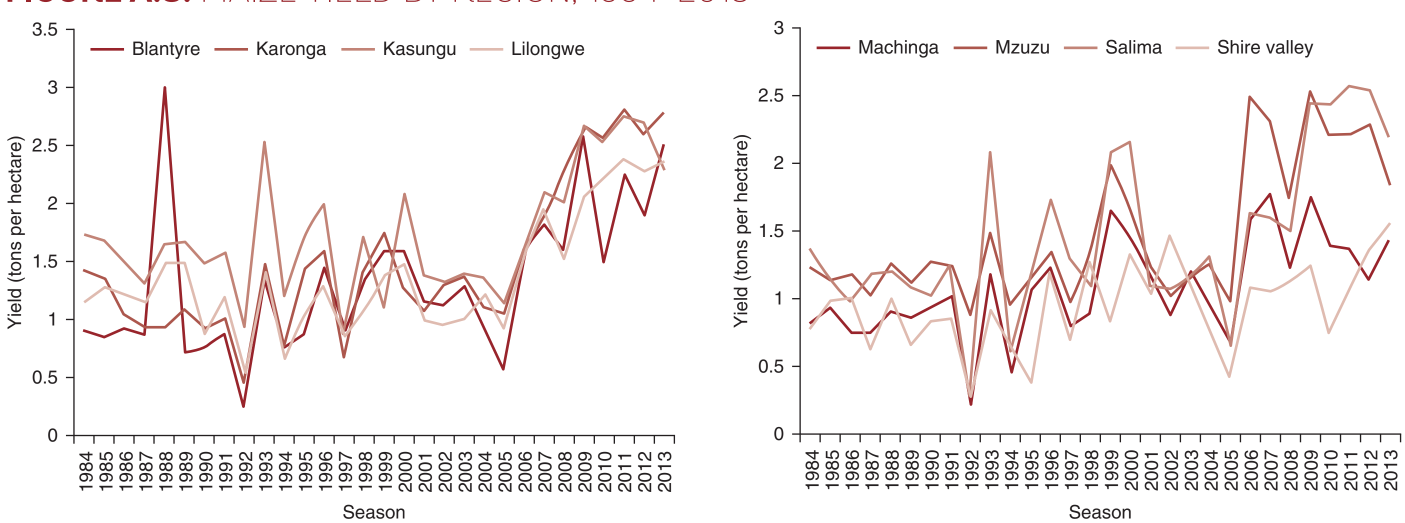
TABLE A.3. SIMPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR MAIZE YIELD

No.	Region	CumRain1	CumRain2	CumRain3	Events1	Events2	Events3
1	Blantyre	5%	6%	0%	3%	5%	8%
2	Karonga	0%	1%	2%	0%	1%	0%
3	Kasungu	0%	1%	5%	0%	4%	6%
4	Lilongwe	3%	1%	3%	0%	0%	2%
5	Machinga	1%	3%	10%	0%	11%	10%
6	Mzuzu	3%	0%	1%	0%	1%	4%
7	Salima	2%	0%	14%	1%	1%	25%
8	Shire Valley	5%	17%	11%	4%	12%	6%

TABLE A.4. MULTIPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR MAIZE YIELD

No.	Region	CumRain1+CumRain2+CumRain3	Events1+Events2+Events3
1	Blantyre	10%	11%
2	Karonga	4%	1%
3	Kasungu	7%	9%
4	Lilongwe	4%	3%
5	Machinga	14%	15%
6	Mzuzu	4%	5%
7	Salima	16%	26%
8	Shire Valley	24%	16%

FIGURE A.3. MAIZE YIELD BY REGION, 1994–2013



Source: Based on data sets provided to the World Bank by the Malawi Meteorological Services Department.

almost two times higher from 2006 onward than in earlier years, perhaps explaining why rainfall does not explain much of the variability in maize yield. To try to solve this problem, the standardized yield for each period of time was used instead of actual yield. Tables A.6 and A.7 show the determination coefficients of these regressions.

With the transformation of yield, rain explains more variability in yield. Particularly worth noting is that

TABLE A.5. AVERAGE MAIZE YIELD BEFORE AND AFTER 2005 BY REGION

		1984–2005		2006–13		
No.	**Region**	**# Years**	**Mean Yield (MT/ha)**	**# Years**	**Mean Yield (MT/ha)**	**Ratio**
1	Blantyre	22	1.090	8	1.962	1.8
2	Karonga	22	1.157	8	2.398	2.1
3	Kasungu	22	1.515	8	2.317	1.5
4	Lilongwe	22	1.123	8	2.033	1.8
5	Machinga	22	0.940	8	1.456	1.5
6	Mzuzu	22	1.221	8	2.201	1.8
7	Salima	22	1.224	8	2.112	1.7
8	Shire Valley	22	0.865	8	1.154	1.3

Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

TABLE A.6. SIMPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR MAIZE YIELD TRANSFORMED

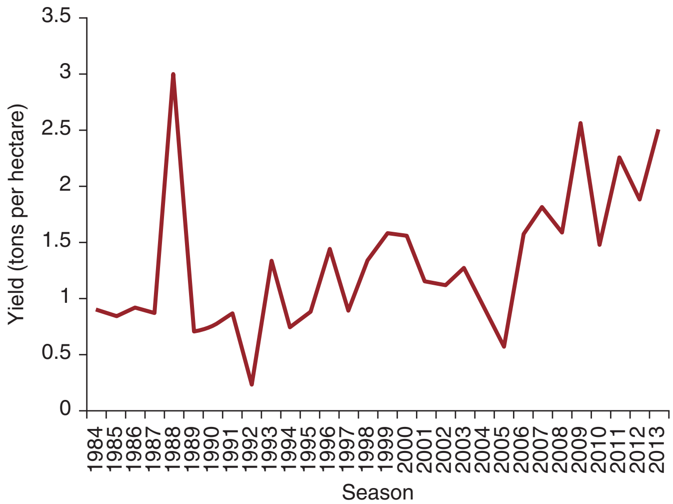
No.	Region	CumRain1	CumRain2	CumRain3	Events1	Events2	Events3
1	Blantyre	1%	10%	0%	0%	7%	4%
2	Karonga	0%	1%	8%	0%	5%	2%
3	Kasungu	1%	1%	3%	0%	8%	4%
4	Lilongwe	7%	15%	27%	5%	18%	25%
5	Machinga	6%	6%	20%	6%	18%	24%
6	Mzuzu	3%	8%	28%	5%	2%	39%
7	Salima	15%	0%	9%	17%	1%	25%
8	Shire Valley	4%	21%	10%	4%	17%	4%

TABLE A.7. MULTIPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR MAIZE YIELD TRANSFORMED

No.	Region	CumRain1+CumRain2+CumRain3	Events1+Events2+Events3
1	Blantyre	10%	9%
2	Karonga	10%	9%
3	Kasungu	5%	11%
4	Lilongwe	33%	32%
5	Machinga	34%	36%
6	Mzuzu	32%	39%
7	Salima	22%	37%
8	Shire Valley	26%	18%

both cumulative rainfall and rainy events during the harvesting season help explain more yield variance in almost all regions except for Blantyre, Karonga, and Kasungu, where the proportion of variance explained is less than 15 percent. A more detailed regional analysis follows.

FIGURE A.4. MAIZE YIELD IN BLANTYRE, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin..

BLANTYRE REGION

Figure A.4 shows maize yield in the Blantyre region over time. The mean yield in the Blantyre region was 1 MT/ha until 2005 (though in 1988 production was almost three times more), but rose to 1.9 MT/ha after 2005. The three worst seasons were in: 1991–92, when yield was 234 kg/ha; 2004–05, when yield was 560 kg/ha; and 2009–10, when yield was 1.4 MT/ha.

Figure A.5 shows that the relationship between cumulative rainfall and yield for the Blantyre region is not strong. But some of the worst yield years can be explained by the low cumulative rainfall during those seasons, as in 1991–92, 1994–95, and 2004–05 when total rainfall was about 600 mm and yield was relatively low. The number of rainy events during these three seasons was also small (about 30 days throughout the whole seven months) compared with an average of 45 days in the whole 28 years of data. Hence, even though the relationship is not very strong, drought explains why yield was low during those seasons.

KARONGA REGION

In Karonga region, the difference in yield levels is more evident (figure A.6). The mean yield before 2005 was 1.15 MT/ha, but since 2006 yield has been 2.39 MT/ha. Three dips on the chart indicate very low yields in the 1991–92, 1993–94, and 1996–97 seasons.

FIGURE A.5. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND MAIZE YIELD IN BLANTYRE

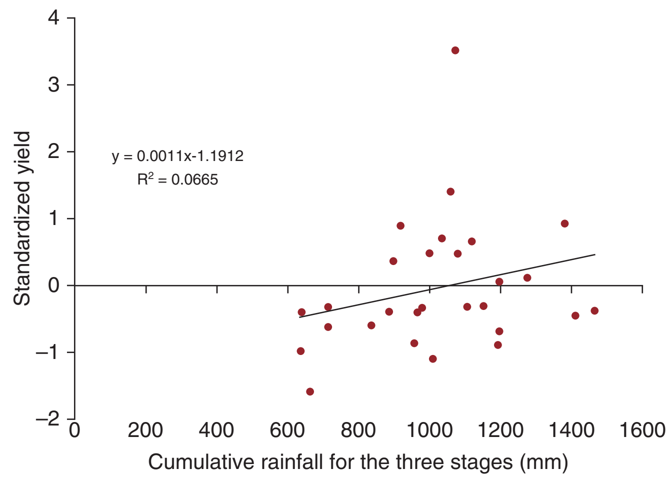
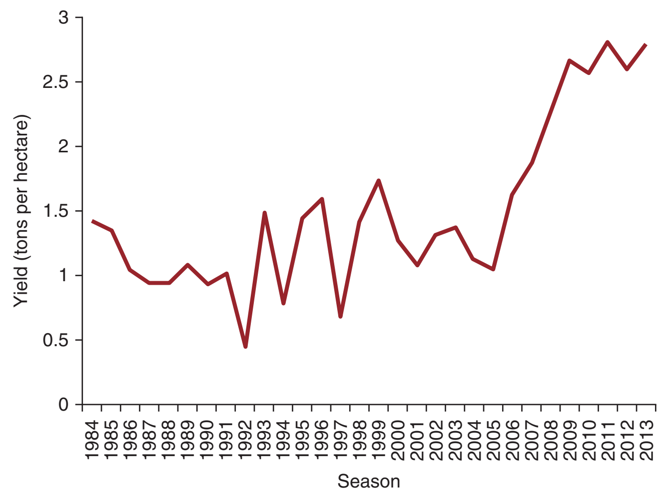


FIGURE A.6. MAIZE YIELD IN KARONGA, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

As with the previous region, the relationship between rain and yield is not strong (5 percent), although the positive slope indicates that the more rain, the better the yield (figure A.7). For instance, rain during the 1993–94 and 1996–97 seasons was scarce (626 mm and 617 mm, respectively), explaining the low yield during those years; but the 1991–92 season, the lowest production year (444 kg/ha), saw 933 mm of rainfall evenly scattered through the three stages, so drought does not explain such low yield during this season.

FIGURE A.7. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND MAIZE YIELD IN KARONGA

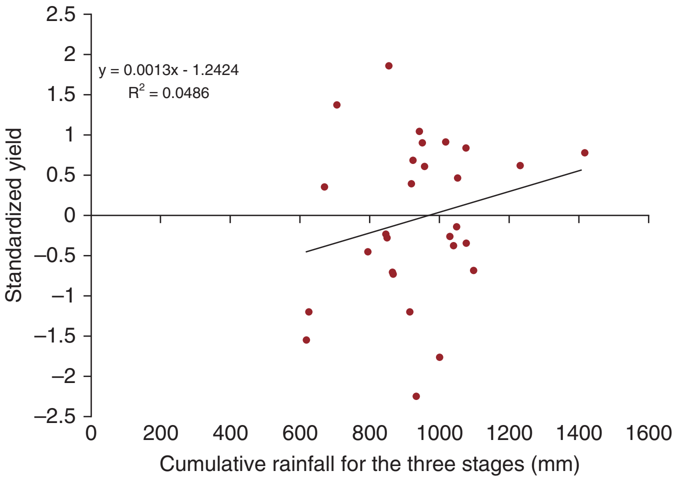
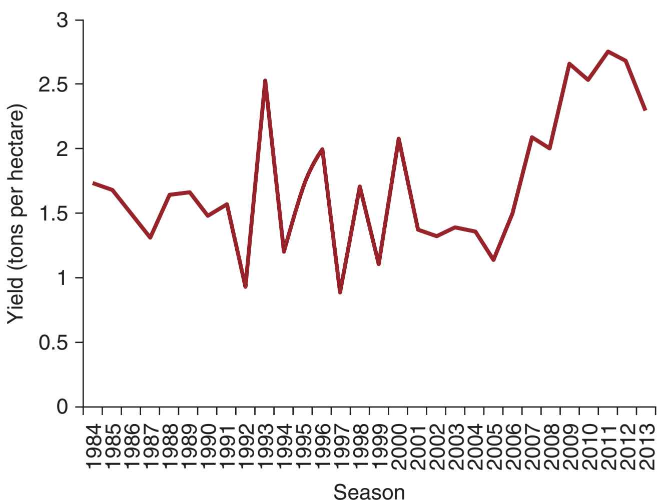


FIGURE A.8. MAIZE YIELD IN KASUNGU, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

KASUNGU REGION

Yield in the earlier years in Kasungu region was the highest with 1.5 MT/ha, but it also rose to 2.3 MT/ha after 2005 (figure A.8). The lowest yield years were the 1991–92 and 1996–97 seasons, when yield was less than 1 MT/ha.

The determination coefficient (R^2) is practically zero, meaning that rain does not explain yield variability in this region (figure A.9). The low yield during the 1991–92 season (0.93 MT/ha) can be explained by low cumulative rainfall (689 mm) and few rainy events (32), but a similarly "dry" season as in 1999–2000 (with 685 mm and 39 rainy events) had a much better yield of 2.07 MT/ha. During the 1996–97 season when yield was also low (0.87 MT/ha), rain was normal with 912 mm and 38 rainy events.

FIGURE A.9. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND MAIZE YIELD IN KASUNGU

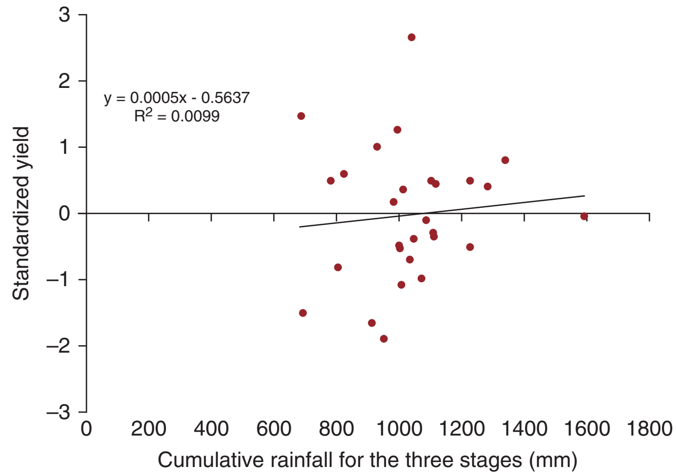
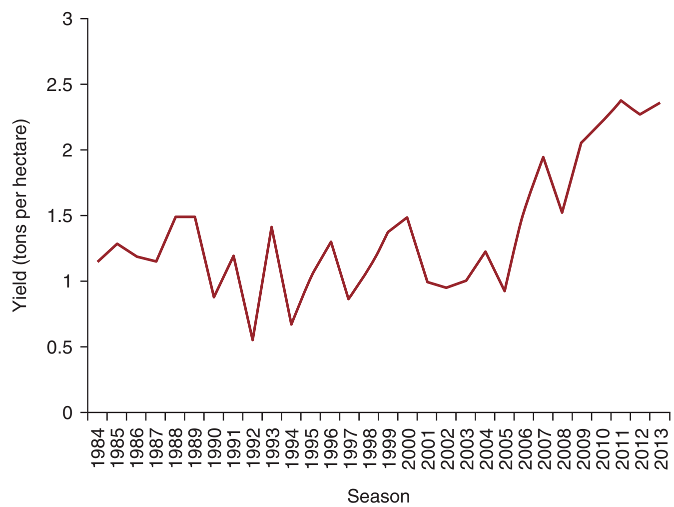


FIGURE A.10. MAIZE YIELD IN LILONGWE, 1994–2013

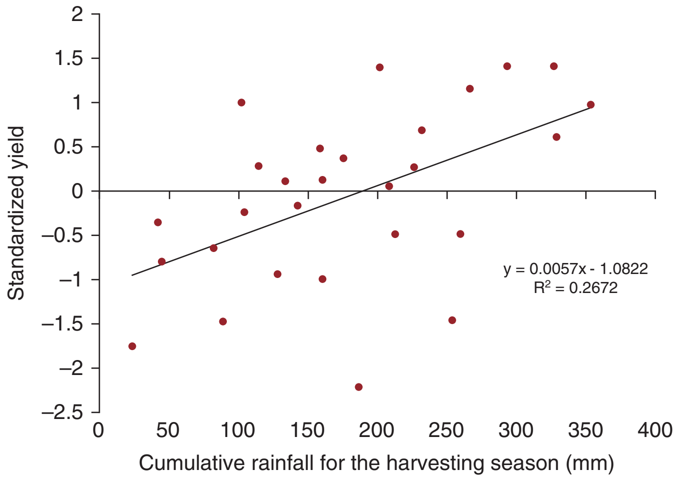


Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

LILONGWE REGION

Figure A.10 illustrates that yield experienced a discrete jump after the 2005 season in Lilongwe region. Before then,

FIGURE A.11. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND MAIZE YIELD IN LILONGWE



mean yield was 1.12 MT/ha; afterward it was 2.03 MT/ha. Consistent with some of the conclusions in the regions discussed previously, the 1991–92, 1993–94, and 1996–97 seasons had the lowest yields over the entire time period.

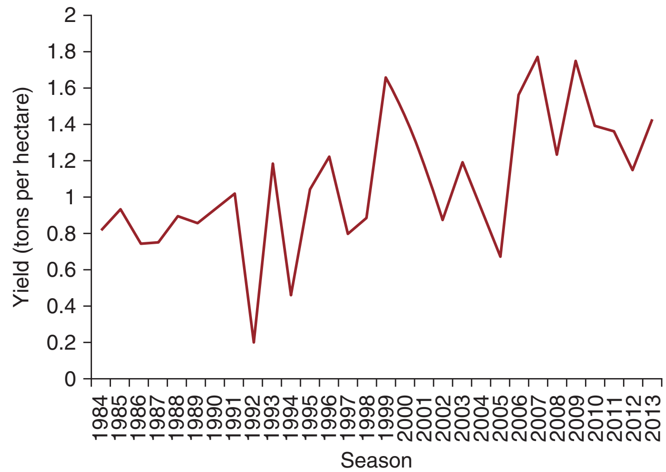
Figure A.11 shows that rain during the harvesting season explains 26 percent of the variability in yield. The positive slope indicates that drought during this period affected the yield. There were three very dry years over this period: the 1993–94, 1994–95, and 2004–05 seasons, when rain was less than 50 mm, consistent with relatively low yield during those years. But the low yield during the 1991–92 season was not due to drought, because 186 mm of rain fell during this season.

MACHINGA REGION

In Machinga region, the increasing trend in maize yield seems more gradual than that seen in the regions already discussed. Mean yield was 940 kg/ha before 2006 and 1.45 MT/ha after. As in other regions, the worst yields occurred in the 1991–92, 1993–94, and 2004–05 seasons (figure A.12).

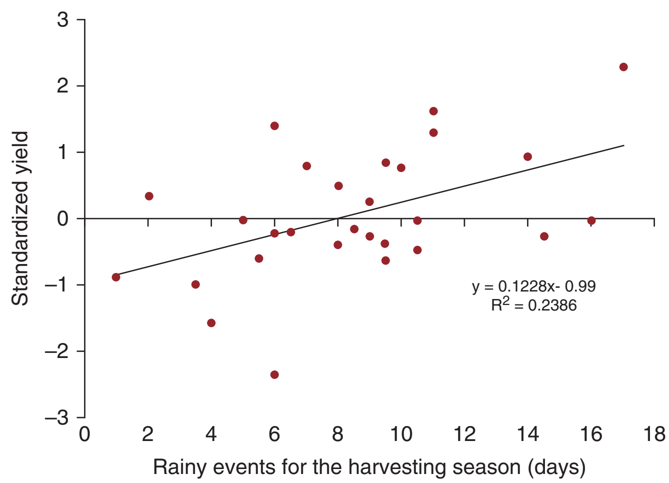
In Machinga region, the number of rainy events during the harvesting season best help explain variability in maize yield (24 percent). The 1993–94 season was very dry, with only 4 rainy events, resulting in mean yield of 444 kg/ha (figure A.13). The 2004–05 drought during the harvesting season also affected yield: only one

FIGURE A.12. MAIZE YIELD IN MACHINGA, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.13. REGRESSION RESULTS FOR RAINY EVENTS AND MAIZE YIELD IN MACHINGA

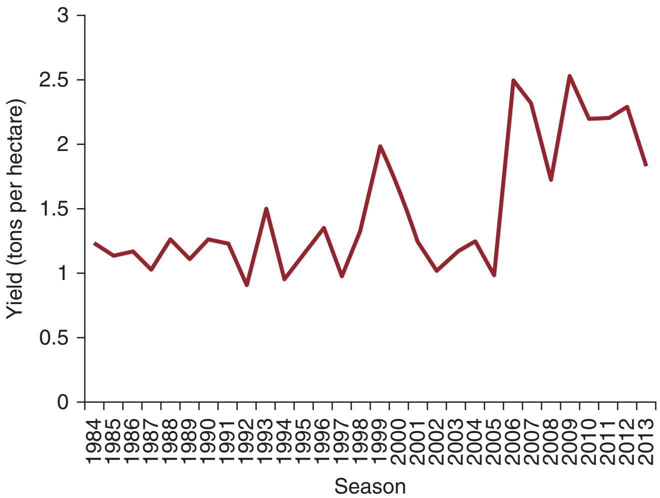


rainy event occurred during the harvesting season, but the sowing and growing seasons had an average number of rainy events (16 and 14, respectively) and yield was barely 662 kg/ha. It can be concluded that in this region, drought has mostly affected maize production during the harvesting season.

MZUZU REGION

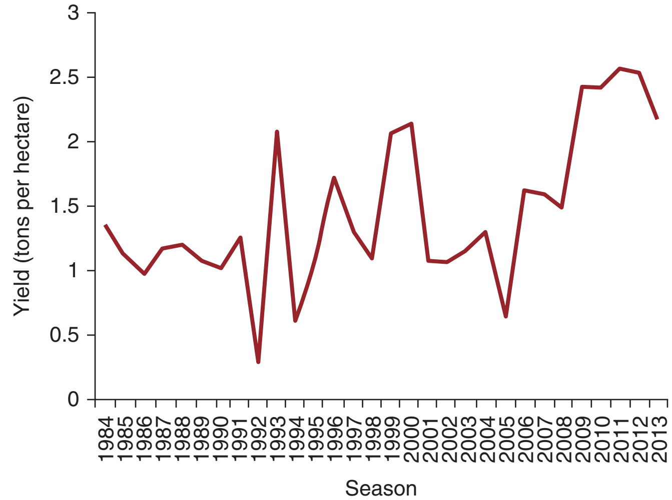
Mzuzu region in another region in which the discrete jump in maize yield is evident. Mean maize yield jumped

FIGURE A.14. MAIZE YIELD IN MZUZU, 1994–2013



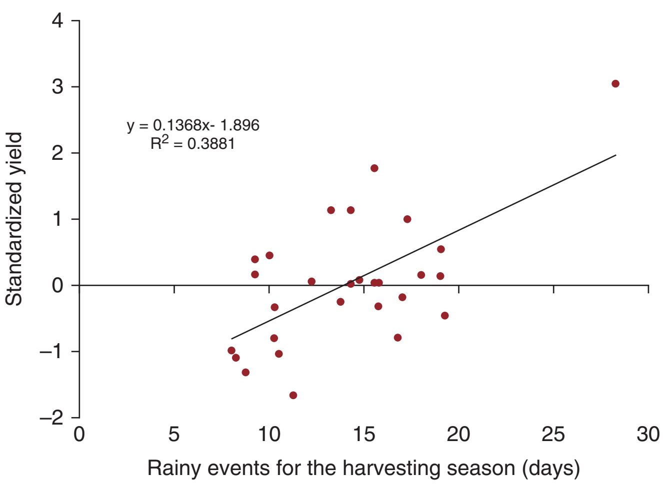
Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.16. MAIZE YIELD IN SALIMA, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.15. REGRESSION RESULTS FOR RAINY EVENTS AND MAIZE YIELD IN MZUZU



from 1.22 MT/ha to 2.2 MT/ha after 2005, although the 1998–99 season yield was also high (1.99 MT/ha). Yield seems steadier in this region, but as in the other regions, the 1991–92, 1993–94, 1996–97, and 2004–05 seasons had the lowest yields (figure A.14).

In Mzuzu region, the number of rainy events during the harvesting season helps explain maize yield variability (39 percent) more than in any other region (figure A.15). This is highly influenced by the 1998–99 season, in which yield was extremely good (2 MT/ha), corresponding to the most humid season (28 rainy events and 808 mm of rain). Most of the low yield years can be explained by the occurrence of fewer rainy events (8).

SALIMA REGION

As stated before, the rise in maize yield is not as clear in the Salima region. The mean yield before 2005 was 1.22 MT/ha versus 2.1 MT/ha after. 2005 itself was generally a low yield year; mean yield increased in 2006–07 and again after 2009. As seen in other regions, the 1991–92, 1993–94, and 2004–05 seasons had the lowest yields (figure A.16).

Similarly, the number of rainy events during the harvesting season best helps explain maize yield variability in Salima region; even though the relationship is not very strong, the positive slope indicates that the higher the rain, the better the yield—thus drought can be considered the main threat to production here. The 1993–94, 1994–95, and 2004–05 seasons each had approximately two rainy events, explaining the critically low yields in those seasons. But 1991–92 was not a dry season, so another reason may explain this year's low yield (282 kg/ha) (figure A.17).

FIGURE A.17. REGRESSION RESULTS FOR RAINY EVENTS AND MAIZE YIELD IN SALIMA

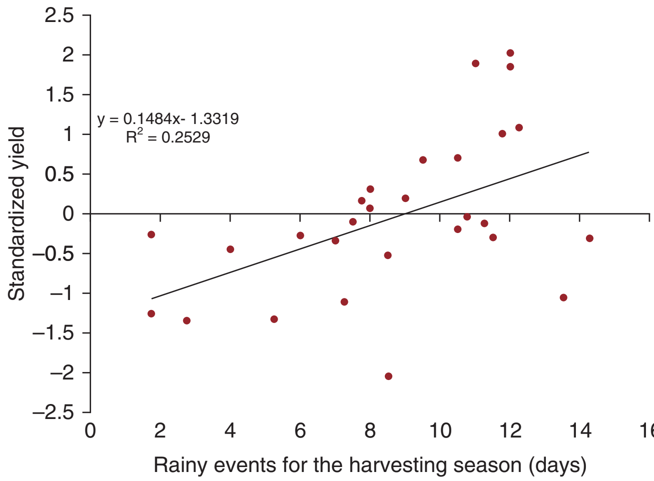
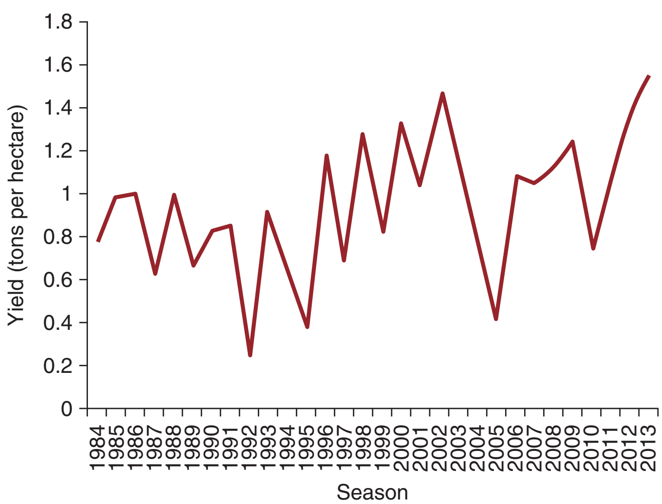


FIGURE A.18. MAIZE YIELD IN SHIRE VALLEY, 1994–2013



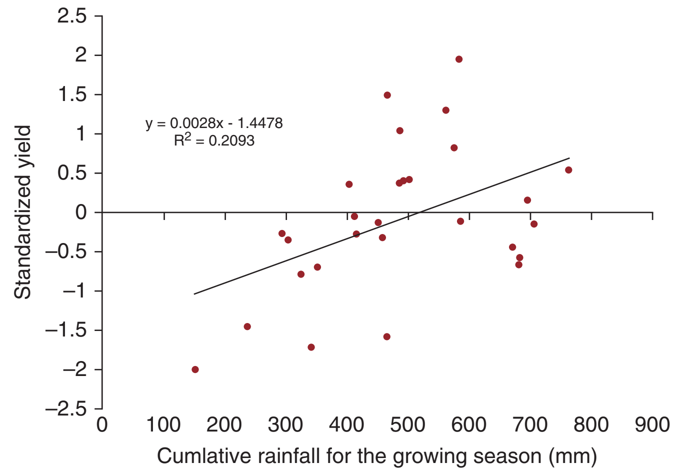
Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

SHIRE VALLEY REGION

The rise in maize yield in Shire Valley region is not significant. The mean yield before 2005 was 865 kg/ha and 1.15 MT/ha after. As seen in previous regions, the 1991–92, 1994–95, and 2004–05 seasons had the lowest yields (figure A.18).

In Shire Valley region, cumulative rainfall in the growing season has the highest impact on yield, explaining 21 percent of its variability. The positive slope indicates that the higher the rain, the better the yield. The 1991–92

FIGURE A.19. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND MAIZE YIELD IN SHIRE VALLEY



season was the driest, receiving 150 mm of rain during the growing season, corresponding to the lowest yield (245 kg/ha). The 2004–05 season was also dry (237 mm of rain), explaining that year's low yield of 415 kg/ha (figure A.19).

CASSAVA

Tables A.8 and A.9 summarize the regression determination coefficients for both the simple and multiple linear regression models, again using the three stages of cumulative rainfall and rainy events variables by region.

Tables A.8 and A.9 both show very small determination coefficients, meaning that none of the different rain indexes, even in the multiple linear regression models, help explain variability in cassava yield. Upon further review, cassava yield also had a discrete jump after 2000. Table A.10 shows the mean cassava yield over 1984–2000 versus 2001–13 for each region:

Mean cassava yield increased from 3 MT/ha to about 18 MT/ha; for some regions, yield was 4 times higher after 2000. This difference in yield might explain why the determination coefficient is so low. The same transformation applied to maize was hence also used for cassava. Tables A.11 and A.12 show the determination coefficients for the simple and multiple linear models using the transformed cassava yield variable:

TABLE A.8. SIMPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR CASSAVA YIELD

No.	Region	CumRain1	CumRain2	CumRain3	Events1	Events2	Events3
1	Blantyre	6%	1%	3%	3%	0%	4%
2	Karonga	0%	1%	1%	3%	1%	0%
3	Kasungu	2%	0%	0%	0%	0%	2%
4	Lilongwe	0%	0%	4%	0%	2%	2%
5	Machinga	0%	0%	0%	1%	0%	0%
6	Mzuzu	0%	3%	1%	4%	6%	1%
7	Salima	10%	0%	2%	13%	0%	3%
8	Shire Valley	0%	1%	0%	0%	0%	0%

TABLE A.9. MULTIPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR CASSAVA YIELD

No.	Region	CumRain1+CumRain2+CumRain3	Events1+Events2+Events3
1	Blantyre	9%	8%
2	Karonga	2%	5%
3	Kasungu	2%	2%
4	Lilongwe	6%	3%
5	Machinga	0%	1%
6	Mzuzu	4%	9%
7	Salima	13%	18%
8	Shire Valley	1%	0%

TABLE A.10. AVERAGE CASSAVA YIELD BEFORE AND AFTER 2005 BY REGION

		1984–2000		2001–13		
No.	Region	# of Years	Mean Yield (MT/ha)	# of Years	Mean Yield (MT/ha)	Ratio
1	Blantyre	17	2.633	13	14.760	5.6
2	Karonga	17	4.320	13	18.582	4.3
3	Kasungu	17	3.639	13	16.650	4.6
4	Lilongwe	17	3.088	13	14.134	4.6
5	Machinga	17	3.320	13	12.768	3.8
6	Mzuzu	17	5.059	13	24.278	4.8
7	Salima	17	4.568	13	20.401	4.5
8	Shire Valley	17	3.968	13	12.184	3.1

Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

From Tables A.11 and A.12, it can be concluded that even though the transformation of cassava yield helped increase the determination coefficients, rainfall explains very little of cassava yield variability, except in the Blantyre region, where cumulative rainfall explains about 40 percent. Because of the low proportion of variance explained, a more detailed regional analysis follows.

BLANTYRE REGION

The mean yield in the Blantyre region increased from 2.6 MT/ha to 14.7 MT/ha, the highest relative

TABLE A.11. SINGLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR CASSAVA YIELD TRANSFORMED

No.	Region	CumRain1	CumRain2	CumRain3	Events1	Events2	Events3
1	Blantyre	20%	23%	1%	12%	14%	8%
2	Karonga	5%	12%	2%	6%	8%	0%
3	Kasungu	5%	1%	0%	5%	0%	1%
4	Lilongwe	1%	0%	0%	4%	0%	1%
5	Machinga	0%	2%	3%	0%	3%	7%
6	Mzuzu	3%	4%	1%	0%	10%	0%
7	Salima	7%	1%	0%	4%	2%	2%
8	Shire Valley	0%	5%	1%	0%	4%	0%

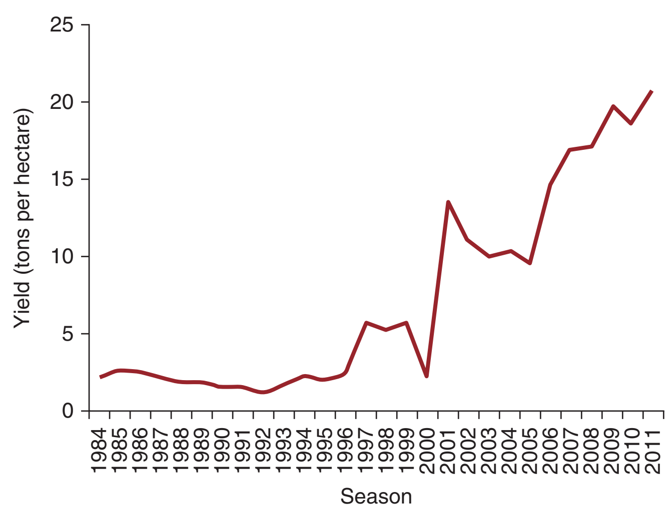
TABLE A.12. MULTIPLE LINEAR MODELS' DETERMINATION COEFFICIENTS FOR CASSAVA YIELD TRANSFORMED

No.	Region	CumRain1+CumRain2+CumRain3	Events1+Events2+Events3
1	Blantyre	40%	24%
2	Karonga	14%	12%
3	Kasungu	6%	6%
4	Lilongwe	1%	5%
5	Machinga	4%	8%
6	Mzuzu	9%	11%
7	Salima	9%	9%
8	Shire Valley	5%	5%

increase of all regions. Yield was steady throughout before 1997, oscillating about 2 MT/ha. The worst season was 1991–92, when yield was barely 1.16 MT/ha (figure A.20).

Cassava yield is most strongly correlated with rain in the Blantyre region. The cumulative rainfall of the three stages helps explain about 30 percent of yield variability, whereas the positive slope indicates that the more rain, the better the yield. It is clear that the highest yield years were also the most humid ones, whereas the lowest yield years saw the least rainfall. The three driest years, 2004–05, 1994–95, and 1991–92 (when about 600 mm fell through the whole 7 month period), correspond to some of the lowest yield years, so drought can be considered the main threat in this region (figure A.21).

FIGURE A.20. CASSAVA YIELD IN BLANTYRE, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.21. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND CASSAVA YIELD IN BLANTYRE

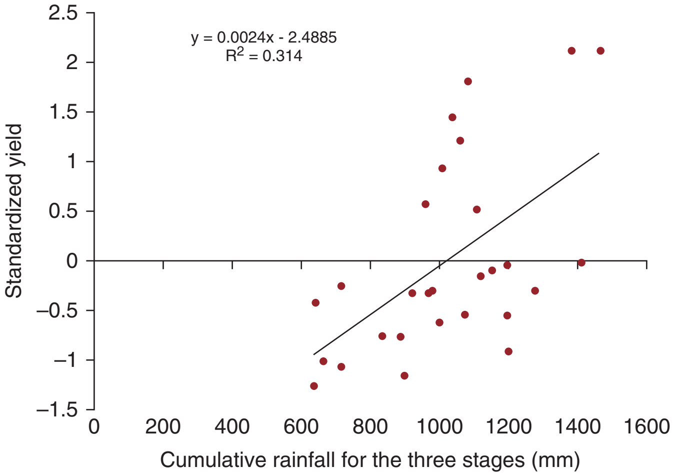
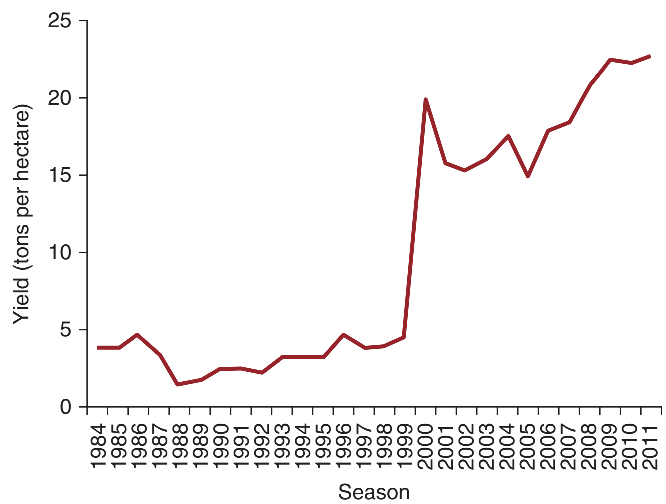


FIGURE A.22. CASSAVA YIELD IN KARONGA, 1994–2013



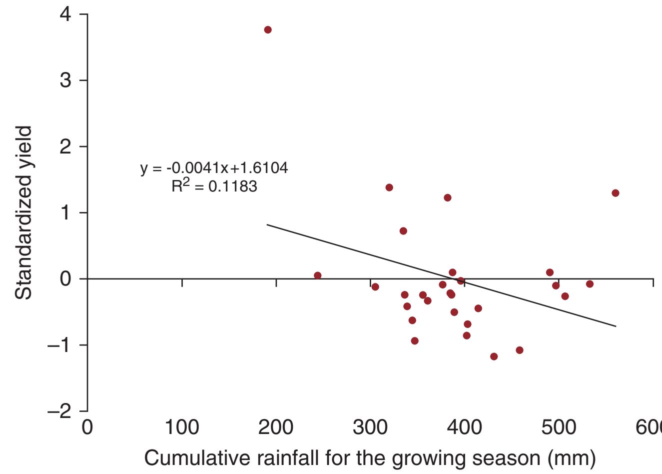
Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

KARONGA REGION

In Karonga region, cassava yield rose from an average of 4.32 MT/ha to 18.5 MT/ha, clearly showing a completely different level after 2000. 2004–05 had the lowest yield in the post-2000 period, at only 15 MT/ha (figure A.22).

Cumulative rainfall in the growing stage for cassava in Karonga region has the highest determination coefficient but it is barely 12 percent. Besides, the negative slope indicates that the higher the rain, the worse the yield. This regression is highly influenced by one outlying observation: the 2000 yield was very high despite the fact that only about 200 mm of rain fell in that year. In general, however, it can be concluded that rain is of little impact on cassava yield in this region (figure A.23).

FIGURE A.23. REGRESSION RESULTS FOR CUMULATIVE RAINFALL AND CASSAVA YIELD IN KARONGA



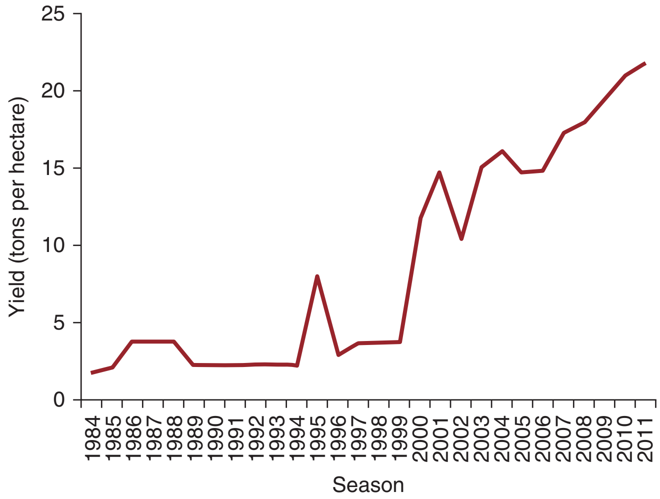
KASUNGU REGION

In Kasungu region, yield follows an upward trend from 2000 onward; the mean yield before 2000 was 3.6 MT/ha and has steadily increased to more than 20 MT/ha in recent years. The 2001–02 season appears to have been inexplicably bad; yield decreased to 10 MT/ha despite being higher before and after. However, rain was normal during this season (999 mm of cumulative rainfall and 45 rainy events), so rain does not explain this fall in yield. No regression results are shown for this region because all determination coefficients were rather small (figure A.24).

LILONGWE REGION

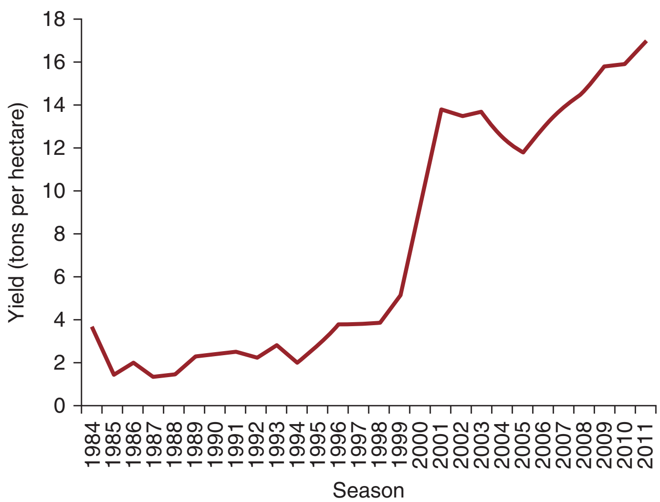
The discrete increase in cassava yield can be seen in Lilongwe region: it increased from roughly 3 MT/ha to 14 MT/ha. It is worth noting that the 2004–05 season had relatively low yield, because the harvesting season was very dry (only 3 rainy days and 45 mm of cumulative rainfall). However, none of the rain indexes were significant enough to explain the variability in cassava yield (figure A.25).

FIGURE A.24. CASSAVA YIELD IN KASUNGU, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.25. CASSAVA YIELD IN LILONGWE, 1994–2013

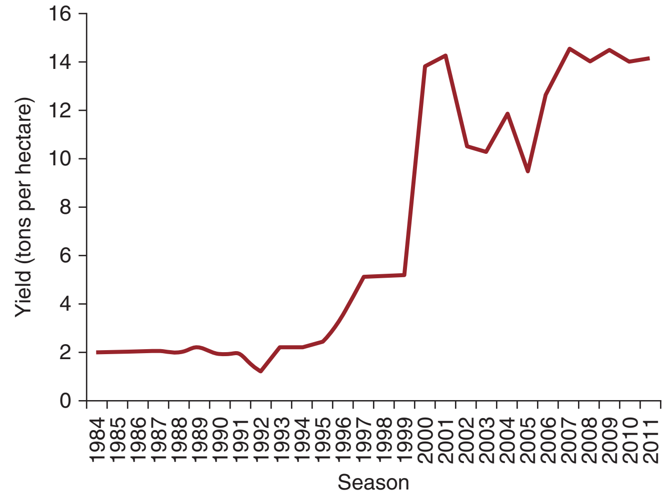


Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

MACHINGA REGION

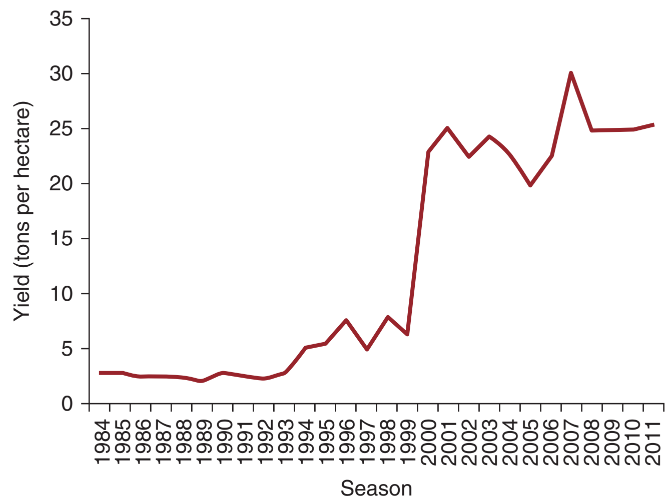
In Machinga region, yield was fairly steady before 1996, oscillating about 2 MT/ha. In 1991–92, yield dipped to almost half that (1.14 MT/ha). Once the new level was reached, the 2001–02, 2002–03, and most importantly, the 2004–05 seasons had low yields as well. As already stated, the 1991–92 and 2004–05 seasons were dry (for example, in 2004–05, there was only 1 rainy event and 43 mm of rainfall), explaining these seasons' low yields. No regression results are shown for this region because the determination coefficients were so small (figure A.26).

FIGURE A.26. CASSAVA YIELD IN MACHINGA, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

FIGURE A.27. CASSAVA YIELD IN MZUZU, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

MZUZU REGION

As in the other regions, the jump in cassava yield in the Mzuzu region is evident after 2000. Again, the worst year was 2004–05, when yield was 19.8 MT/ha even though the new mean was more than 24 MT/ha. Clearly something else affected yield during this season. The harvest season was the driest in this year (only 166 mm of rain in a region where 334 mm is normal), so the dry months of March and April may explain the relatively lower cassava yield in 2004–05 (figure A.27).

FIGURE A.28. REGRESSION RESULTS FOR RAINY EVENTS AND CASSAVA YIELD IN MZUZU

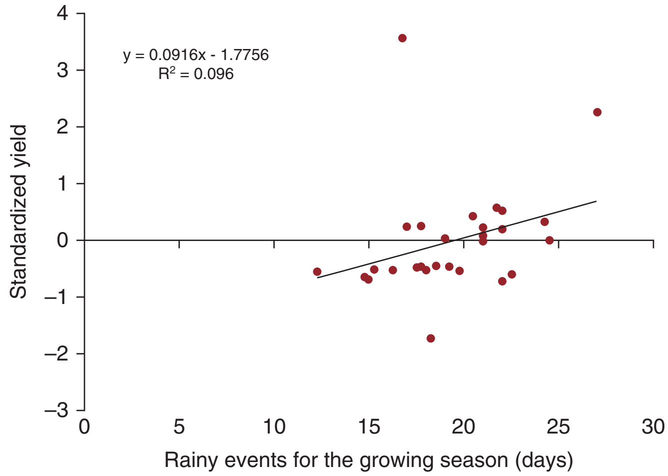
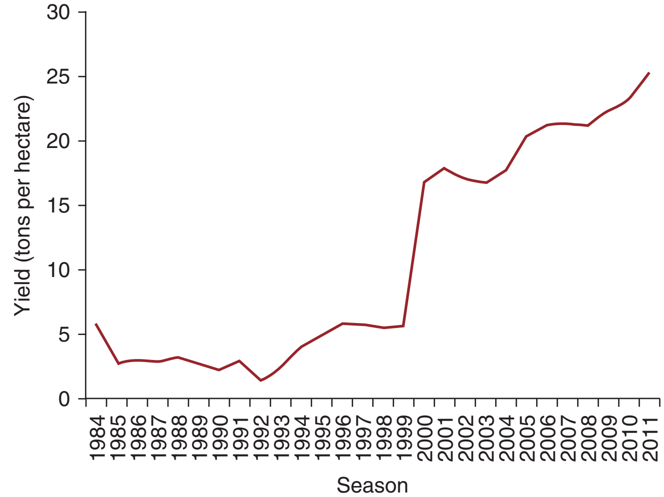


FIGURE A.29. CASSAVA YIELD IN SALIMA, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

The number of rainy events during the growing season in Mzuzu region had the highest determination coefficient but still only explained 10 percent of the variability in cassava yield, which is not significant (figure A.28).

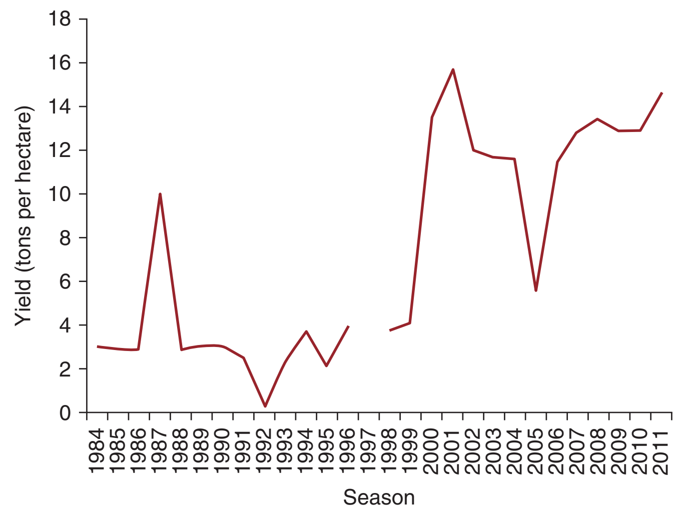
SALIMA REGION

A similar pattern can be seen in the Salima region, which had a steady yield of 4.5 MT/ha before 2000 and 20.4 MT/ha after. Similarly, 1991–92 had the lowest yield (1.4 MT/ha), explained by the low rain during the growing season (204 mm in a region where 485 mm are normal). Since 2000, yield has increased steadily, with no shock events, perhaps explaining why the relationship between cassava yield and rain is not significant. No regression results are shown for this region because all determination coefficients were insignificant (figure A.29).

SHIRE VALLEY REGION

In Shire Valley region, the shocks of the 1991–92 and 2004–05 seasons are more extreme. Cassava yield during the 1991–92 season was only 269 kg/ha versus a mean yield of roughly 4 MT/ha. During the 2004–05 season, yield decreased to 5 MT/ha, versus the post-2000 mean of 12 MT/ha. This indicates that something else affected cassava yield in this year (figure A.30).

FIGURE A.30. CASSAVA YIELD IN SHIRE VALLEY, 1994–2013



Source: Authors' calculations, based on data from MAFS 2013 Annual Statistics Bulletin.

Even though none of the rain variables were significant enough to explain cassava yield variability, a dry sowing season during 1991–92 (151 mm and 7 rainy events) and a dry harvesting season during 2004–05 (67 mm and 4 rainy events) explain the relatively lower yields in these years.

APPENDIX B
CLIMATE AND CLIMATE CHANGE

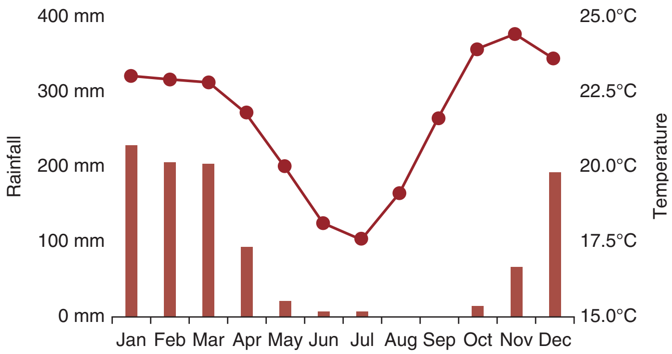
CURRENT CLIMATE AND WEATHER PATTERNS IN MALAWI

Malawi has a subtropical climate (meaning hot, humid summers and mild winters) that is distinctly seasonal. The warm, wet season runs from November to March, during which most of the annual rainfall takes place. This is the main agricultural growing season. May to August is the cool, dry season; and September and October constitute the hot, dry season. Although Malawi is a relatively small country, it has large variations in topography that create significant differences in temperature ranges and rainfall totals across the country, and thus a diverse range of agroecological zones. Higher elevations typically see cooler temperatures and more rainfall; for example, in the northern and southern highlands. The hotter and drier zones are located at lower elevations, as is the case in the Shire River valley.

The main drivers of rainfall are the Inter-Tropical Convergence Zone (ITCZ) and the Congo Air Boundary (CAB). The ITCZ is where the northern and southern hemispheres' weather systems meet. The CAB is where Indian Ocean and southern Atlantic Ocean air masses meet. Flooding in Malawi is associated with both the ITCZ and CAB bringing rain at the same time. The rainy season in Malawi is demarcated by the passage of the ITCZ over the country. In normal years, the ITCZ begins to move across Malawi in late October, moving southward throughout November, and begins its return north in late March–April, marking the beginning of the dry season. Late arrival of the ITCZ means a late start to the rainy season, and an early departure means an early cessation. Intra-Seasonal Oscillations (ISOs), or dry spells of 10–60 days duration, can be caused by a number of atmospheric circulation patterns, including episodes of tropical cyclone disturbances east of Madagascar and high-pressure cells over South Africa.

Figure B.1 shows annual temperature patterns, with warmer temperatures corresponding to the wet season and cooler periods to the dry season(s).

FIGURE B.1. AVERAGE MONTHLY TEMPERATURE AND RAINFALL IN MALAWI



Source: World Bank Group, Climate Change Knowledge Portal. See http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=MWI#.

CHANGES IN WEATHER PATTERNS

Weather pattern deviations, meaning pronounced departures from normal climate patterns, occur in Malawi over different time scales. The short waves of climate change involve teleconnections, which are linkages between climate oscillations or anomalies that are widely separated across the globe. The changes they bring about are temporary, and generally happen within a one- to two-year time frame. In the medium term, analyses of rainfall data have shown that Malawi goes through several different wardyear cycles of wet and dry periods.

Malawi's climate is affected by several different teleconnections. Chief among them is El Niño/La Niña or El Niño-Southern Oscillation (ENSO). El Niño events are strongly connected with drought in Malawi, whereas La Niña is associated with unusually wet years. If there is an El Niño event, the following growing season in Malawi is 80 to 90 percent likely to experience a significant drought. ENSO events change Malawi's climate by causing changes in the prevailing wind patterns. Other influential teleconnections are the Quasi-Biennial Oscillation (QBO), which involves oscillations of the wind patterns in the stratosphere, and sea surface temperature (SST) anomalies in the southern Atlantic and Indian Oceans.

Some of these cycles appear to be to be associated with ENSO and QBO events, meaning they both happen on a regular basis. Malawi's climate also oscillates between decade-long wet and dry spells with a periodicity of 11.1 years. It is speculated that this longer oscillation is related to regular changes in sunspot activity.

GLOBAL CLIMATE CHANGE AND MALAWI

The long waves of climate change are the permanent shifts of average temperatures and precipitation caused by global increases in temperature brought on by increased concentrations of greenhouse gases in the atmosphere (that is, global climate change).

Global climate change (hereafter referred to as climate change) is forecast to change temperatures and precipitation in Malawi over the next 50 years. The average annual temperature is forecast to increase 1°C–3.5°C, and the number of hot days[12] is also forecast to increase. This level of increase is significant enough to raise evapotranspiration rates. The food crops and varieties grown in Malawi that are heat intolerant will have trouble absorbing sufficient moisture from the soil at those temperatures.

Figures B.2 and B.3 show that monthly temperatures have already increased significantly over the past 100 years.

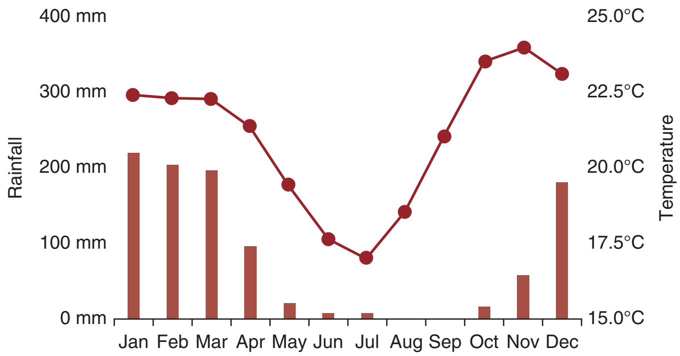
The number of hot days is projected to increase significantly (figure B.4). Whereas from 1961–2000 the highest scenario reported 18.9 hot days at its maximum, by 2046–65, the number jumps up to 28.3 days. The mean temperature is projected to change from 1 to 3 degrees every month from 2020 until 2039 (figure B.5).

The distribution of rainfall is forecast to change in significant ways. For example, more heavy rainfall days are anticipated. Figure B.6 shows the results of nine climate change models for the 2020–39 time frame. According to the models, January and February will see markedly heavier rainfalls compared with current levels.

Extreme rain patterns are forecast to become more frequent. Figures B.7 and B.8 show the projected number of days without rain and with extreme rain, respectively, in

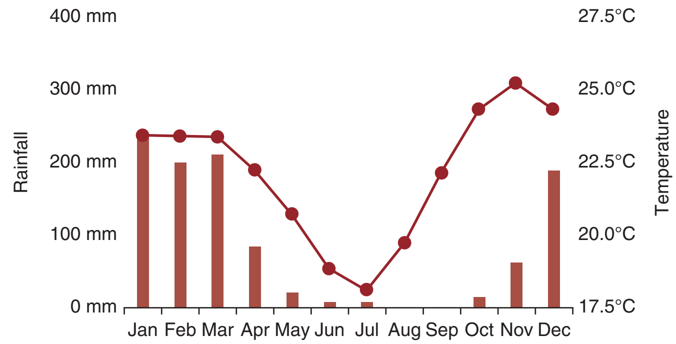
[12] A hot day is one that exceeds the hottest 10 percent of all days per year.

FIGURE B.2. AVERAGE MONTHLY TEMPERATURE AND RAINFALL FOR MALAWI, 1900–1930



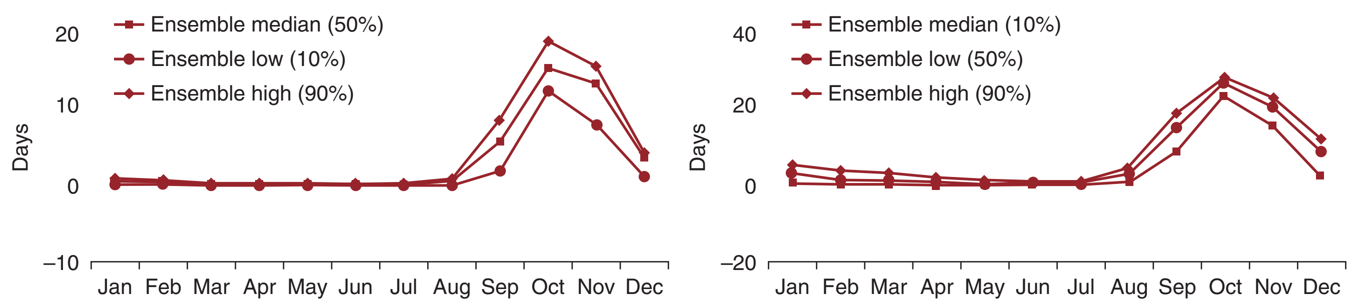
Source: World Bank Group, Climate Change Portal.

FIGURE B.3. AVERAGE MONTHLY TEMPERATURE AND RAINFALL FOR MALAWI, 1990–2009



Source: World Bank Group, Climate Change Portal.

FIGURE B.4. NUMBER OF HOT DAYS OVER A YEAR IN MALAWI, 1960–2000 AND 2046–65



Actual hot days for Malawi from 1961 to 2000
Source: World Bank Group, Climate Change Portal.

Projected hot days for Malawi from 2046 to 2065

2046–46 compared with 1961–2000. It can be seen that days without rain and days with heavy rain are expected to occur more often.

IMPACTS ON CROPS

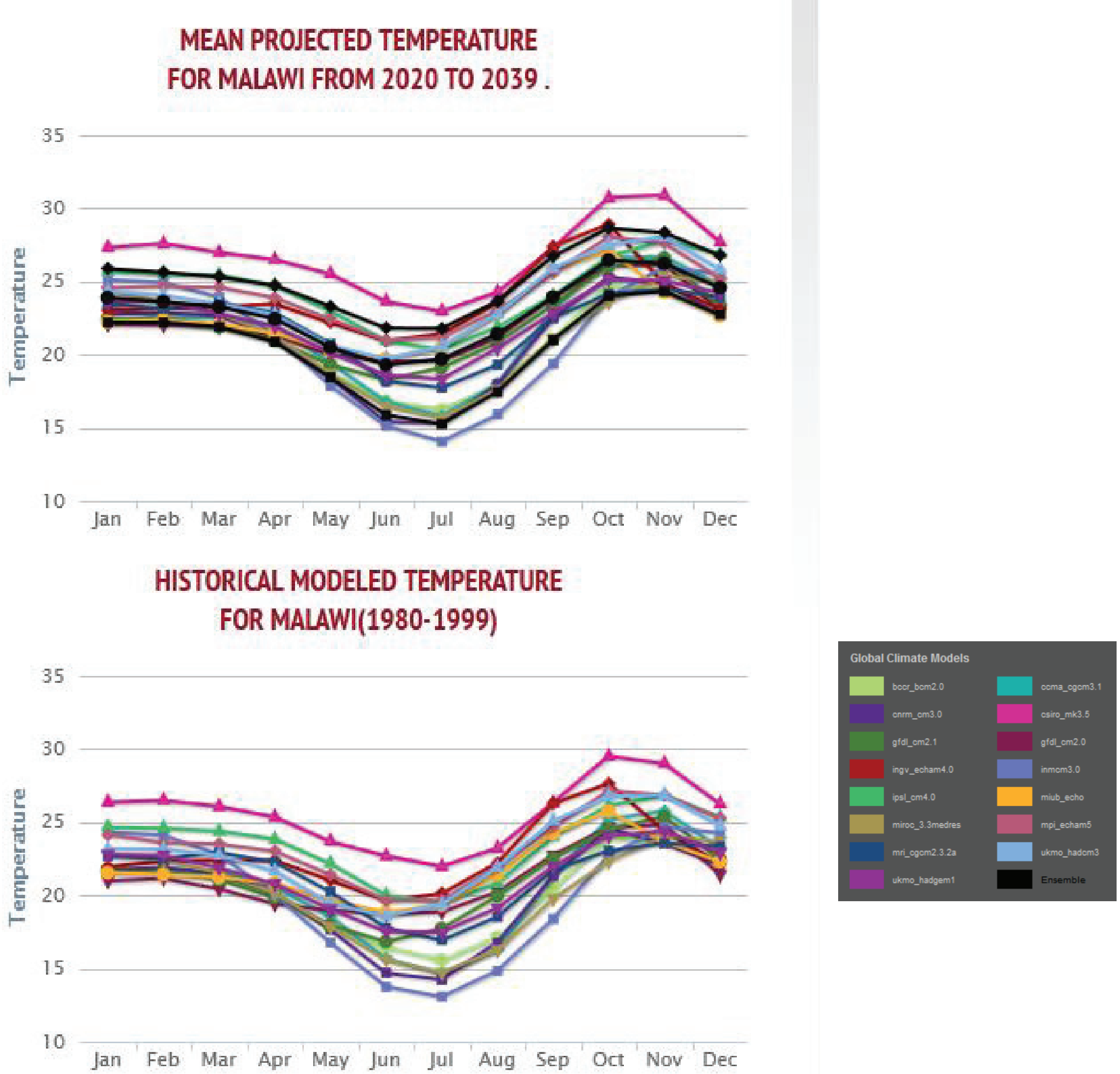
One recent analysis[13] of the projected effects of climate change on key crops in Malawi from 2020–60 reached the following conclusions:

Maize: There will be a high to very high likelihood of decreased yield due to periods of extreme heat and drought. On the other hand, increased rainfall is likely to cause outbreaks of pests and diseases in maize. There is currently no ideal maize variety for the projected climate change in Malawi. Improved and hybrid varieties, touted for their ability to grow in short seasons, still possess numerous disadvantages over traditional varieties. For instance, they are more susceptible to prolonged dry spells, are more easily introduced to pests in storage, and require fertilizer to attain yields similar to traditional varieties (USAID 2013, 42). Traditional varieties meanwhile are no panacea. Although they can produce favorable yields in high temperatures, yield rates are very vulnerable to water stress and poor levels of micronutrients in soil (ibid., annex D, 2).

Groundnuts: Increases in temperature and variable precipitation decrease groundnut productivity. Heavy late rains promote aflatoxins, which limit export potential. Additionally, pests and diseases become a

[13] USAID 2013: "The Global Climate Models used to downscale climate change projections in the USAID report came from the 2012 Coupled Model Inter-comparisons Project Phase 5 (CMIP5 [Taylor 2012]) archive. This archive contains simulations of the historic and future climate yielded by multiple Global Climate Models (GCMs), assumes a range of emission scenarios, and is produced by the world's leading climate modeling institutions."

FIGURE B.5. PROJECTED MEAN TEMPERATURE IN MALAWI ACCORDING TO NINE CLIMATE CHANGE MODELS, 2020–39

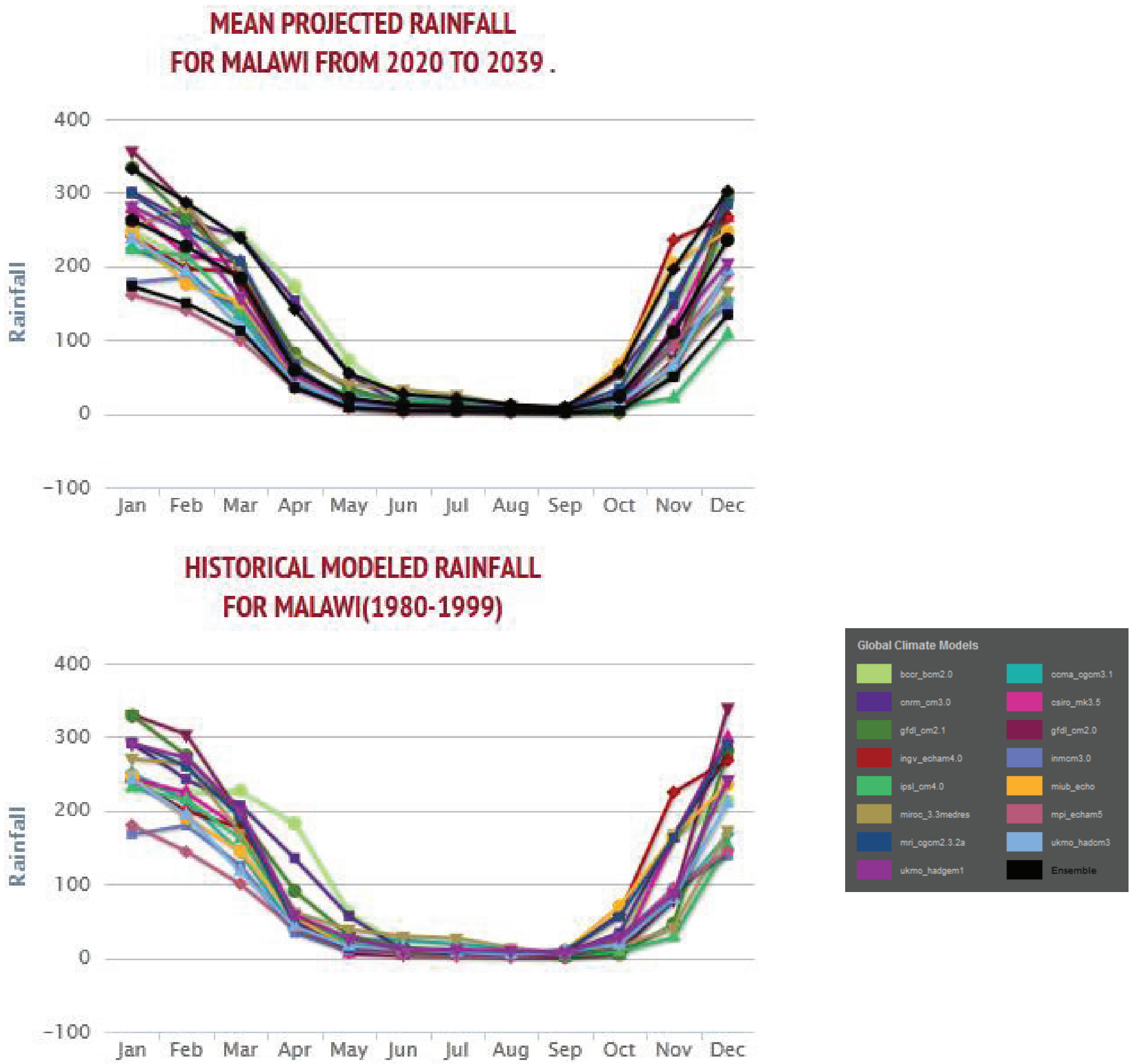


Source: World Bank, Climate Change Portal. The World Bank graphs use the IPCC scenario A2. The A2 storyline and scenario family describe a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines. For more information, see http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate_down&ThisRegion=Africa&ThisCcode=MWI.

greater risk for groundnuts under both decreased and increased rainfall conditions. Of particular note is the possibility of a groundnut rosette virus (GRV), which occurs in decreased rainfall conditions, and can cause losses of up to 90 percent for the crop (ibid., annex D, 5). Uptake of early-maturing varieties of groundnuts, which perform better in low rainfall conditions, has been very low, perhaps due to the fact that their time-consuming harvesting interferes heavily with other crops.

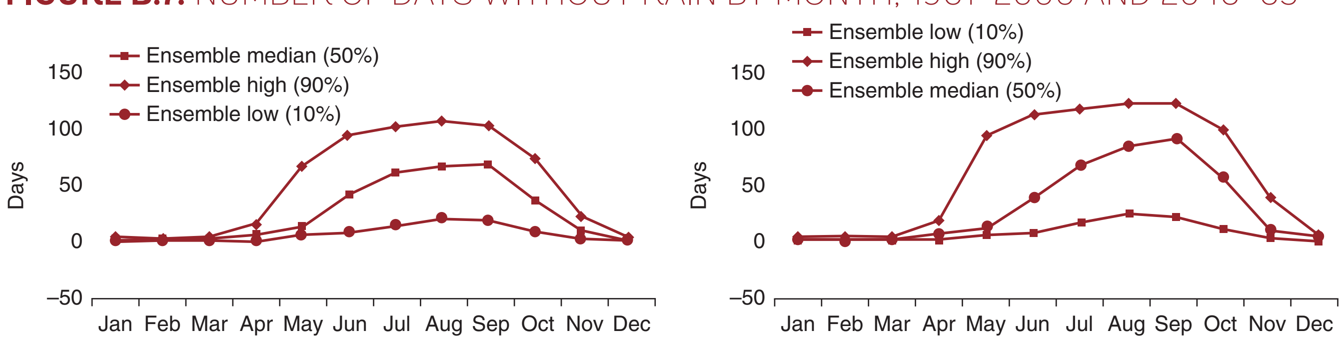
Pigeon peas: Pigeon peas show favorable yields even in areas with low moisture. However, earlier-maturing varieties are more likely to show lower yields overall. Increased rainfall raises the potential for greater bouts of diseases, which thrive under such conditions.

FIGURE B.6. PROJECTED MEAN RAINFALL IN MALAWI ACCORDING TO NINE CLIMATE CHANGE MODELS, 2020–39



Source: World Bank, Climate Change Portal.

FIGURE B.7. NUMBER OF DAYS WITHOUT RAIN BY MONTH, 1961–2000 AND 2046–65

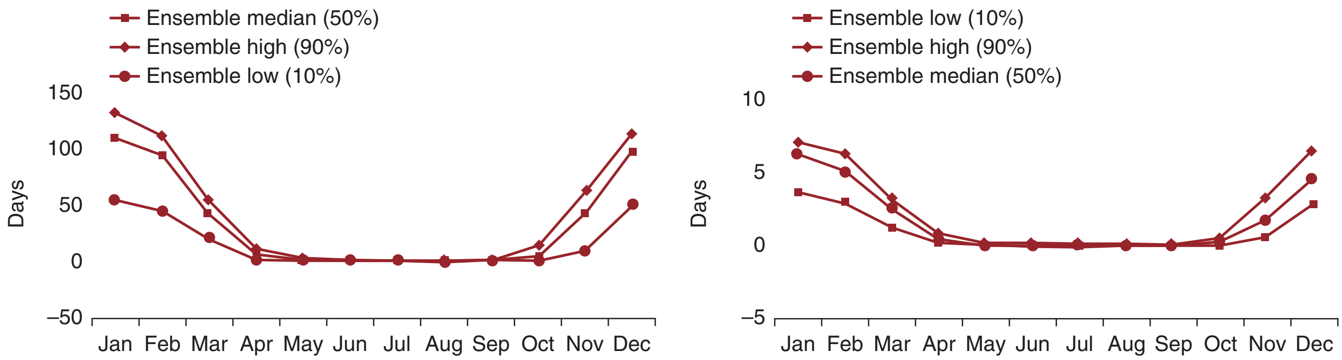


Actual days without rain, 1961–2000

Projected days without rain, 2046–65

Source: World Bank Group, Climate Change Portal.

FIGURE B.8. NUMBER OF DAYS WITH EXTREME RAIN BY MONTH, 1961–2000 AND 2046–65



Actual days with extreme rain, 1961–2000

Projected days with extreme rain, 2046–65

Source: World Bank, Climate Change Portal.

Soybeans: Soybeans have very good drought tolerance. However, they are also very sensitive during particular portions of their growing cycle. Therefore climate change may still be a source of stress for the plant, particularly at an early stage when it is drought intolerant. Although only slight decreases in productivity are expected for soybeans, the potential is high for the increased prevalence of diseases under increased rainfall and warmer temperature conditions. This includes soybean rust, which affects all stages of the crop's production.

Export crops are also likely to be affected by water and electricity shortages. Water availability, which is critical to crops such as sugar, is likely to be significantly affected in the country. On the whole, the country's water balance is expected to drop by half by 2035.[14] Adding to this pressure will be the increased use of small-scale irrigation by smallholder farmers, thereby reducing water sources for large-scale (mostly export-heavy) irrigation systems. Electricity, another key component for processing most export crops, will also pose significant production challenges with the onset of climate change. Most of the country's electricity production is currently obtained through hydropower. Extended dry seasons, population growth, and increased demand will tax the already overburdened electricity system.

REGIONAL VARIATION OF CLIMATE CHANGE IMPACTS

RAINFALL

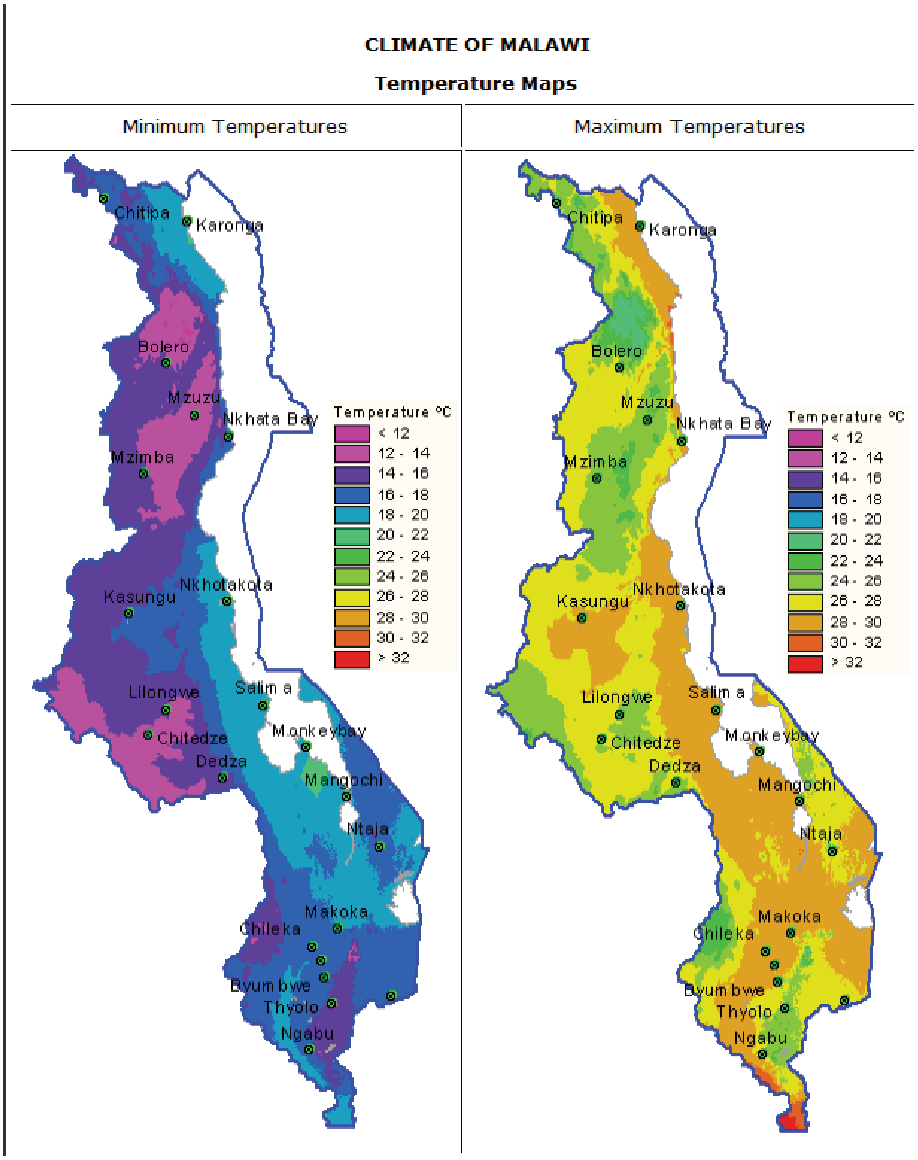
In one study of the 2020–40 time period, rainfall in the northern part of the country was predicted to remain at similar levels and frequencies, with the exception of a decrease in November rainfall levels. For 2040–60, however, the impact was much clearer—the dry season was predicted to extend to December and rainfall levels to increase in February and March (USAID 2013).

In the lakeshore area, most of the studied areas are projected to have less rainfall in early and late summer from 2020–40. In the 2040–60 period, both November and December are expected to become drier, whereas January and February will be wetter (USAID 2013).

In the south, the 2020–40 and 2040–60 time periods show similar results. November and April will become drier, both in terms of days and rainfall levels, whereas rain will increase in the same manner in February and March. The only difference between the two periods is that in 2040–60, total monthly rainfall is expected to decline (USAID 2013).

[14] Water balance here refers to availability-demand (USAID 2013, 4).

FIGURE B.9. CURRENT MINIMUM AND MAXIMUM TEMPERATURES IN MALAWI

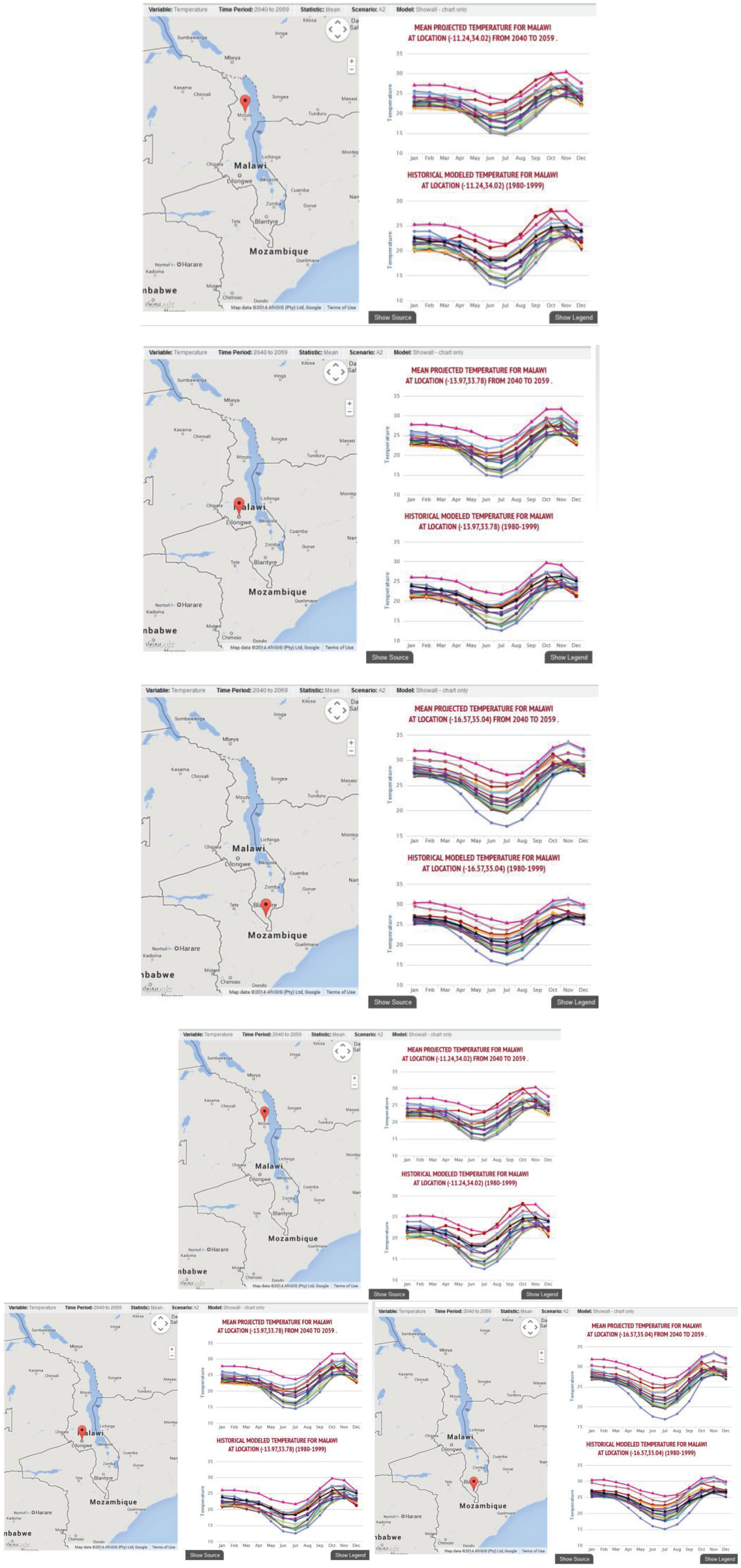


Source: Ministry of Natural Resources, Energy and Environment, Department of Climate Change and Meteorological Services. "Temperature Maps" found at http://www.metmalawi.com/climate/temperature.php.

TEMPERATURE

Current and projected future temperatures also vary by region. Figure B.9 shows current minimum and maximum temperatures in Malawi. The south of the country is significantly hotter than other parts of the country. This trend is expected to continue to hold in the future, but will be exacerbated by hotter temperatures overall. Figure B.10 shows the results of nine climate change models.

FIGURE B.10. RESULTS OF NINE CLIMATE CHANGE MODELS FOR THE NORTHERN, CENTRAL, AND SOUTHERN PARTS OF MALAWI



Source: World Bank, Climate Change Portal.

APPENDIX C

VULNERABILITY ANALYSIS[15]

CONTEXT

The Malawi Vulnerability Assessment Committee[16] divided the country into 11 livelihood zones based on the livelihood options that households use to make a living (table C.1). In all livelihood zones, the main source of food is own crop production, often supplemented by food purchases from local markets. Poor households also often sell their household labor (locally known as "*ganyu*") in exchange for food.[17] In some livelihood zones, wild foods are also an important source of food, especially during lean periods. Crop sales remain an important source of cash for households in all the livelihood zones. In some zones where cash crops (such as tobacco and cotton) are widely grown, they provide an important source of cash for households. In all zones, food crop sales also contribute significantly to household incomes. Other important sources of income for the majority of households, especially the poor, include *ganyu*, self-employment, and sale of nonfarm products, such as firewood and charcoal. Table C.1 provides details of sources of food and cash in each of Malawi's 11 livelihood zones.

Vulnerability can be perceived as the existence and the extent of a threat of poverty and destitution (Dercon 2005). Regardless of how vulnerability is defined, its underlying factor is a sense of insecurity regarding the extent to which a shock or a hazard will result in a decline in household or community welfare (Makoka 2008). Although poverty is perceived as a static phenomenon, vulnerability is a forward-looking measure of household welfare. Poverty can therefore be defined as an ex ante measure, whereas vulnerability is an ex post measure of household well-being (Dercon 2001).

[15] This appendix borrows heavily from Makoka 2011 and 2013b.

[16] MVAC is a consortium of the Malawi government, NGOs, and UN agencies in Malawi and is chaired by the Ministry of Economic Planning and Development. Its role is to provide accurate and timely information on food insecurity, thereby informing policy formulation, development programs, and emergency interventions to reduce food insecurity and vulnerability of the population.

[17] The household economy approach distinguishes the sources of food mainly into "purchase,'" "own crops," and "*ganyu*."

TABLE C.1. LIVELIHOOD OPTIONS, KEY HAZARDS, AND RESPONSE STRATEGIES IN MALAWI'S 11 LIVELIHOOD ZONES

Livelihood Zone	Districts Under the Zone	Main Food Sources	Main Cash Sources	Key Hazards	Response Strategies to Hazards
Central Karonga	Karonga	• Own crops (maize, cassava, sweet potatoes, rice) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat	• Sale of own crops (maize, cassava, rice, sweet potatoes) • Self-employment • Sale of livestock • Sale of household labor (*ganyu*)	• Dry spells affect crop production • Flooding • Armyworms attack maize crop	• Increased livestock sales • Local sale of household labor (*ganyu*) • Sale of household assets • Reduced number of meals • Consumption of maize husks
Western Rumphi and Mzimba	Rumphi Mzimba	• Own crops (maize, pulses, sweet potatoes, groundnuts) • Food purchase • Food in exchange for labor (*ganyu*)	• Sale of tobacco • Sale of maize • Sale of other crops (pulses, sweet potatoes) • Self-employment • Sale of livestock • Sale of household labor (*ganyu*)	• Dry spells affect crop production • Newcastle disease affects chickens • Highly volatile maize and tobacco output prices	• Local and distant *ganyu* • Increased consumption of wild foods and roots • Sale of household assets • Extreme reduction in number of meals
• Mzimba Self-Sufficient	Mzimba	• Own crops (maize, cassava, sweet potatoes, pulses, millet) • Food purchase • Wild foods • Own milk/meat • Food in exchange for labor (*ganyu*)	• Sale of tobacco • Sale of maize • Sale of other crops (cassava, sweet potatoes, soybeans) • Self-employment • Sale of livestock • Sale of milk • Sale of household labor (*ganyu*)	• Dry spells • Excessive rainfall and waterlogging • Crop diseases • Cattle diseases (for example, foot-and-mouth)	• Local and distant *ganyu* • Increased consumption of less preferred food (cassava) • Sale of household assets • Excessive livestock sales • Extreme reduction in number of meals
Nkhatabay Cassava	Nkhatabay Karonga Rumphi Nkhotakota	• Own crops (cassava, maize, sweet potatoes, groundnuts, rice, pulses, bananas) • Food purchase • Food in exchange for labor (*ganyu*)	• Sale of cassava • Sale of bananas • Sale of other crops (groundnuts, sweet potatoes, pulses) • Small business enterprises • Sale of household labor (*ganyu*)	• Flooding • Dry spells • Crop pests (such as armyworms) • Drought	• Local and distant *ganyu* • Sale of household assets • Increased sale of nonfarm products (firewood, fish) • Expenditure switching

TABLE C.1. *continued*

Livelihood Zone	Districts Under the Zone	Main Food Sources	Main Cash Sources	Key Hazards	Response Strategies to Hazards
• Kasungu-Lilongwe Plain	Mzimba Kasungu Lilongwe Dowa Ntchisi Dedza Mchinji	• Own crops (maize, sweet potatoes, groundnuts, pulses) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat • Wild foods	• Sale of tobacco • Sale of maize • Sale of other crops (groundnuts, sweet potatoes, soybeans, pulses) • Small business enterprises • Sale of household labor (*ganyu*) • Sale of livestock	• Waterlogging • Dry spells • Livestock theft • Crop pests (such as armyworms) • Wildfires • Drought	• Increased local and distant *ganyu* • Sale of household assets • Increased sale of nonfarm products (firewood, fish) • Consumption of maize bran • Consumption of wild roots
Southern Lakeshore	Nkhotakota Salima Mangochi	• Own crops (maize, rice, cassava, sweet potatoes, sorghum) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat • Wild foods	• Fishing • Fishing *ganyu* • Crop sales (rice, sweet potatoes, maize, cassava) • Small business enterprises • Self-employment (firewood sales, mat-making, and so on) • Sale of livestock	• Flooding • Dry spells • Threat from wild animals (elephants, hippos) • Drought	• Increased local and distant *ganyu* • Migration • Sale of household assets • Eating less preferred foods • Reduction in number of meals
Lake Chilwa and Phalombe	Machinga Zomba Chiradzulu Phalombe Thyolo Mulanje	• Own crops (maize, rice, cassava, sweet potatoes, pigeon peas, sorghum, cowpeas) • Food purchase • Food in exchange for labor (*ganyu*) • Wild foods	• Sale of tobacco • Sale of maize • Sale of other crops (groundnuts, sweet potatoes, soybeans, pulses) • Small business enterprises • Sale of household labor (*ganyu*) • Sale of livestock (goats)	• Flooding (of Lake Chilwa) • Dry spells • Drought	• Increased local and distant *ganyu* • Sale of household assets • Increased sale of nonfarm products (firewood, fish) • Consumption of maize bran • Consumption of wild roots
Southern Lakeshore	Salima Dedza Ntcheu Mangochi	• Own crops (maize, rice, cassava, sweet potatoes, pigeon peas, sorghum, cowpeas) • Food purchase • Food in exchange for labor (*ganyu*) • Wild foods • Own milk/meat	• Sale of rice • Sale of maize • Sale of other crops (groundnuts, sweet potatoes, soybeans, pulses) • Livestock sales • Small business enterprises • Sale of household labor (*ganyu*)	• Flooding • Dry spells • Drought	• Increased local and distant *ganyu* • Migration • Sale of household assets • Consumption of less preferred foods • Reduction in number of meals

(*continued*)

TABLE C.1. *continued*

Livelihood Zone	Districts Under the Zone	Main Food Sources	Main Cash Sources	Key Hazards	Response Strategies to Hazards
Shire Highlands	Machinga Mangochi	• Own crops (maize, rice, cassava, sweet potatoes, pigeon peas, sorghum) • Food purchase • Food in exchange for labor (*ganyu*)	• Fishing • Fishing *ganyu* • Crop sales (rice, sweet potatoes, maize, cassava) • Small business enterprises • Self-employment (firewood sales, mat-making, and so on)	• Flooding • Dry spells • Threat from wild animals (elephants, hippos) • Drought	• Increased local and distant *ganyu* • Migration • Sale of household assets • Consumption of less preferred foods • Reduction in number of meals
Middle Shire Valley	Blantyre Mangochi Balaka Zomba Mwanza Neno	• Own crops (maize, rice, cassava, sweet potatoes, pigeon peas, sorghum, cowpeas) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat	• Sale of cotton • Sale of pigeon peas • Sale of other crops (rice, sweet potatoes, soybeans, pulses) • Livestock sales • Fish sales • Sale of charcoal/firewood • Sale of household labor (*ganyu*)	• Flooding • Dry spells • Drought	• Increased local and distant *ganyu* • Sale of household assets • Increased sale of nonfarm products (firewood, fish) • Consumption of maize bran • Consumption of wild roots
• Thyolo-Mulanje Tea Estates	Thyolo Mulanje	• Own crops (maize, cassava, sweet potatoes, pigeon peas, cowpeas, bananas) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat	• Sale of pigeon peas • Sale of other crops (sweet potatoes, cowpeas, bananas) • Livestock sales • Fish sales • Sale of charcoal/firewood • Sale of household labor (*ganyu*)	• Dry spells • Drought • Banana diseases	• Increased local and distant *ganyu* • Migration • Sale of household assets • Consumption of less preferred foods • Reduction in number of meals
Lower Shire Valley	Chikwawa Nsanje	• Own crops (maize, rice, millet, sweet potatoes, pigeon peas, sorghum, cowpeas) • Food purchase • Food in exchange for labor (*ganyu*) • Own milk/meat	• Sale of cotton • Sale of pigeon peas • Sale of other crops (rice, sweet potatoes, soybeans, pulses) • Livestock sales • Fish sales • Sale of household labor (*ganyu*)	• Flooding • Dry spells • Drought • Livestock diseases	• Increased local and distant *ganyu* • Sale of household assets • Increased livestock sales • Increased sale of nonfarm products (firewood, fish) • Eating less preferred foods • Consumption of wild roots

In the context of this study, vulnerability is a term used to describe exposure to hazards and shocks. Literature highlights the fact that vulnerability is a product of two components: *exposure to a hazard* (a shock) and *resilience* (the ability to manage the hazard) (Devereux et al. 2006).

COMMON SHOCKS FACED BY MALAWIAN HOUSEHOLDS

Households in Malawi face a wide range of shocks, most of which threaten their livelihoods and their survival. Shocks are defined as adverse events that lead to a loss of household welfare via a reduction in consumption, income, and/or a loss of productive assets (Dercon 2005). Shocks are classified into two groups: idiosyncratic shocks, which are household specific, such as death and illness; and covariate shocks, which are communitywide, affecting all households. Examples include floods, drought, and agricultural pests and diseases, among others (Makoka 2008). These shocks may push an already poor household deeper into poverty or drive a nonpoor household below the poverty line (Grosh et al. 2008).

Households in Malawi, especially those residing in the rural areas, live in environments where shocks are common. In particular, smallholder farmers who are dependent on rain-fed agriculture in Malawi often cope not only with severe poverty but also extremely variable incomes because of the wide range of shocks they face (Bardhan and Udry 1999). Studies have shown that the majority of rural households in Malawi are exposed to a number of shocks, most of which are livelihood threatening. For example, using Integrated Household Survey 2 (IHS2) data, the Malawi government and the World Bank (2007) report that 95 percent of the sampled households reported experiencing at least one shock in the past five years. Further, literature suggests that urban households tend to experience fewer shocks than rural households. For example, in the IHS2 data, about 60 percent of urban households reported experiencing three or fewer shocks, whereas over 75 percent of rural households reported encountering four or more shocks in the last five years (World Bank 2007). In the WFP study of 2009, whereas 36 percent of rural households reported not experiencing a shock, 29 percent reported experiencing one shock, and 35 percent experienced more than one shock (WFP 2010). Using IHS2 data, Devereux and others (2006) were able to show that poor households who experience shocks are more likely to experience a decline in well-being than nonpoor households who experience the same number of shocks.

An assessment of the major types of shocks facing Malawian households shows that climate and environmental shocks (such as droughts and floods) and economic shocks (such as rising food prices, falling prices for cash crops, household business failure) are the underlying factors contributing to high vulnerability in Malawi. For instance, using data on 12,288 households collected during IHS3 from 27 districts of Malawi between 2010 and 2011, NSO (2012) shows the major type of shocks reported by households (table C.2). Among the most common shocks are: drought (reported by 38.7 percent of the households); the high cost of agricultural inputs (reported by 26.2 percent); and unusually high prices of food (24.5 percent). As table C.2 shows, floods (reported by only 3.5 percent of the population) and crop pests and diseases (5.2 percent) are less common shocks. The statistics also show that the proportions of female-headed households that face various shocks are similar to those of male-headed households (table C.2).

KEY GROUPS VULNERABLE TO VARIOUS SHOCKS

Vulnerable groups are defined as individuals or households characterized by exceptionally low levels of income or high levels of poverty (World Bank 2007). Grosh and others (2008) identify vulnerable groups as individuals who face special difficulties in supporting themselves because of some particular aspect of their situation. According to the authors, these groups typically include the elderly, orphans, widows, people with disabilities, people with HIV/AIDS, refugees, and internally displaced persons, among others.

The Malawi Growth and Development Strategy (MGDS) (2006–11) provides an excellent exposition of vulnerable groups in Malawi. The MGDS defines the most vulnerable as including individuals or households affected by disasters; households headed by orphaned children, the elderly, and single parents (especially female headed);

TABLE C.2. PROPORTION (%) OF HOUSEHOLDS SEVERELY AFFECTED BY SHOCKS DURING THE PAST 12 MONTHS BY LOCATION, SEX, AND REGION IN MALAWI, 2011

Shock		Place of Residence		Sex		Region		
	Total (%)	Urban (%)	Rural (%)	Male (%)	Female (%)	North (%)	Central (%)	South (%)
Drought/irregular rains	37.8	9.1	43.1	36.2	42.8	27.9	17.3	58.3
Unusually high costs of agricultural inputs	26.2	8.5	29.5	26.1	26.4	26.0	36.5	17.3
Unusually high prices for food	24.5	17.7	25.7	23.8	26.5	24.8	26.2	22.9
Unusually low prices for agricultural output	12.2	2.0	14.1	12.9	10.0	10.1	20.4	5.6
Serious illness or accident of household member	11.5	6.2	12.5	11.6	11.1	10.0	12.7	10.8
Unusually high level of livestock disease	5.7	1.1	6.5	6.0	4.9	6.8	7.7	3.7
Theft of money/ valuables/assets/ agricultural output	5.6	5.6	5.6	5.6	5.8	3.2	6.0	5.9
Unusually high level of crop pests or disease	5.2	0.7	6.0	5.3	4.8	3.3	8.2	3.0
Floods/landslides	3.5	1.1	4.0	3.6	3.5	5.3	4.7	2.1
Conflict/violence	3.2	3.3	3.2	3.1	3.8	1.9	3.7	3.2
Death of other household member(s)	3.1	2.6	3.2	2.8	4.1	2.1	3.0	3.5
Earthquakes	2.9	2.7	2.9	3.0	2.4	14.7	2.3	0.2
Break-up of household	2.4	1.2	2.6	1.2	6.1	1.7	2.0	2.9
Birth in the household	2.3	1.6	2.4	2.6	1.2	2.7	2.2	2.3
Reduction in earnings from household	1.7	2.9	1.5	1.8	1.6	1.4	1.4	2.1
End of regular assistance/ aid/ remittances from outside	1.6	0.6	1.7	1.2	2.6	1.0	1.6	1.7
Household (nonagricultural) business failure	1.5	2.1	1.4	1.6	1.2	2.0	1.2	1.6
Death of income earner(s)	1.2	0.6	1.3	0.5	3.4	1.0	1.0	1.5
Reduction in the earnings of currently salaried household member	0.9	2.1	0.7	1.0	0.5	0.3	1.0	1.0
Loss of employment of previously salaried member	0.7	1.1	0.7	0.9	0.3	0.4	0.6	0.9
Other	1.9	2.1	1.8	1.9	1.7	1.6	2.0	1.8

Source: Makoka 2013b.

persons with disabilities; children under five and lactating and pregnant mothers; orphans in streets, orphanages, foster homes, and extended family member households; the unemployed and underemployed in urban areas; and the land constrained in rural areas. However, the MGDS emphasizes that not all individuals in the above categories are classified as most vulnerable. The determining factor is made based on their inability to meet their basic needs and on the basis of poverty characteristics.

Grosh and others (2008) highlight that vulnerable groups tend to have a low level of education, are poorly integrated in the labor market, and own few assets. Further, many vulnerable groups face discrimination, making it even more difficult to generate independent income to support themselves. It is important to note that different vulnerable groups face problems specific to that group. Ellis (2003) describes vulnerable groups as those "living on the edge.[18]

Using ultrapoverty as a proxy for vulnerability because of data limitations, the Malawi Poverty and Vulnerability Assessment report of 2007 identifies a number of ultrapoor households. *Female-headed households* were found to be significantly more likely to be ultrapoor, and are therefore seen as one of the vulnerable groups in Malawi (World Bank 2007).[19] A number of other studies also classify female-headed households as a vulnerable group, including Grosh and others (2008) and Christiaensen and Subbarao (2004). In his study of vulnerability in southern Africa, Ellis (2003) argues that female-headed households are vulnerable because of women's lack of access rights to land and their lack of time to cultivate land, among others. Along the same line, *widows* and *divorced women* are classified as vulnerable because of loss of a previous partner's contribution to household livelihood (Ellis 2003). Malawi Government and World Bank (2007) also report that larger households[20] and households with more young children are more likely to be ultrapoor. Box C.1 highlights the major gender vulnerabilities to which widows, divorced women, and female-headed households are subject in Malawi.

Ellis (2003) also notes that ***children under the age of five*** are a key group vulnerable to undernutrition, malnutrition, and infectious diseases. Further, child-headed households are an important vulnerable group in Malawi. A child-headed household may be defined as *a household characterized by a child under age 18 years acting as a guardian for siblings, relatives, and other children.* Child-headed households are vulnerable because the head is not old enough to take over the responsibility of looking after siblings and taking care of household affairs.[21]

FACTORS INCREASING VULNERABILITY TO SHOCKS

Limited Livelihood Options: In all the districts of Malawi, the majority of the population is dependent on rain-fed agriculture. However, in many livelihood zones, the annual precipitation rates are usually not sufficient to support rain-fed food production. As a result, dry spells are a frequent hazard that affects food production (see table C.1). For the households to be able to withstand food insecurity-related shocks, livelihood opportunities must exist outside rain-fed agriculture. Households that have access to land along rivers are able to grow maize and other crops along the wetlands, thereby widening their sources of food and cash. However, the majority of households that do not have such access. Further, households' reliance on *ganyu* is also conditional on rainfall since the *ganyu* is usually provision of farm labor. Lack of adequate

[18] The phrase "living on the edge" provides a graphic image of the livelihood circumstances that vulnerability tries to convey (Ellis 2003). It was first used as a title of a Save the Children report (namely, Pearce, Ngwira, and Chimseu 1996).

[19] It is important to note that using the IHS2 data, female-headed households were also found to be poorer than male-headed households in Malawi. Holding all other factors constant, a female-headed household had 14 percent less consumption per capita than a male-headed household (World Bank 2007).

[20] Although larger households are associated with increasing vulnerability, some studies have found larger family size associated with decreasing vulnerability to poverty, including Christiaensen and Subbarao (2004) in their study of vulnerability in rural Kenya. The authors argue that larger household size may reduce household vulnerability because of the larger supply of labor, which may be useful during periods of consumption shortfall.

[21] Factors contributing to the rising phenomenon of child-headed households in Malawi include frequent deaths due to HIV/AIDS; abject poverty; the weakening of the extended family support system; poor long-term planning for families; and the lack of adequate support to the existing community-based OVC structures (Makoka 2011).

BOX C.1. GENDER VULNERABILITY IN MALAWI

- Women make up 70 percent of the agricultural labor force but are less likely to engage in cash crop production because of labor and time constraints.
- In 2005, a female-headed household had 14 percent less consumption per capita than a male-headed household, according to the Malawi Poverty and Vulnerability Assessment Report.
- The value of assets owned by male-headed households is more than double that of female-headed households and male-headed households are more likely to own agricultural assets.
- Women's rate of pay for *ganyu* is likely to be only two-thirds the rate paid to men.
- Women face more difficulties in accessing credit, because many do not possess the assets required as collateral.
- According to the 2008 Malawi Population and Housing Census, 59 percent of women were literate compared with 69 percent of men.
- Unequal employment opportunities exist between men and women outside the agriculture sector in Malawi. For example, according to the 2010 Malawi Millennium Development Goal Report, the share of women in wage employment outside the agriculture sector was only 15 percent in 2006, and is projected to be 18.8 percent in 2015.
- As household assets are depleted, women are more likely to engage in sexual transactions and other risky behaviors to meet household subsistence needs.
- Women and girls typically take on the burden of caring for sick family members.
- Young girls are more likely than young boys to be withdrawn from school to care for younger siblings or the sick and to assist with domestic and agricultural work following a livelihood shock to the household.
- Female-headed households are more dependent on external support (gifts from relatives, food aid, public works programs) for subsistence than are male-headed households.
- Women are rarely represented on councils of elders, and so are unable to influence decisions over access to land and inheritance rights, among others.

Source: Adapted from Hay and Phiri 2008.

livelihood options outside agriculture is therefore a key source of vulnerability in many livelihood zones.

Poverty: Poverty is an important driver of vulnerability in Malawi. According to the IHS3 of 2011, the poverty rate was highest in Chikwawa (81.6 percent) and lowest in Nkhotakota (32.1 percent), with a national average rate of 50.7 percent. Poverty remains a more serious problem in the rural areas, where 56.6 percent of the population is estimated to live below the national poverty line, versus 17.3 percent in urban areas (2011). Regionally, the poverty rate is highest in the southern region (55.5 percent), followed by the northern region (54.3 percent); it is lowest in the central region (44.5 percent). Studies have shown that households are vulnerable to food-insecurity shocks because of their poverty situation (Makoka and Kumwenda 2013). In particular, poverty makes them susceptible to any food-related shock as they do not have the capacity to prevent the shock or to manage its effects when it occurs. This is a more serious problem for female-headed households, as 57 percent of people living in female-headed households are poor, versus 49 percent in male-headed households (2011).

Limited Productive Assets: Another key factor that is a major source of vulnerability to a range of idiosyncratic and covariate shocks is households' limited assets. There is vast literature on the use of household assets to protect households from shocks (see Dercon 2000; Makoka 2008). Many households do not have assets to cushion themselves against a range of shocks, including drought. Productive assets, including livestock, are an important source of livelihood, especially in the face of shocks. As table C.1 shows, in some livelihood zones (such as Western Rumphi and Mzimba, Mzimba Self-Sufficient, and Lower Shire Valley), households depend on livestock as a source of food and cash. They are able to respond to shocks by increasing the sale of their livestock. Initiatives that build households' asset base would therefore be effective in ensuring that households' vulnerability to various livelihood shocks is minimized.

Low Own-Food Production: As table C.1 shows, the main source of food across all livelihood zones is own production. However, in many households, own-food production is too low to last the whole food consumption year. Therefore, they depend on the market to fill their food gap. Unfortunately, the majority of food-deficit households do not have the financial capacity to get sufficient food from the market. This makes them more vulnerable to any food-related shock. Prolonged dry spells, droughts, unreliable rainfall, lack of inorganic fertilizer, and poor soils are all factors responsible for low own-food production. For female-headed households, low landholdings and lack of household labor exacerbate the problem of low own-food production (see box C.1).

Illnesses Due to HIV and AIDS: HIV/AIDS-related illnesses in communities are another important factor contributing to the high vulnerability of households to food-related shocks. Illnesses disrupt households from undertaking productive activities. At times, even healthy members of the household, especially women, withdraw household labor to nurse sick relatives.

RISK-MANAGEMENT STRATEGIES TO MAIN SHOCKS

There is evidence in the literature that vulnerable groups undertake different risk-management strategies in the face of shocks. A distinction is made between the strategies undertaken before a shock occurs—ex ante risk-management strategies—and those taken after a shock has already occurred—ex post coping strategies. The goal of ex ante risk-management measures is to prevent the shock from occurring, or if prevention is not possible, to mitigate the effects of the shock (Holzmann 2001; Makoka 2008). Studies have shown that households' level of economic vulnerability is a function of not only the degree to which they are exposed to negative shocks that have an effect on their welfare, but also the extent to which they can cope with the shocks when they occur (Christiaensen and Subbarao 2004; Dercon 2001; Makoka 2008).

Ex Ante Risk-Prevention Strategies: The common ex ante risk-mitigating strategies in Malawi include income diversification, especially through crop diversification, and nonfarm income-generating activities. Using data from IHS2, the Malawi government and the World Bank (2007) report that large shares of both urban and rural households have nonfarm income sources, with wealthier households in rural areas earning income from nonagricultural household enterprises.[22] Other income sources for rural households reported by the Malawi government and the World Bank (2007) include tobacco sales (16 percent of households), nontobacco crop sales (53 percent), livestock sales (30 percent), and informal sale of household labor (*ganyu*) (52 percent), among others.

Other ex ante risk-management strategies include migration of household members as a way of diversifying income for the household (World Bank 2007). However, although migration can be seen as a means for individuals to seek new opportunities and to diversify income sources for the household, it can also arise due not to economic reasons but family issues. In the IHS2 data, most reported migration was related to family issues, such as marriage and divorce (World Bank 2007). It is important to note, however, that migration can be undertaken ex ante or ex post.

Further, informal insurance (via village savings and loan groups [VSLs]) to protect households against future shocks is known to exist in Malawi but has not been accurately captured by nationally representative data. Nevertheless, informal group-based insurance schemes, as well as formal group-based lending facilitated by microfinance institutions, are an important source of household income that reduces the impact of shocks when they occur. In many communities, VSLs are usually used by women to shield their households from livelihood shocks.

Because drought or irregular rainfall is one of the most severe shocks in Malawi, one of the most common ex ante strategies employed is to grow drought-resistant crops. In drought-prone areas of Balaka, Chikhwawa, and Nsanje, for example, planting crops such as millet and cassava is encouraged to enable farmers to manage the risk of drought. Regardless of the form it takes, an ex ante risk-management strategy is largely about building up assets to provide households with buffers against uncertain events (Swift 1989). It also entails diversifying activities on and off farm and this diversity needs to comprise activities that have risk profiles that differ from one another (Ellis 2003).

[22] In the IHS2 data, about 34 percent of all rural households reported earning an income from household enterprise. In particular, more wealthy households reported earning income from nonfarm enterprises than did poorer households. For instance, 27 percent of the poorest 20 percent of rural households had an enterprise income compared with 38 percent of the richest 20 percent of rural households.

Ex Post Coping Strategies: Most households have limited ex ante strategies to mitigate risks in Malawi. As a result, when a particular shock occurs, households undertake a number of strategies to relieve the impact of the shock. From a range of coping options, households initially adopt a coping strategy that is "nonerosive" to enable it to survive without disintegration or significant cost (World Bank 2007). Examples of nonerosive responses include reducing consumption of nonfood items, sending a family member to town to look for work, and gathering wild food, among others (Ellis 2003). Other viable strategies include getting assistance from neighbors and family friends or using a modest amount of household savings.

One of the first responses to major shocks reported by households is the use of *cash savings*. In his two-period study of 259 rural households in Malawi, Makoka (2008) indicates that 10 percent of the sampled households reported using cash savings to cope with shocks in 2004 and 9 percent used the strategy in 2006. Christiaensen and Sarris (2007) argue that the use of liquid savings does not disrupt households' productive resource base.

Households may also *sell assets* to cope with shocks. Table C.1 shows that sale of household assets is an important coping strategy in all 11 livelihood zones. Literature suggests that households that respond to shocks by selling assets are those that had built up assets (such as livestock, farmland) in "good" years to deplete in "bad" years, a form of self-insurance (Christiaensen and Subbarao 2004; Dercon 2004). Makoka (2008) noted that the majority of household that employ this strategy may be vulnerable but are usually nonpoor. However, the sale of productive assets (such as land) can put households on a long-term lower earning path, as it undermines households' future productive capacity (Christiaensen and Sarris 2007). Sale of household assets is therefore an erosive response, causing a downward spiral in the asset status of the social unit (Ellis 2003) and its future ability to manage shocks.

Another important coping strategy is *household supply of temporary labor*, both on and off farm, commonly known as *ganyu*. *Ganyu* is a major coping strategy employed in rural Malawi. In all livelihood zones the poor, who are often subject to food-related shocks, use *ganyu* as a major source of exchange for food (see table C.1).

Households also get support from *social networks*, by borrowing from relatives and neighbors or sending children to live with their relatives elsewhere, as a means of coping with shocks (Makoka 2008). Further, Makoka (2008) was able to show that wealthier households use social networks as a coping strategy more often than poorer households.

Another important form of coping with shocks, especially those that affected households' ability to access food, is *changing household dietary patterns.* In its study of 4,908 households in 2009, WFP (2010) reports that the most common coping strategy to cope with various shocks is reduction of food portion size (reported by 57 percent) followed by a reduction in the number of meals (55 percent). Malawi Government and World Bank (2007) report that consuming less food was the first coping strategy for about 14 percent of all households that reported experiencing a shock. Table C.1 shows that changing dietary patterns is an important coping strategy in many livelihood zones. Ellis (2003) also points outs that as a coping strategy, households may substitute between foods, for instance eating cassava instead of maize.

Poor and vulnerable households cope with shocks through support from *social support programs*. In IHS2, about 3 percent of households that experienced shocks used assistance from different programs as a first coping strategy (World Bank 2007). Makoka (2008) reports that about 25 percent of the sampled households reported using support from social safety net programs as the first response to cope with shocks.

Other erosive coping strategies include withdrawing children from school, engaging in commercial sex work, and overexploiting natural resources (World Bank 2007). It is important to note that households employ nonerosive responses first; if they still cannot cope after using the initial strategy, they move to erosive strategies that entail substantial permanent damage to their ability to engage in productive activities.

AGRICULTURE GLOBAL PRACTICE TECHNICAL ASSISTANCE PAPER

WORLD BANK GROUP REPORT NUMBER 99941-MW

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