Which climate services do farmers and pastoralists need in Malawi?

Working Paper No. 112

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Jeanne Y. Coulibaly, Joash Mango, Martha Swamila

Arame Tall, Harneet Kaur, James Hansen

Working Paper

CGIAR

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CCAFS

Which climate services do farmers and pastoralists need in Malawi?

Baseline Study for the GFCS Adaptation Program in Africa

Working Paper No. 112

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Jeanne Y. Coulibaly
Godfrey Kundhlande
Arame Tall
Harneet Kaur
James Hansen

Correct citation:
Coulibaly Y. J., Kundhlande G., Tall A., Kaur H., Hansen, J., 2015. Which climate services do f armers and pastoralists need in Malawi? Baseline Study for the GFCS Adaptation Program in Africa. CCAFS Working Paper no. 112. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

This document is published by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is a strategic partnership of the CGIAR and the Earth System Science Partnership (ESSP). CCAFS is supported by the CGIAR Fund, the Danish International Development Agency (DANIDA), the Government of Australia (ACIAR), Irish Aid, Environment Canada, Ministry of Foreign Affairs for the Netherlands, Swiss Agency for Development and Cooperation (SDC), Instituto de Investigação Científica Tropical (IICT), UK Aid, and the European Union (EU). The Program is carried out with technical support from the International Fund for Agricultural Development (IFAD).

The work is supported by The GFCS Adaptation Programme in Africa, which is funded through a grant from the Norwegian Agency for Development Cooperation (NORAD), and is implemented with technical support from the World Meteorological Organization (WMO).

Contact:
CCAFS Coordinating Unit - Faculty of Science, Department of Plant and Environmental Sciences, University of Copenhagen, Rolighedsvej 21, DK-1958 Frederiksberg C, Denmark. Tel: +45 35331046; Email: ccafs@cgiar.org

Abstract

This report presents final findings from the baseline data collection exercise conducted for the Global Framework for Climate Services (GFCS) Adaptation Programme in Africa. The GFCS programme seeks to improve climate services for agriculture, food security, heath and disaster risk reduction in Tanzania and Malawi. Under the auspices of this GFCS project, the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS) is responsible to support baseline data collection and monitoring and evaluation to evaluate climate services for farmers and pastoralists in both countries. The purpose of this report is to inform national partners on farmers' current needs and access to climate information services.

Households interviewed in Malawi are mostly crop farmers, and have access to conventional climate information. However, they rely more on indigenous knowledge, personal experience and traditional cropping calendar than on climate information for their farm decision-making. Respondents would like to receive more advice about improved cropping practices, and better communication of climate information through village meetings and in their local languages. The climate information farmers would like to receive includes forecasts of extreme events, onset of the rains, seasonal rainfall, daily weather, and pest and diseases. These forecasts should be timely. Seasonal forecasts should be available preferably months before the start of the season to allow farmers to integrate them in their farm management decisions. The preferred communication channels were visits from extension agents, radio messages and SMS in cell phones. Farmers trust information from government extension agents, radio presenters and NGOs. Women particularly trust NGO workers.

Keywords

Climate Services; Baseline Survey; Monitoring & Evaluation; Malawi; Africa; Gender Equity.

About the authors

Jeanne Y. Coulibaly is a scientist, agricultural economist working for the World Agroforestry Center based in Nairobi, Kenya. Dr Coulibaly's work focuses on assessing vulnerabilities of smallholder farmers to climate risks and analyzing community based adaptation to climate change. Contact: j.coulibaly@cgiar.org

Godfrey Kundhlande is an agricultural economist working for the World Agroforestry Centre's (ICRAF) East and Southern Africa regional program, and is based Malawi. Dr Kundhlande's work focuses on assessment of the economic viability, profitability and social acceptability of agroforestry innovations, and their contribution to improving the well-being of smallholder farmers. Contact: G.Kundhlande@cgiar.org

Arame Tall is the climate services expert of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), based at the International Food Policy Research Institute (IFPRI), in Washington, D.C. Contact: A.tall@cgiar.org.

Harneet Kaur is Program Support Consultant with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) - Flagship 2: Climate Information Services and Climate-Informed Safety Nets, based at the International Livestock Research Institute (ILRI) in Nairobi (Kenya) Contact: h.k.kaur@cgiar.org / kaur.harneet@outlook.com

James Hansen is the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) Flagship 2 Leader: Climate Information Services and Climate-Informed Safety Nets, based at the International Research Institute for Climate and Society (IRI), Columbia University, in New York. Contact: jhansen@iri.columbia.edu

Acknowledgements

This study was commissioned and overseen by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS); and conducted by World Agroforestry Center, under the auspices and with financial support of the Global Framework for Climate Services (GFCS) Adaptation Programme in Africa. The Global Framework for Climate Services (GFCS) is an international partnership seeking to harness scientific advances and improve the availability, accuracy and use of climate information, which will help society cope with climate change and hazards such as droughts and floods. The GFCS Adaptation Program in Africa aims to increase the resilience of people most vulnerable to the impacts of weather and climate-related events through the development, implementation and evaluation of a joint program for the target countries: Tanzania and Malawi. The program seeks to build integrated frameworks within countries and will support existing initiatives to improve the provision and use of climate services for food security, nutrition and health, and disaster risk reduction.

We would like to thank the following experts for their inputs, efforts, and support for the baseline survey: Henry Neufeldt, John Gathenya, Gladys Zimba, Steven Khuleya, Lazarus Gonani, Joseph Moyo, Patricia Phiri and Augustine Tonde, Anthony Kimaro and Mathew Mpanda.

Contents

Acronyms

GFCS	Global Framework for Climate Services
WFP	World Food Programme
CCAFS	CGIAR Research Program on Climate Change and Food Security
CGIAR	Consortium of International Agricultural Research Centers
SMS	Short Message Service
ICRAF	International Centre for Research in Agroforestry
ADMARC	Agricultural Development and Marketing Corporation

Introduction

Agriculture plays a critical role in the livelihood of smallholder farmers in Malawi as in many developing countries. Farmers rely on rainfed agriculture for their daily subsistence and for income generation. Increased climate variability in Malawi poses great challenges to farming activities and leaves farmers very vulnerable to the impact of weather and climate fluctuations. Thus, improving climate information and advisory services is recognized as a strategy that could help farmers to deal with the weather and climate uncertainty and thereby improve their decision making on crop management. Climate information provides useful knowledge that contributes to the adoption of new technologies, improved inputs and new cultivation practices (Msangi et al. 2006). Resultantly, there would be reduced risk and vulnerability to changing climate and enhanced crop productivity and food security. Hence, access to timely, accurate, reliable climate information and agricultural advice presents opportunities for reducing vulnerability and becoming more resilient to climate change.

To respond to this major challenge of increased climate variability, the international community established the Global Framework for Climate Services (GFCS) to promote operational climate services at the national and regional levels. This intergovernmental partnership is supported by the United Nations and other international organizations, and coordinated by WMO. The Adaptation Program in Africa, which targets Tanzania and Malawi, is the first multi-agency initiative to be implemented under GFCS. It is a 3-year project, funded by the Government of Norway, that aims to strengthen capacity both to develop and use climate services and combines cutting-edge science with traditional knowledge. The Adaptation Program in Africa is a joint effort of WMO, CCAFS, the Centre for International Climate and Environmental Research - Oslo (CICERO); the Chr. Michelsen Institute (CMI); the International Federation of Red Cross and Red Crescent Societies (IFRC) through the Tanzanian and Malawian Red Cross; the World Food Programme (WFP); and the World Health Organization (WHO). CCAFS-led activities include the implementation of research-based Monitoring and Evaluation regarding the access, use and needs of climate services by end users (farmers, pastoralists). A first step in this process was an

implementation of a baseline survey that collected detailed information on the current situation of climate services accessed and used by farmers and pastoralists. This information provides benchmark indicators against which progress and performance of the project will be measured.

This report presents a synthesis of the findings of the key benchmark indicators regarding the access, use and availability of climate information services in Malawi. Tanzania is covered in a separate report. The results shed light on what kinds of information farmers and pastoralists need, and in what formats. This baseline information will be used to compare against data after the implementation of the program activities by partners in order to evaluate the impact of climate services on the livelihood of the rural communities targeted.

Survey Instruments

The survey instruments developed for the baseline include both a structured individual household questionnaire and a key informant interview guide. Both instruments were derived from pilot CCAFS baseline tools to measure the value of climate services for farmers, to which GFCS partners contributed questions and specific input to adapt the survey to the country context and needs of the GFCS project. The protocol instruments have been tested and validated in several CCAFS research sites in West Africa (Kaffrine in Senegal), East Africa (Nyando in Kenya) and South Asia (India) (Tall et al., 2014). These efforts have resulted in an effective context driven tool kit to evaluate climate services across countries. The toolkit encompasses a pre-assessment survey to understand background contextual issues related to the usefulness of climate information services and guidelines for monitoring and evaluation of climate service projects. The baseline survey instruments have been adapted and implemented in Tanzania and Malawi for the purpose of this baseline exercise. The data collected from the survey instruments are used to develop a set of indicators on access, needs and use of climate services that will be monitored during the project implementation in order to assess changes in the beneficiaries' livelihoods as a result of the project.

The individual household questionnaire focuses on 6 sets of indicators: household assets and risk to agricultural productivity, the general sources of information on agriculture, the specific sources of information on climate, the use of climate information and the perceived impacts, gendered access to climate information and finally, impact of climate service use on

crop/livestock production and food security. The key informant interview guide was more concise since it aims to complement the information generated from the individual households' interviews. Indicators from this guide include community risks, sources of information on climate and agriculture, communication of climate information, gender and access to climate information.

Prior to the administration of the survey instruments in the target districts, the tools were tested in a pilot village, Kagombe, in Mpingu Extension Planning Area (EPA) west of the district of Lilongwe. The goal of this pre-testing was to check the relevance of the questions to the context of the survey, ensure a very good understanding of the survey tools and key concepts by the enumerator team.

Site Selection

A stratified random sampling design including village experiments (to receive the program) and controls (to serve as comparison) was used for the individual household data collection process. Key informants interviews involved a purposive sampling design. The stratified sampling design involved a three-stage selection process. First, districts were selected in the same sites where the GFCS project partners, mainly the Malawi National Red Cross Societies, and the World Food Programme (WFP), operate and plan interventions and climate service delivery between 2014 and 2016. For Malawi, we found that the Malawi Red Cross is planning to work in Lilongwe and Nsanje districts, while WFP will be working in Zomba.

Following the choice of districts, villages were then selected randomly from the list of villages where these partners plan to implement the GFCS project activities. Finally, in each village, households were randomly selected from a list provided by village leaders, together with local development workers of partner organisations. In addition to the selection of villages where partners have planned their activities, control villages where no GFCS activities are expected to take place between 2014-16 were also selected to serve as a comparison group. The control groups were selected from villages with similar vulnerability status, agro-ecology, socio-economic setting as the target experimental villages, but outside the range of influence of project activities to avoid information leakages. Selection of experimental and control villages will allow us to use a randomized control trial (RCT) approach when evaluating the project's effectiveness and impact for local farmers and

pastoralists at the end of the project. In Malawi, 20 villages have been surveyed (12 experiments and 8 controls) and 320 households interviewed with 76% male headed.

Populations sampled in each district have been weighted according to their total population figures. In Malawi, the larger number of villages selected in Zomba is partly because this district has a larger population 583,167 (census report 2008) (compared to Nsanje - 194,924 in 2008). In addition, the GFCS project activities in Zomba are planned to focus on rural areas with large numbers of farm households, as the survey instrument was designed with a main focus on agriculture and farm households. In Lilongwe, the target populations for the activities planned by Red Cross are populations at the outskirt of the city, where the majority of the households derive their livelihood from trading and wage labour. In these areas, Red Cross activities will focus on climate extremes and their effect on sanitation issues. This latter issue was not the focus of the questionnaires and therefore will reduce the relevance of the survey tools for this area. But, it was insightful to compare households' ability to cope with climate variability and access to climate information from these two perspectives, urban and rural areas. In addition to the individual households, 46 key informants were also interviewed based on a semi-structured interview guide, in order to triangulate information obtained at the household levels but also to obtain general background information, constraints encountered in agriculture and risk management.

Table 1. Summary of sampling sites and respondents in Malawi.

Districts	Number of villages	Number of households	Number of key informants
Lilongwe	5	80	12
Nsanje	5	80	12
Zomba	10	160	22
Total	*20*	*320*	*46*

Survey implementation

To implement the survey, ICRAF entered a partnership with ICRAF's offices in Malawi, WFP, Red Cross and district officers. ICRAF's offices in these countries have extensive experience conducting farm household surveys. They recruited experienced enumerators, and assisted in the training and the supervision of the enumerator team during the field survey.

The training of the enumerators took place at ICRAF's office in Lilongwe in September 2014. The training covered explanation of the purpose of the study, in-depth review of the baseline survey tools, pre-testing of the questionnaires and de-briefing sessions to improve the tools and sharpen the ability of the enumerators to administer the questions.

The implementation of the survey took place from September to October 2014. The survey team comprised 8 to 10 enumerators, and two supervisors including the ICRAF field technician and the agricultural economists from ICRAF's offices.

Administrative protocols for entering districts were facilitated by the partners WFP and Red Cross. Then, upon arrival in these districts, the field team completed the formalities by meeting with the district officers of partner organisations to explain the purpose of the survey, discussed selection of control villages (sites where no GFCS activities will be carried out over the course of the project) and ask to be introduced to local leaders in communities where the survey will take place, and to government agricultural extension officer responsible for the area in which the survey took place. After obtaining permission to interview households from the Group Village Headman and the Village Headman, the enumerators proceeded to conduct the household survey. The survey team also sought help of a local person in each village to guide the enumerators to the households in the village, ensure that only households falling within the selected villages were interviewed and help with translation issues if needed.

Results

Agro-ecological Zones and Climate in the Districts Surveyed

Mtandire community is a peri-urban settlement located on the outskirt of the city of Lilongwe. The area falls under T/A Chigoneka. The area was previously a rural farming community, but as the city of Lilongwe has expanded over time, the area has increasingly become integrated into the city. Mtandire is essentially an informal settlement/ city slum. It is not yet fully recognized as part of Lilongwe city. The inhabitants of the area are generally poor and most of the houses are not built in accordance with a formal settlement plan, and a large number of houses are built from mud or uncured bricks and thatched with grass or plastics. There is lack of basic infrastructure such roads, potable water and drainage systems. All the roads in the settlement are unpaved. Most households obtain water for household use from boreholes

dotted around the community. There are a number of open drainage channels to lead storm water away from the settlement during the rainy season to various streams that drain the area. However, these open storm drains get clogged with litter thereby causing flooding and contamination of drinking. Nevertheless, it was reported that there is already a process underway to formally incorporate the area under the jurisdiction of the city of Lilongwe and ensure that residents access services such as improved roads and sanitation. The city of Lilongwe lies in the Kasungu-Lilongwe plain, at an altitude of about 1,040 metres above sea level. On average Mtandire receives about 900 mm of rainfall per annum. The rainy season starts at end of November or early December and ends sometime in March.

Photo 1: Housing units in Chigoneka village, T/A Chigoneka, Lilongwe district. Photo credit: Godfrey Kundhlande.

Photo 2: Enumerator visiting a homestead in Chingwalu village (T/A Chigoneka), Lilongwe district. Photo credit: Tionge Nyondo.

Photo 3: Descending from Shire Highlands to TA Mlumbe in middle ShireValley, Zomba district. Photo credit: Nellie Amosi.

Zomba receives an average rainfall ranging from 600 mm to 1500 mm, and the rainy season spans from the month of November to April. The part of the district, under T/A Mlumbe is low lying and is located in the upper Shire valley. The area generally receives less rainfall compared to the part under TA Chikowi, which is part of the Shire Highlands zone.

Nsanje district is located in the southern part of Malawi. The average altitude for Nsanje district lies between 60 m and 610 m above sea level. The area receives an average rainfall of 740 mm. The rains last from January to April. Temperatures in Nsanje range between 52ºC in October and 8ºC in the cool season (May to July). The central part of the districts lies in the lower Shire river flood plain, and as such, flooding is the most common hazard in the district frequently causing loss of life and property. The other part of the district away from the flood plains is dominated by hills and mountain ranges, on both the east and west. The area under T/A Mlolo is on the east bank of the Shire River. All households in the area engage in some form of agricultural production – crop and livestock production - as part of their livelihood. In T/A Mlolo, both (Cholomali and Makhapha) are located in the flood plain, while the control village is located on higher ground, further away from the river. Many households have plots in areas within the river's flood line and irrigate their fields or really on residual moisture of receding floodwaters to grow crops.

Photo 4: House washed away during flood, February 2014 T/A Mlolo, Nsanje district
Photo credit: Augustine Tonde.

Photo 5: House washed away during flood, February 2014 T/A Mlolo, Nsanje district.
Photo credit: Augustine Tonde.

Primary Livelihood Activity

The largest proportion of households interviewed was engaged in farming as a primary livelihood activity with 45% in Lilongwe, 56% in Zomba and 68% in Nsanje (Table 2). Agro-pastoralism is the second most practiced activity in all districts surveyed, with the largest proportion of households (41%) reported in Zomba. As in most places in southern and central Malawi, land is a limiting factor and households generally do not raise large stock such as cattle. Households that are engaged in livestock production raise small stock such as goats

and chickens. Lilongwe had the highest proportion of respondents whose primary livelihood activity was not farming or pastoralism (33%) compared to 3% and 4% for Zomba and Nsanje respectively. These households in Lilongwe derive their main livelihoods from trading and wage labour activities. Literacy levels in the study areas were generally high with more than 56% of the sample having primary or higher education. Literacy levels appear higher in Lilongwe also, with more than 26% of household heads having secondary or higher education compared to 15% in Zomba and 19% in Nsanje.

Table 2. Socio-demographic characteristics of individual households, CCAFS baseline survey Malawi.

	Lilongwe	Zomba	Nsanje
Level of Education (percentage of households)			
None	10	16	24
Primary School	62	69	57
Secondary School	26	15	17
Post-secondary	1	0	1
Other	1	0	1
Primary Livelihood Activity (percentage of households)			
Farmer	45	56	68
Agro-Pastoralist	21	41	28
Pastoralist	0	1	1
Trade	13	0	1
Other	20	3	2

Household's Agricultural Production

Crop production is the main agricultural activity in the districts surveyed. The households interviewed practice livestock only marginally, so, this section focuses on results for crop production. Results in Figure 3 show that the major crops grown by the respondents are maize, groundnuts, sorghum, cotton, rice, pigeon peas and sweet potato. Maize is the leading crop grown by the respondents in all the surveyed districts. In Lilongwe, maize represents 64% of all crops planted in 2013 while in Nsanje and Zomba this share is about 35%. Farmers interviewed are small-scale farmers with an average of 1 acre of crop planted and two third of the production consumed at home.

Table 3. Major Crops grown and areas cultivated in 2012-2013 in the districts surveyed during the Agricultural Season 2012-2013.

	Lilongwe		Nsanje		Zomba	
	Share	Area	Share	Area	Share	Area
Crop	(%)	(acres)	(%)	(acres)	(%)	(acres)
Cotton	0%	0.00	10%	0.90	19%	1.00
Groundnuts	23%	0.80	2%	0.70	6%	1.40
Maize	75%	1.60	40%	1.30	46%	1.40
Sorghum	1%	1.00	21%	1.00	8%	1.40
Pigeon Peas	0%	0.00	1%	2.00	17%	1.70
Rice	0%	0.00	16%	1.10	3%	1.30
Sweet potato	1%	1.00	9%	0.39	2%	0.41

Key informant types

Table 4 presents the types of key informants interviewed in Malawi. In Lilongwe, respondents were mainly expert farmers engaged also in business activities (29%). This is understandable as many households in the surveyed villages in Lilongwe make their living from trading as they are located in a peri-urban area. In Zomba, their principal occupation was agricultural extension officer (41%) and in Nsanje they were chiefly involved in area development (31%).

Table 4. Socio-Demographic characteristics of key informants.

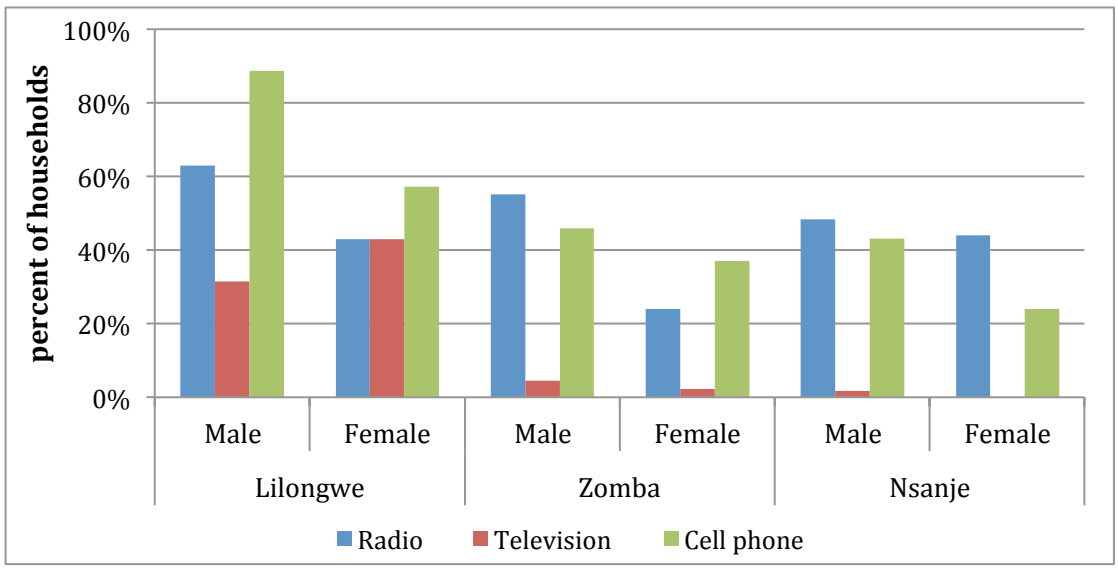
Respondent Role in Community/Organization (%)	Lilongwe	Zomba	Nsanje
Agricultural Ext Development Officer	7	41	13
Area Development Committee Member	0	18	31
Expert farmers	29	12	0
Chief/Village Head	14	12	0
Climate Change Advisor	21	6	0
Club Director/Chair	0	0	19
Other	29	12	38

Asset ownership

Figure 1 provides a description of the communication assets owned by households headed by both men and women. These assets shape households' access to climate and agricultural information and their ability to act on that information. Results showed the three communication assets, radio, television and cell phones, are commonly owned by the

respondents. Across districts, a significantly higher proportion of men own these assets compared to women, except in Lilongwe where television is owned by a larger proportion of female respondents (40%) relatively to the male respondents (30%). Also, the largest proportion of households that own radio, television and cell phone is reported in Lilongwe. Radio and cell phone are the most popular communication assets reported by households. In Lilongwe, 89% of the male respondents own cell phone while in Nsanje and Zomba, lower percentage respectively 43% and 46% of the respondents own this asset. Radio is owned by 63% of the male households interviewed in Lilongwe. In Nsanje and Zomba, fewer households, on average 51% and 33% of male and female household heads claimed to own radio.

Figure 1. Households' communication asset ownership by district.

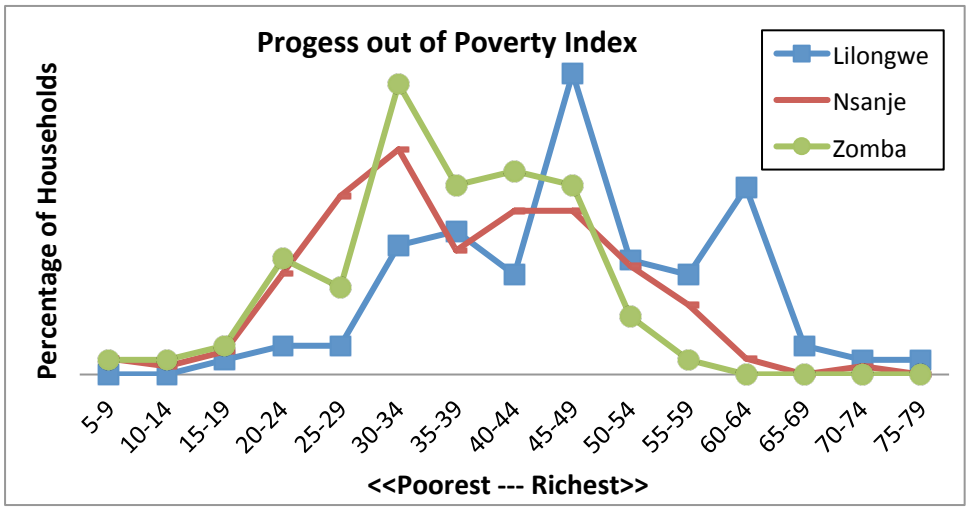


Asset ownership across the 3 districts was further used to evaluate the poverty level in the different districts using the Progress out of Poverty Index. Indicators used to compute this index include households characteristics – literacy level, housing quality, livelihood activity, source of cooking fuel – and asset ownership: radio, cell phone, television, bicycle, motorcycle, truck, sickle.

The progress out of poverty index runs from 0 to 100 in groups of five with higher scores reflecting greater household wealth. Households in Lilongwe are generally wealthier than those in Nsanje and Zomba (Fig. 2). A larger proportion of households in Nsanje and more so in Zomba had scores below the 40-44 range, while a larger proportion of households in

Lilongwe had higher scores. Findings of wealthier households in Lilongwe are as expected since respondents were closer to the urban city, diversified their farming activities with off farm employment (business), have higher literacy levels, and communication assets.

Figure 2. Percentage Distributions of Households by the Progress out of Poverty Index Score card.



Land ownership

Most households surveyed in the districts reported to own their farm land as indicated in table 5. The largest percentages of households owning land were reported in Zomba (68%) and Nsanje (74%). The most common condition of ownership and access to farmland cited by the respondents was customary rights. Grazing is generally done on communal land and access is by customary rights as well.

Table 5. Percentage of households with ownership and access to land in the districts surveyed.

	Farm land			Grazing land		
	Lilongwe	Zomba	Nsanje	Lilongwe	Zomba	Nsanje
Land ownership	56	68	74	1	2	1
Land Access	95	100	96	5	14	15
Land access & ownership	52	68	70	1	2	1

Distinct variations are observed across districts. Households in both Nsanje and Zomba owned more farming land compared to households in Lilongwe. Households in Nsanje and Zomba were also more likely to access land by customary right compared to those in Lilongwe, which means that households in Lilongwe were more likely to report land ownership by title deed or by lease.

Market access

Access to markets influences household's ability to sell or purchase crop, livestock commodities and farm inputs. Results in table 6 below show that households in the survey were quite closer to the markets, on average about 1 km away from every market and the nearest agricultural officer. Households in Nasnje were the nearest to the agricultural officer and to the market for farm inputs compared to Zomba and Lilongwe respectively, while households in Lilongwe were the nearest to the market for crop outputs and the livestock market compared to Nsanje and Zomba respectively. Proximity of the different markets to the households suggests that market will not represent a significant constraint that can undermine households' ability to act on climate information if these markets are adequately supplied with farm inputs.

Table 6. Average distance in kilometers to nearest market

	Lilongwe	Zomba	Nsanje	Total
Market for Crop Outputs	0.4	1.4	1.2	1.1
Livestock Market	1.1	1.4	1.4	1.4
Nearest market for farm inputs (seeds, fertilizer)	1.3	1.0	0.8	1.0
Nearest Agricultural Officer (for Farm advice)	1.7	1.0	0.7	1.1

Key Risks to Agricultural Productivity

Climate stress namely erratic rainfall, flood, drought, pest and diseases and agricultural disturbances including lack of inputs, soil erosion are the main threats that jeopardize agricultural activity (Fig. 3). Key informants confirmed these top five threats (Fig. 4). In Lilongwe and Zomba, lack of inputs and erratic rainfall are the two most frequently cited threats to agricultural productivity as reported by at least 75% of the respondents. In Nsanje, flood is also of major concern to the farm households. This latter threat has been reported by 59% of the respondents in Nsanje, almost as much as the threat of erratic rainfall. The report

of lack of inputs consistently among the top agricultural threats across the three districts highlights considering the interaction of climate and other agricultural stressors in assisting households to better adapt to climate change.

Figure 3. Top 5 risks that jeopardize livelihood activity according to households.

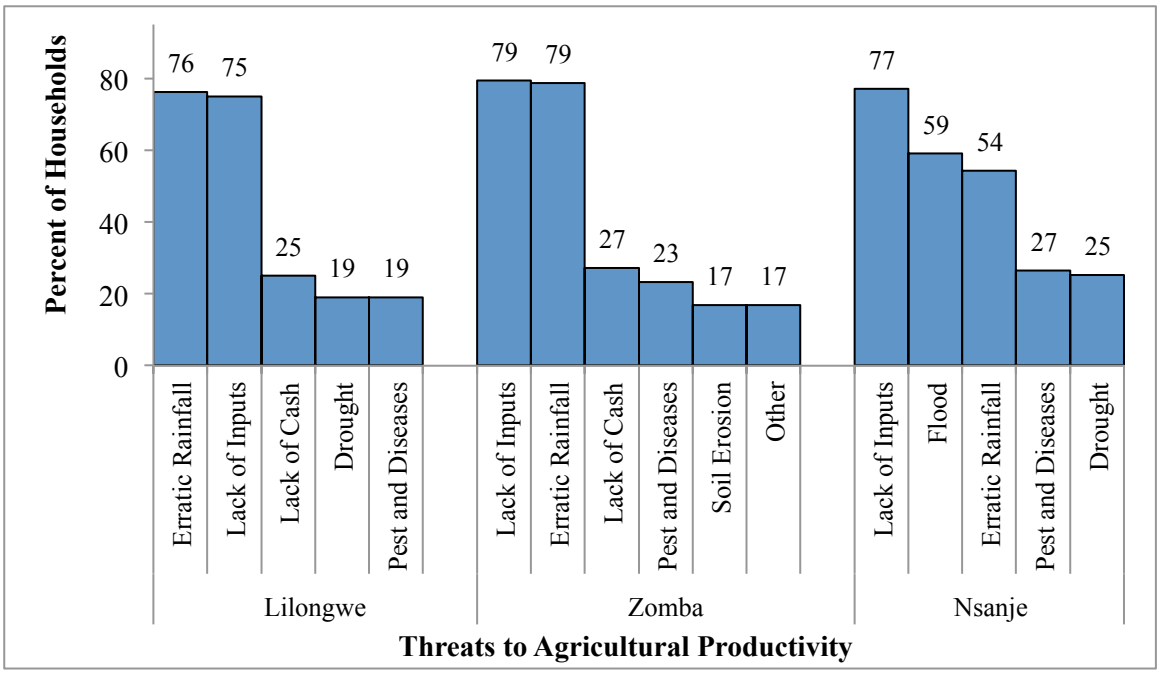
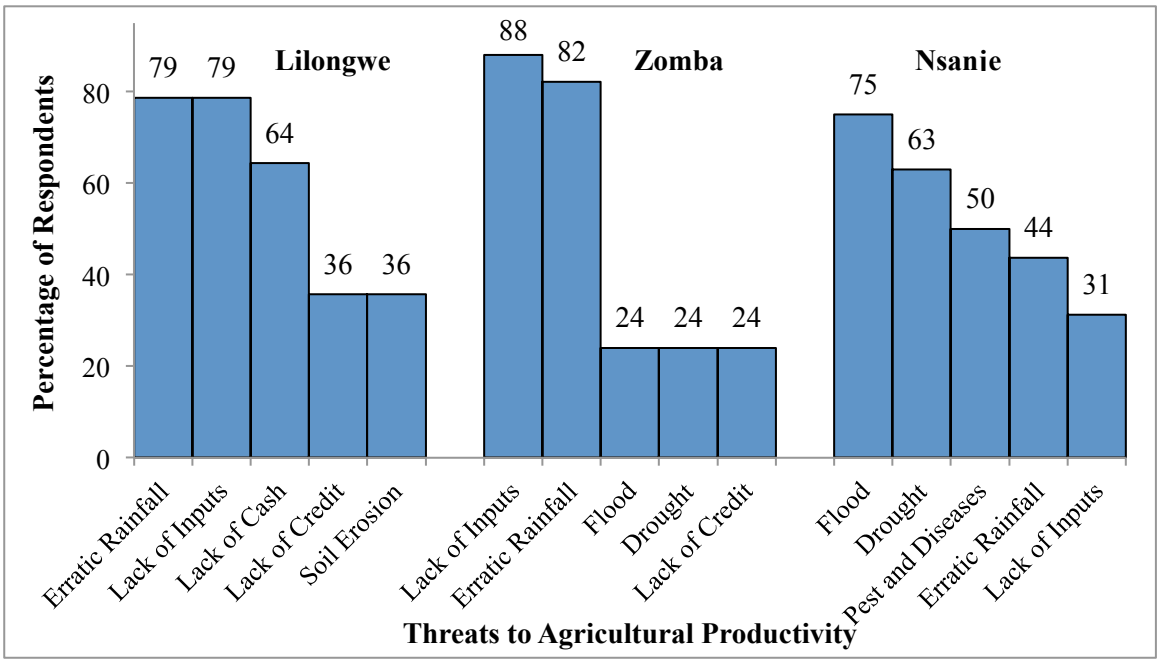


Figure 4. Top 5 risks that jeopardize livelihood activity according to Key Informants.



Climate shocks during the last 5 years

Focusing on climate shocks, results in Figure 5 show that the most commonly experienced climate shocks in the last 5 years were erratic rainfall in Lilongwe and Zomba and flood in Nsanje. Flood is the most common hazard in Nsanje as expected as the central part of this district is located in the shire river basin so very exposed to flood events. The largest proportions of the top climate shocks reported by respondents were experienced in the years 2013 and 2012. About 30% of households interviewed reported these shocks in 2013 and between 15 and 25% cited these shocks in 2012.

Figure 5. Climate Shocks that have affected Households during the last 5 years.

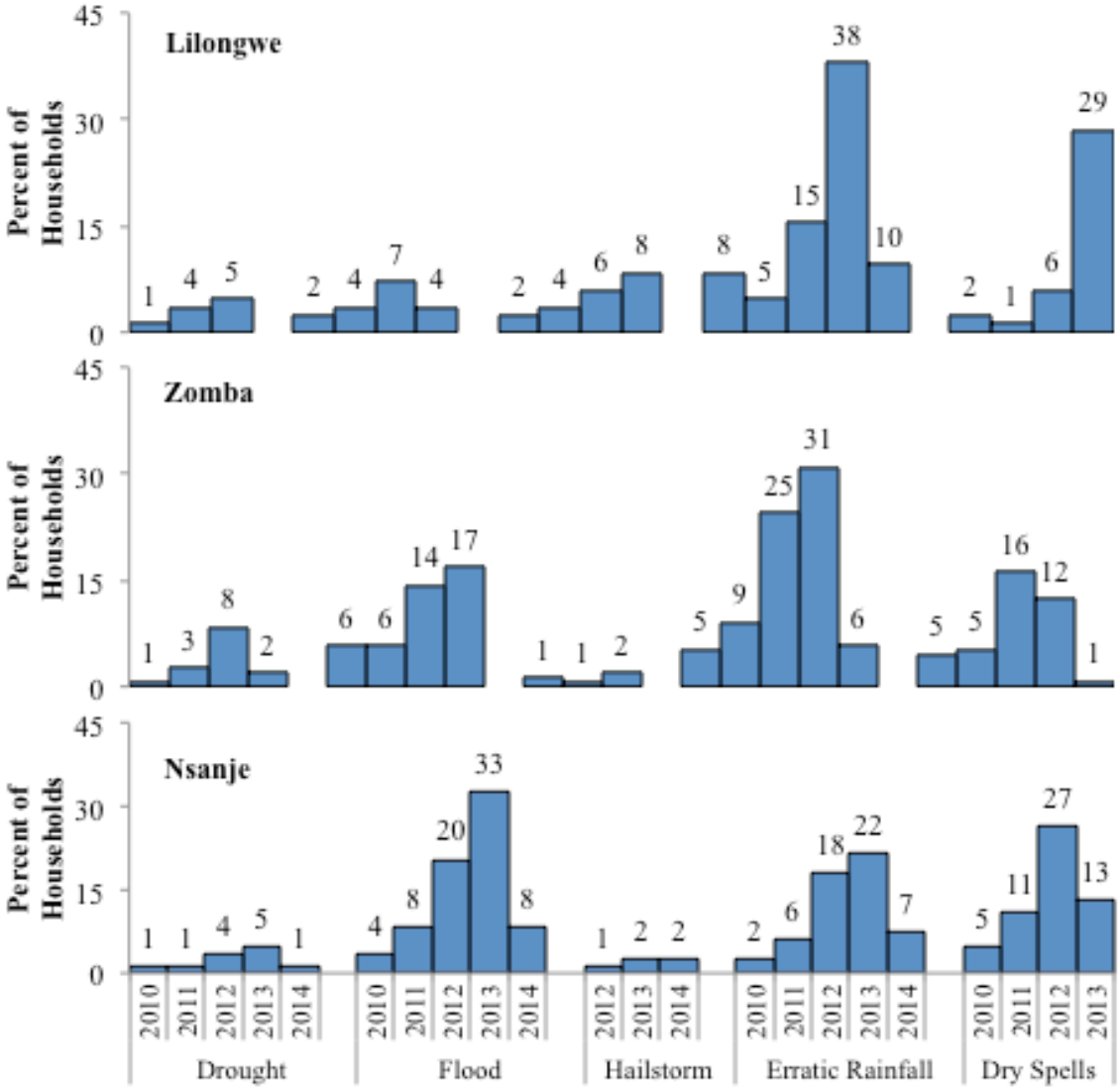
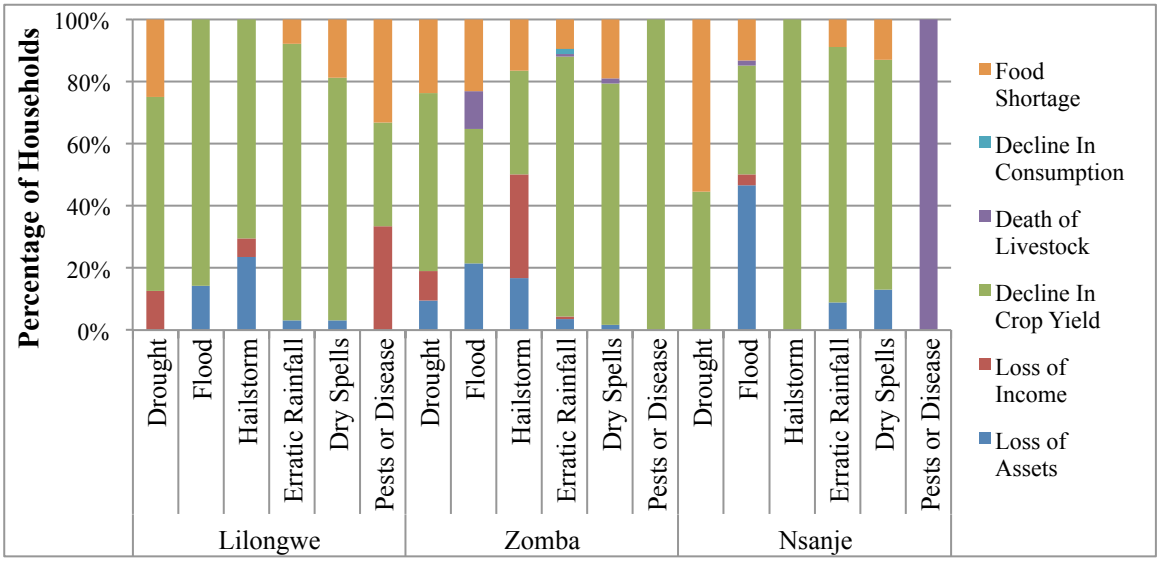


Figure 6 shows the impacts of the climate shocks reported by households. The most immediate reported outcome after a climate shock regardless of the type of shock was decline in crop yield, which threatens households' food security. Increased food shortage loss of assets and income were also reported.

Figure 6. Impact of climate shocks in the last 5 years.



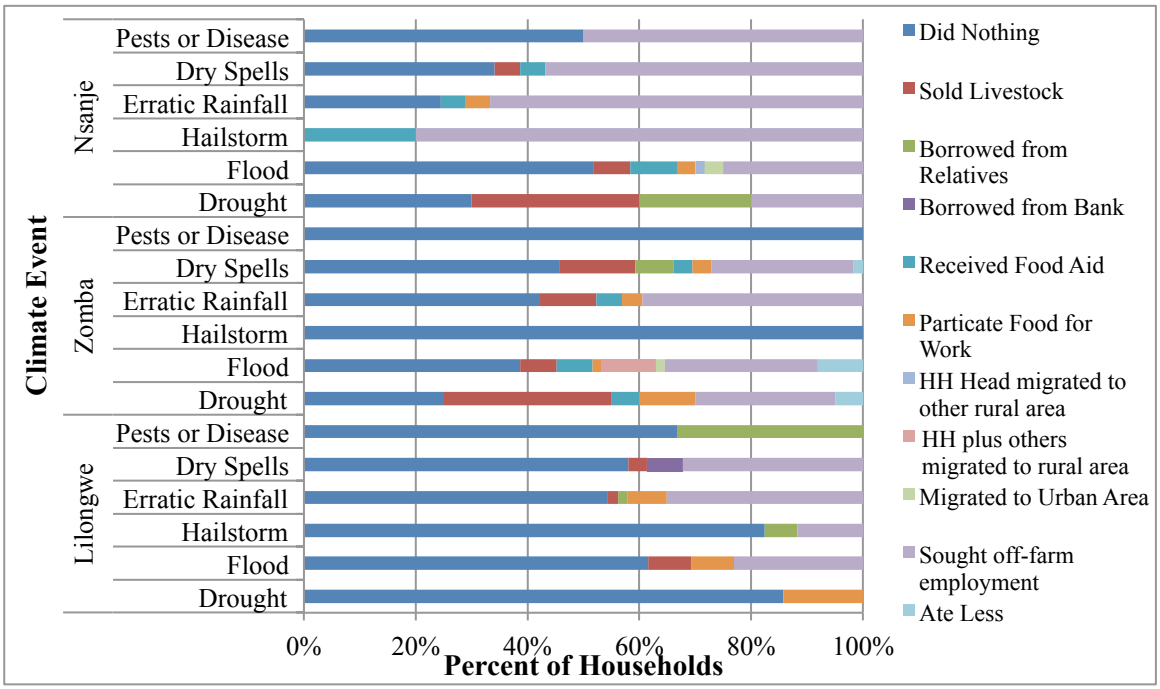
Households adopted various strategies to respond to climate shocks (Fig. 7). Most often, households claimed to be powerless when they face a climate shock, even in Lilongwe where households were found to be relatively wealthier than respondents in the other districts. Households were particularly powerless when confronted to pest, diseases and hailstorms shocks. When they were able to respond to the climate shocks, the most common coping strategies reported were off-farm employment particularly casual labour "*ganyu labour*", participation in food for work, sales of livestock. In Lilongwe, the wealthier households sometimes borrowed money from the bank to cope with the adverse effect of the shock.

Food Security Status in the Districts Surveyed

The previous sections have stressed out that decline in crop yield and the resulting food insecurity was the most frequently cited impact of the agricultural including climatic stresses. This section shed light on the current level of food security in the households surveyed. This status will be tracked over the course of the project to measure the impact of greater access to climate information on households' food security.

The most common definition used for food security is "secure access to sufficient food for a healthy life" (Maxwell and Frankenberger, 1992). This definition captures the notions of food supply, access, vulnerability and sustainability. It can also be applied at a global, regional, national and local, household level. At the local level, household food insecurity occurs when there is some uncertainty about food availability and access, insufficiency in the amount and kind of food necessary for meeting dietary requirements, or the need to use socially unacceptable ways to acquire food. So, the analysis of households' food security will require understanding the household supply, consumption and ability to cope with insufficient level of food.

Figure 7. Strategies adopted to respond to Climate Shocks in the last 5 years.



Household food supply

Results in Figure 8 show that more than 55% of the interviewed households reported that in the past year they were not able to produce enough staple food for the entire year to meet their consumption needs. A larger proportion of respondents indicated deficit in food supply in Zomba (63%) and Nsanje (81%) compared to Lilongwe (58%). Moreover, about 60% of the households reported that their food supply from their own farm has been decreasing year to year (Fig. 9). The main reasons cited for the change in food supply were changes in rainfall,

use of fertilizer, and lack of advice on farm inputs or the resources to acquire necessary farm inputs.

Figure 8. Staple food supply.

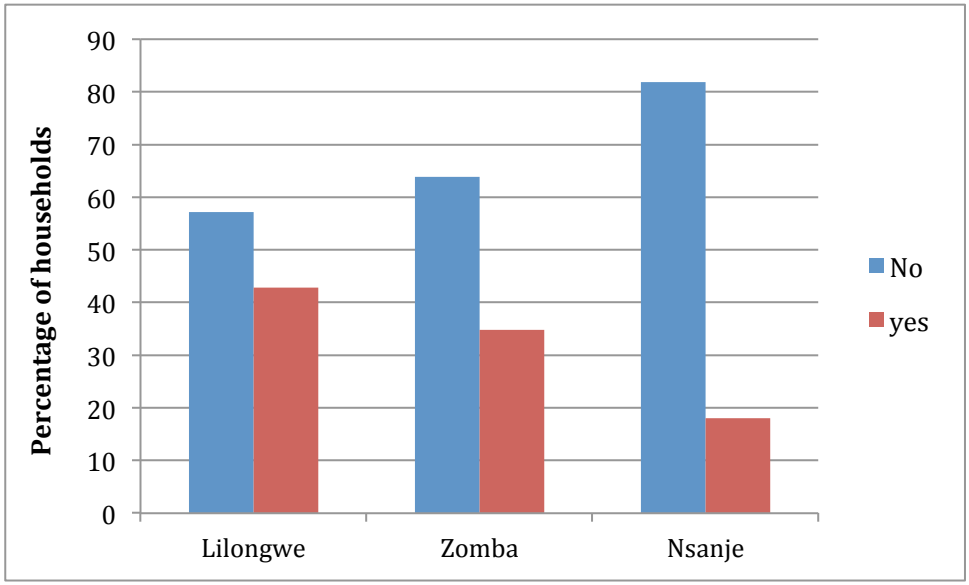
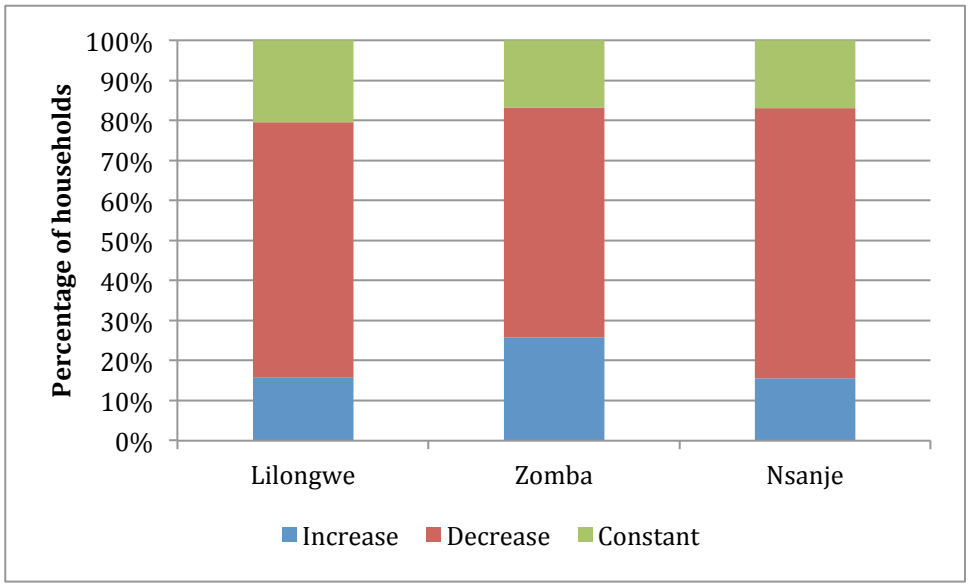


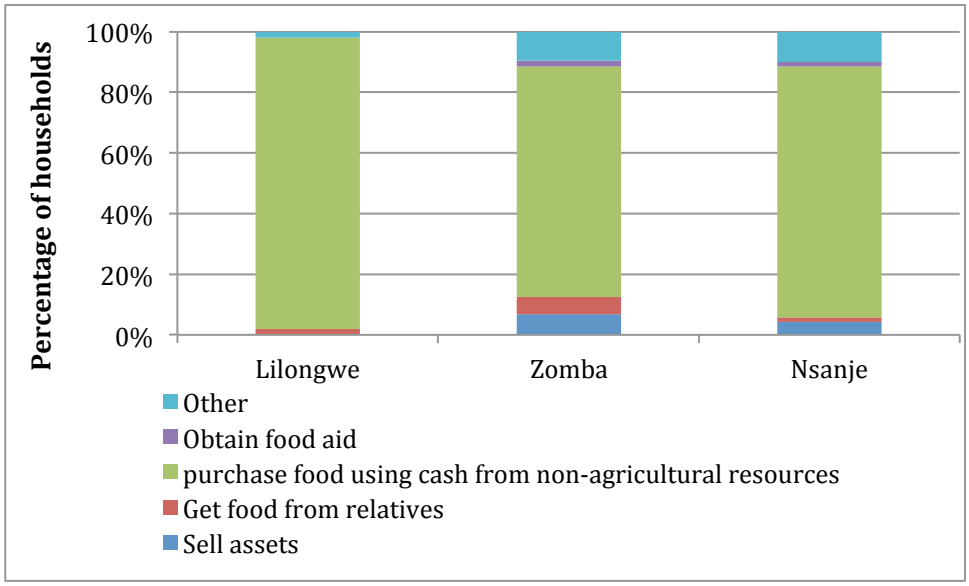
Figure 9. Change in food supply over last year.



Households that did not have enough food for the entire year coped by becoming mostly net buyers of food (80%) and purchased food by using cash from non-agricultural sources (Fig. 10). In the villages surveyed, households' production of maize lasts for 6-8 months. For the 4-

6 months after own stocks have run out, households purchase their maize requirements from either private sellers or the state agency (Agricultural Development and Marketing Corporation, ADMARC). Other coping strategies used to a lesser extent include selling assets (4%), and getting food aid or food from relatives (3%).

Figure 10. Strategies Households adopted to cover the gap in food supply.



Household food consumption

Maize is the main staple food eaten almost every day by the households interviewed. All households interviewed in the district consume *ntsima* (a thick porridge made from maize flour) as their staple, which is eaten with relish of boiled vegetables or meat. The second most common food consumed reported by households is vegetable (Table 7) as expected. In Nsanje, some households grow rice for sale and some is consumed at the household. Other food items consumed by households include cassava, sweat potato and beans. Animal protein (meat, milk, eggs) is eaten less frequently and purchased by the households.

Food security index

Food security is estimated in this study using a set of questions to capture the short-term food sufficiency at the household level, following the approach developed by Maxwell (1995). Reliance on a range of short term coping mechanisms to deal with food insufficiency and the frequency ("every day," "never," "one to two times a week," or "3 to 5 times a week") of using a given coping strategy in the past 7 days is measured as indicator of food security at

the household level. A scale of 1 to 4 was developed for the frequency of each individual coping strategies: 4=”never” 3=“one or fewer times a week” 2=“3 to 5 times a week”, 1=“every day.” So, the higher the number on the scale and the less often a strategy has to be used, the higher the level of food security.

Table 7. Household food consumption pattern in the surveyed districts, average number of days.

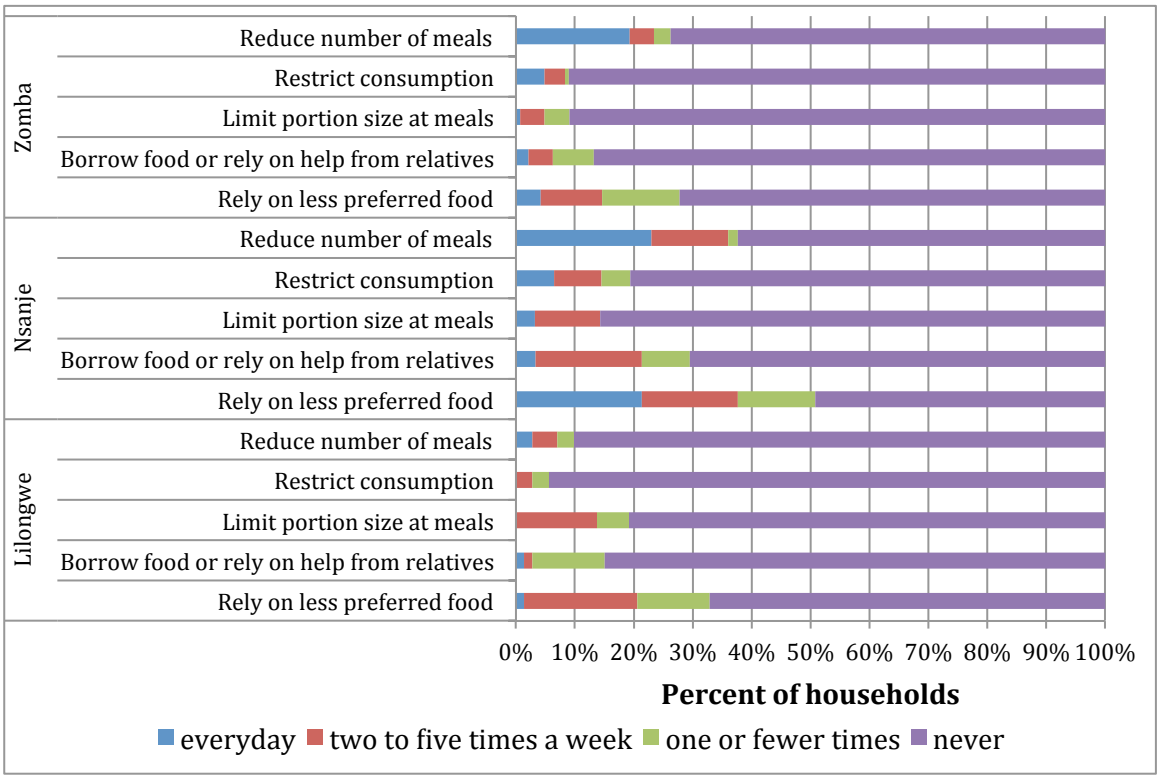
Food consumption	Lilongwe	Zomba	Nsanje
Sorghum	0.4	0.6	1.1
Maize	6.6	6.8	6.0
Cassava or other tubers	1.6	0.9	1.3
Pulses	2.7	2.5	2.0
Vegetables	5.9	5.2	5.4
Fruits	1.7	1.9	3.3
Meat and poultry	1.4	0.7	0.7
Eggs	1.2	0.8	0.5
Fish	3.4	2.3	2.3
Milk	1.2	0.3	0.5
Sugar	4.9	1.1	2.0
Oil	4.4	2.9	2.8

Results in Table 8 and Figure 11 show comparable levels of food security across districts. The most common and least drastic coping strategies adopted by the respondents to deal with food insecurity were to reduce the number of meals taken in a day and to rely on less preferred food. These strategies were more popular in the districts of Nsanje and Zomba. Households in Lilongwe were relatively better off compared to Nsanje and Zomba, as expected.

Table 8. Food Security index of households interviewed in the surveyed districts.

Short term coping strategies	Lilongwe	Nsanje	Zomba
1. Rely on less preferred food	3.6	3.1	3.6
2. Borrow food or rely on help from relatives	3.8	3.6	3.8
3. Limit portion size at meals	3.8	3.8	3.9
4. Restrict consumption	4.0	3.6	3.8
5. Reduce number of meals	3.8	3.2	3.3

Figure 11. Frequency of food shortage coping Strategies undertaken by households.



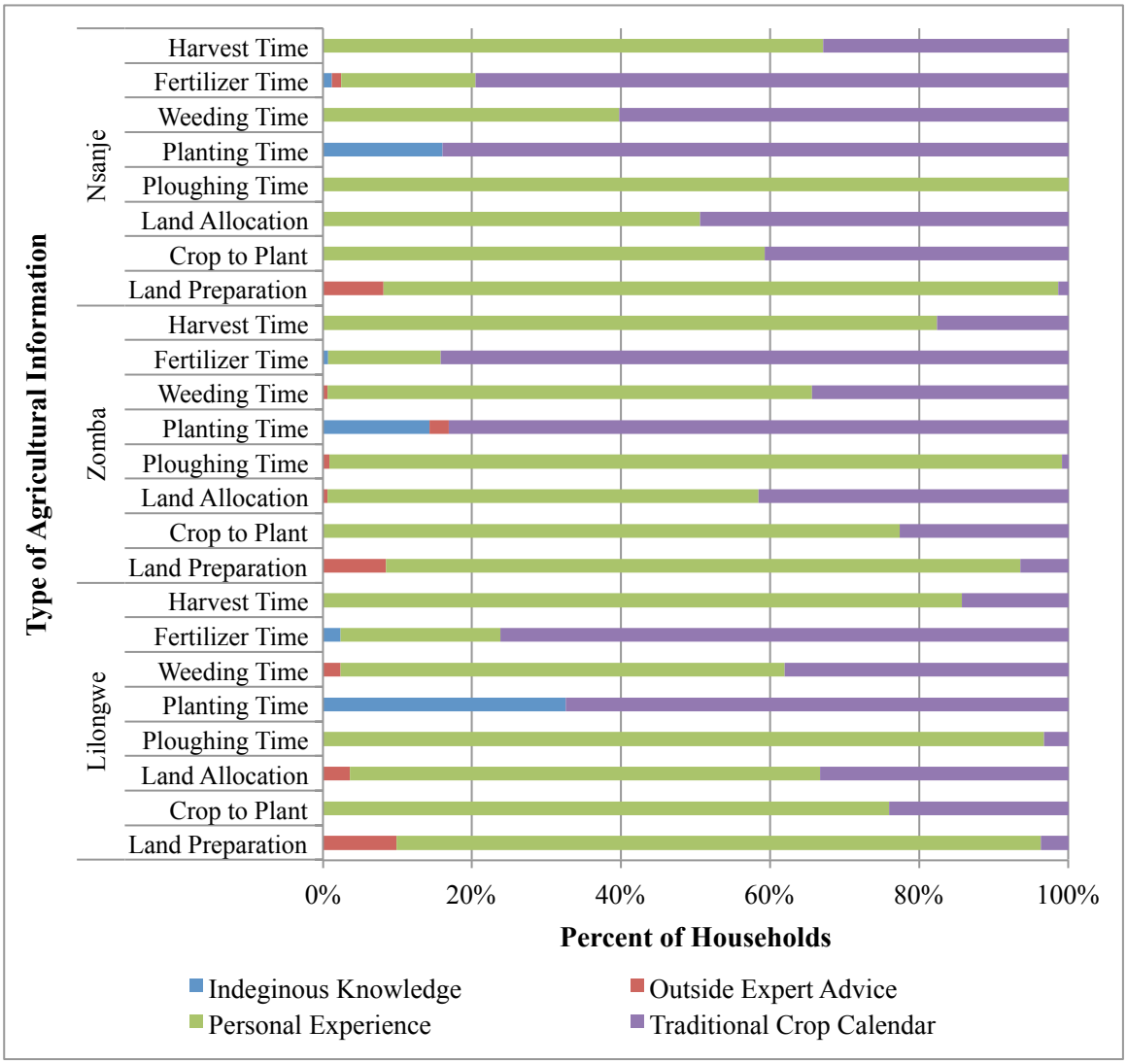
Climate Information Households Currently Receive

Sources of information

The sources of information households have been using over the course of the last 3 years to inform their agricultural decisions (Fig. 12) can be used to monitor changes in the kind of information households will be using over the course of the project and whether the relative importance of these information has changed overtime. The expected sources included climate forecast, extension agents, indigenous knowledge, observations, personal experience, traditional cropping calendar and advice from agricultural experts. Results showed a similar pattern across districts. For most farmers, decisions on when to start land preparation are based on traditional cropping calendar, as reported by about 70% of the respondents. Farmers use the month of the year to know when to start land preparation. Majority of farmers do their land preparation from the month of August to October. Traditional cropping calendar is also largely used to determine ploughing time by on average 80% of the households interviewed. This is generally done from October to November. Decisions to allocate land rely for more than 70% on personal experience. Farmers make their decisions based on land availability,

soil type, crop rotation system. On average 83% of households reported that decisions on what crops to plant are influenced largely by personal experience. Respondents acknowledged to be influenced by the availability of seeds, crop performance and yield of the previous season. They have a preference for hybrid varieties, early maturing and drought resistant varieties. Planting time is driven by traditional cropping calendar (70%) and observation of the environment (about 20%). Households who rely on traditional cropping calendar plant often on November and December. Observation of the environment includes observation of the first rains, sufficient quantity of rainfall and soil wetness. Weeding time was influenced by observations as reported by 30% to 60% of the respondents. Farmers look for the appearance of weeds or rains.

Figure 12. Sources of household information to inform their agricultural decisions.



Across districts, approximately 67% of households reported that fertilizer application time was influenced by personal observation such as of the height of the crops. They also rely to some extent on traditional cropping calendar by applying fertilizer immediately after planting time. Harvest time was determined based also on personal observation (on average 57%) on when crops became dry and mature or using the traditional cropping calendar, with an average of 41%, between March and June. It is worth noting that a only very small proportion of households (< 1%) scientific climate information to inform their planting decisions.

Information for livestock decision-making

Fewer households responded to the question on sources of information for large livestock and small livestock decision-making, since these activities are barely practiced by farm households in the surveyed districts. Households in Lilongwe largely did not respond to questions on large livestock since a very few number of respondents own these types of livestock, but focused on small livestock, mostly goats and chicken. Household decisions about which livestock breeds to keep and when to sell were influenced primarily by personal experience (Fig. 13). Decisions on where to graze cattle were influenced by observation or indigenous knowledge. The season of the year and a preference for grazing areas that were away from the field crops were the main determinants. Decisions on when to vaccinate and when to move livestock depended on advice from extension agents and observation or personal experience.

Use and impact

The three most common types of climate information received by households interviewed are forecasts of extreme events, forecasts of the onset of rainfall, and daily weather forecasts (Fig. 14). The same types of information are received by both men and women but to a lesser extent by women. A proportion of 80 of male household heads in Lilongwe and Zomba reported receiving information on forecast of extreme events while 71% of women in Lilongwe and 54% in Zomba acknowledged receiving this type of information. In Nsanje this percentage is estimated at 80% for both men and women. Forecast of the onset of the rain is reported by around 70% of the interviewees in all districts. Daily weather forecast is the third most received climate information. An average of 50% of the respondents receives this information in Zomba and Nsanje and 64% in Lilongwe. Households less frequently receive

seasonal monthly forecasts, and forecasts of pests and disease. Less than 40% of the respondents reported receiving this information.

Figure 13. Sources of households' information for decision-making on small livestock.

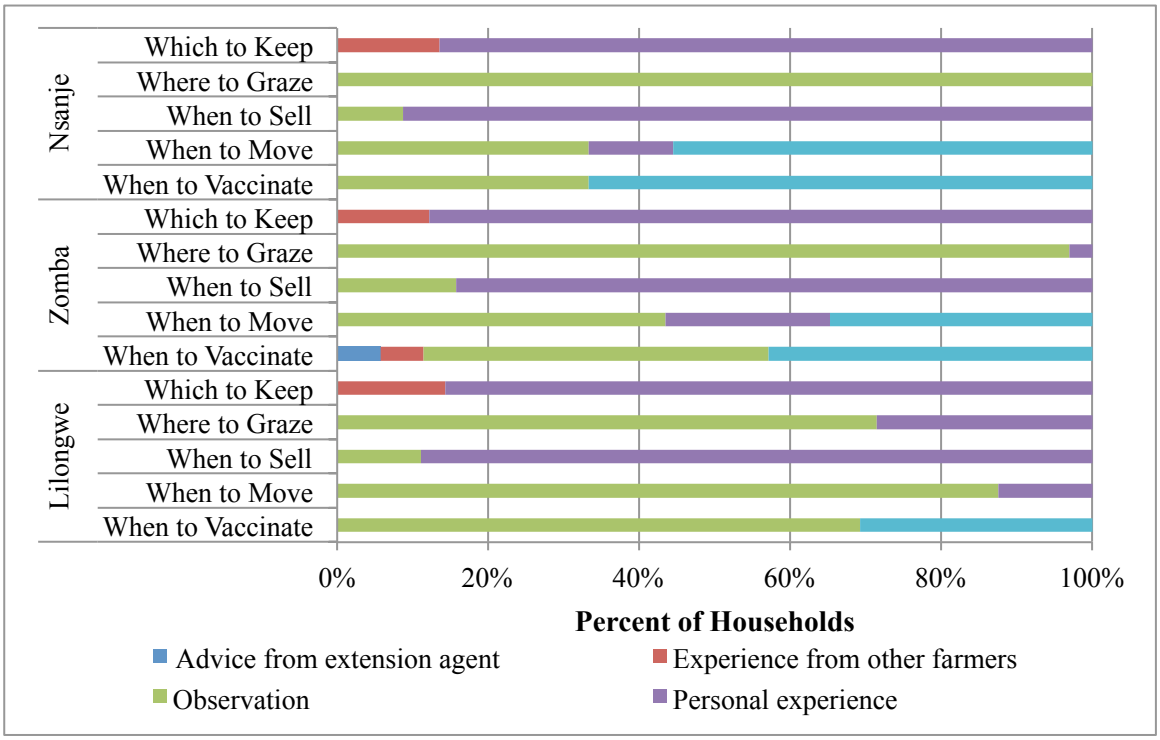
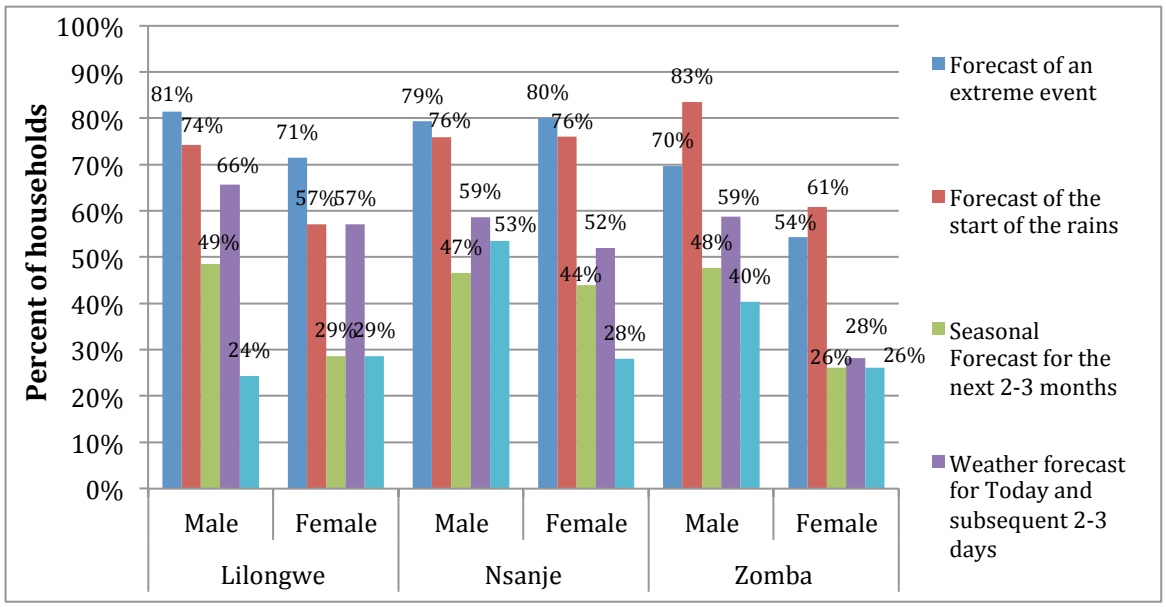
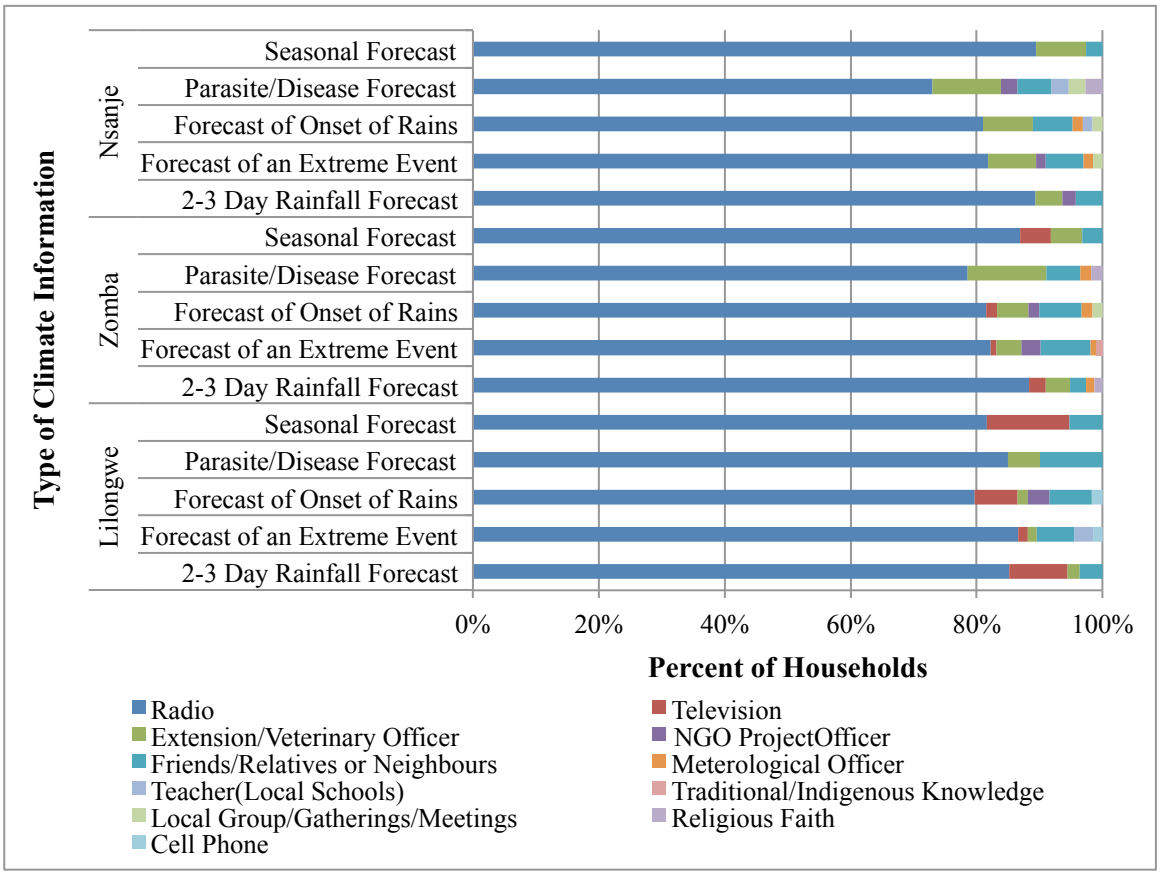


Figure 14. Climate information received by the respondents in the districts surveyed.



Regardless of the type of information, radio is by far the major source through which climate information is channelled to households, as reported by about 80% of the respondents (Fig. 15). Extension agents are the second largest channel of climate information for households, followed by friends, relatives and neighbours. In the districts surveyed, the extension staffs from government and NGOs provide information of onset of rains, expected seasonal rainfall and risk of floods. In Lilongwe, television is also a significant source of climate information particularly for the daily weather forecast, the seasonal forecast and the forecast on the onset of rainfall. Key informants recognized the same sources of climate information, with television being most important.

Figure 15. Sources of Climate Information.



Both results from the household and key informant surveys (Fig. 16) show that information was mostly received on a seasonal basis except for the daily weather forecasts, which were received daily. The most frequently reported lead times on climate information were months ahead of the forecasted event, and weeks ahead (Fig. 17). For the daily weather forecast, the lead-time selected was few hours ahead of the event.

Figure 16. Frequencies of climate information received by households.

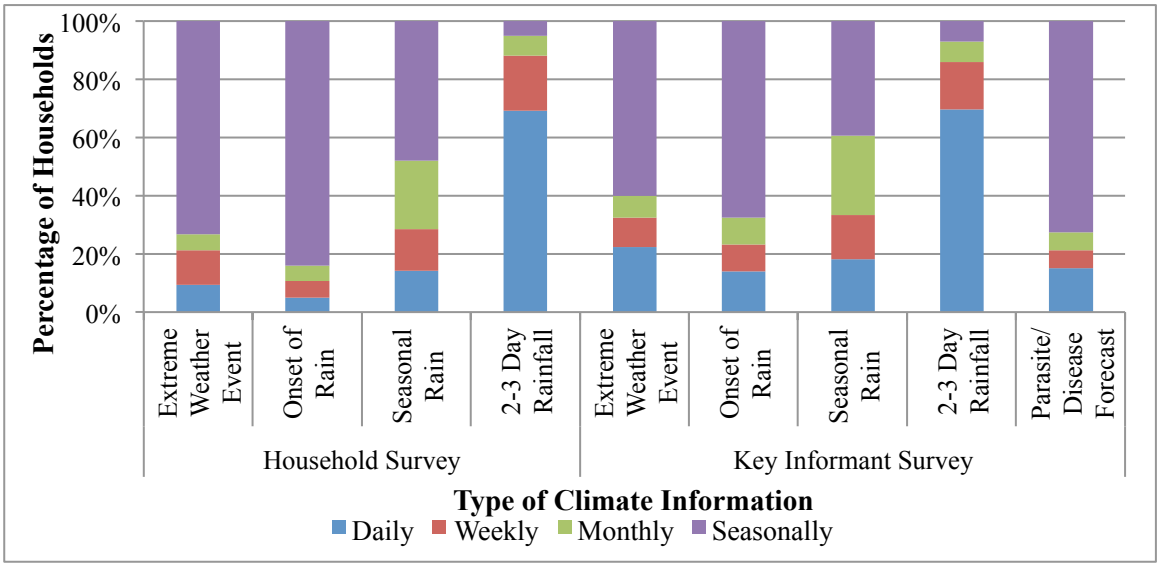
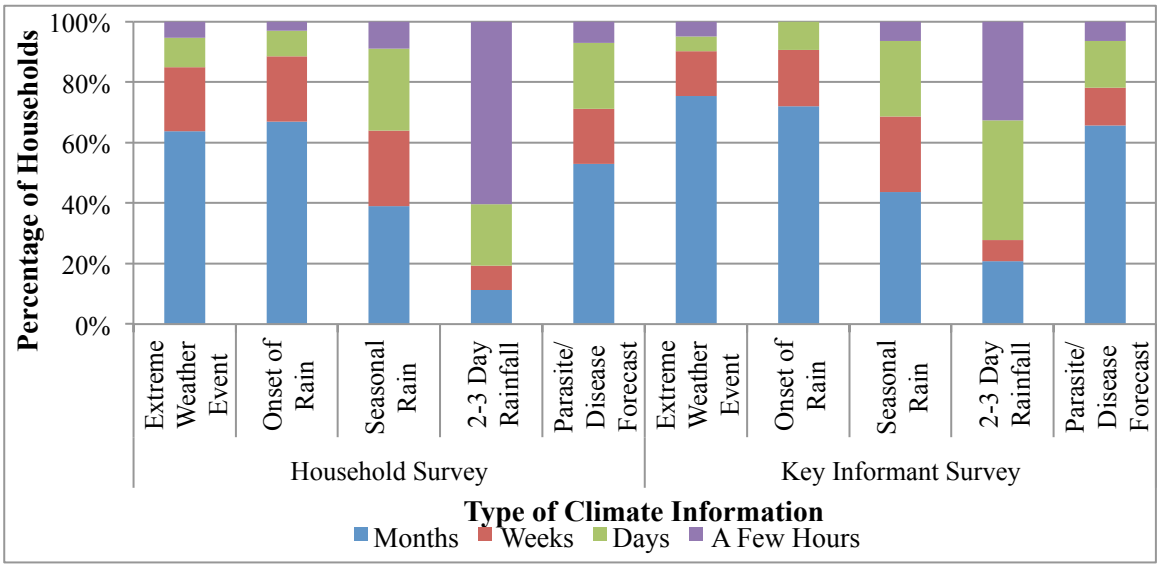


Figure 17. Lead-time on climate Information.



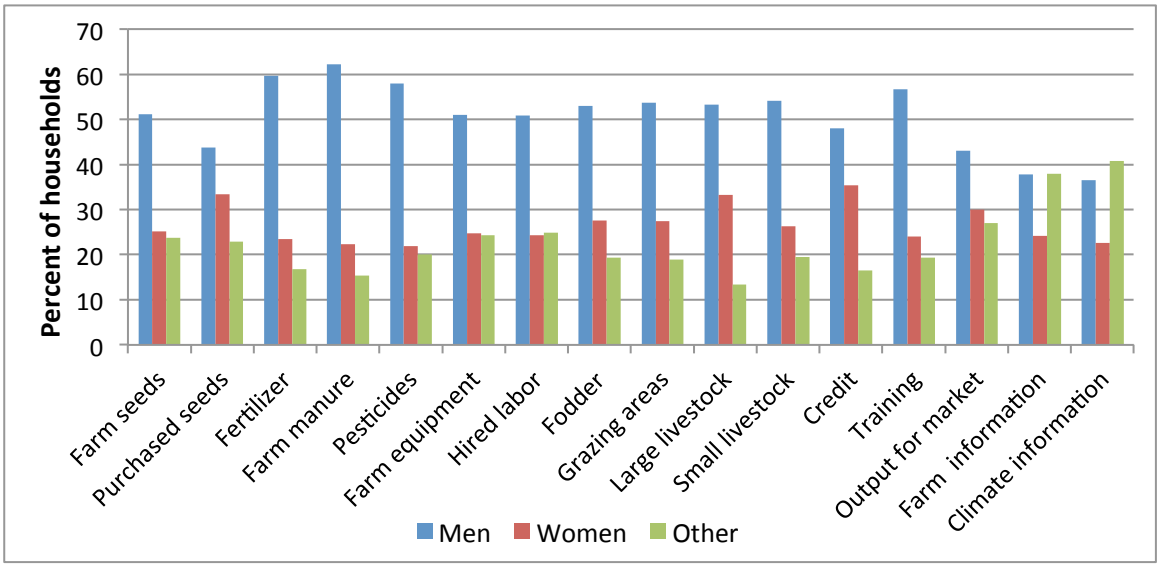
Households were asked whether the climate information received was paired with agricultural advice and whether they were able to use the advice. Results (Table 9) show almost equal proportions of men and women who declared receiving the information with advice. In Lilongwe, less than 50% of the respondents revealed that most climate information was delivered with advice. However in Nsanje and Zomba, a larger proportion of households, more than 50% reported that climate information was paired with advice except seasonal forecast in Nsanje and daily weather forecast in both Nsanje and Zomba. The extension

agents used as a source of information in these districts could explain households' claim that climate information delivered was supported by agricultural advisories. In all villages surveyed, advice provided by extension agents and climate service providers are often very basic agricultural information, advice on security of persons and property. Concerning the ability to use the agricultural advice, overall fewer households declared to be able to use the advice and women were significantly less able to use the advice compared to men. This is explained by women's poor control and access to households' agricultural assets (Fig. 18).

Table 9. Information received with advice and ability to use the advice.

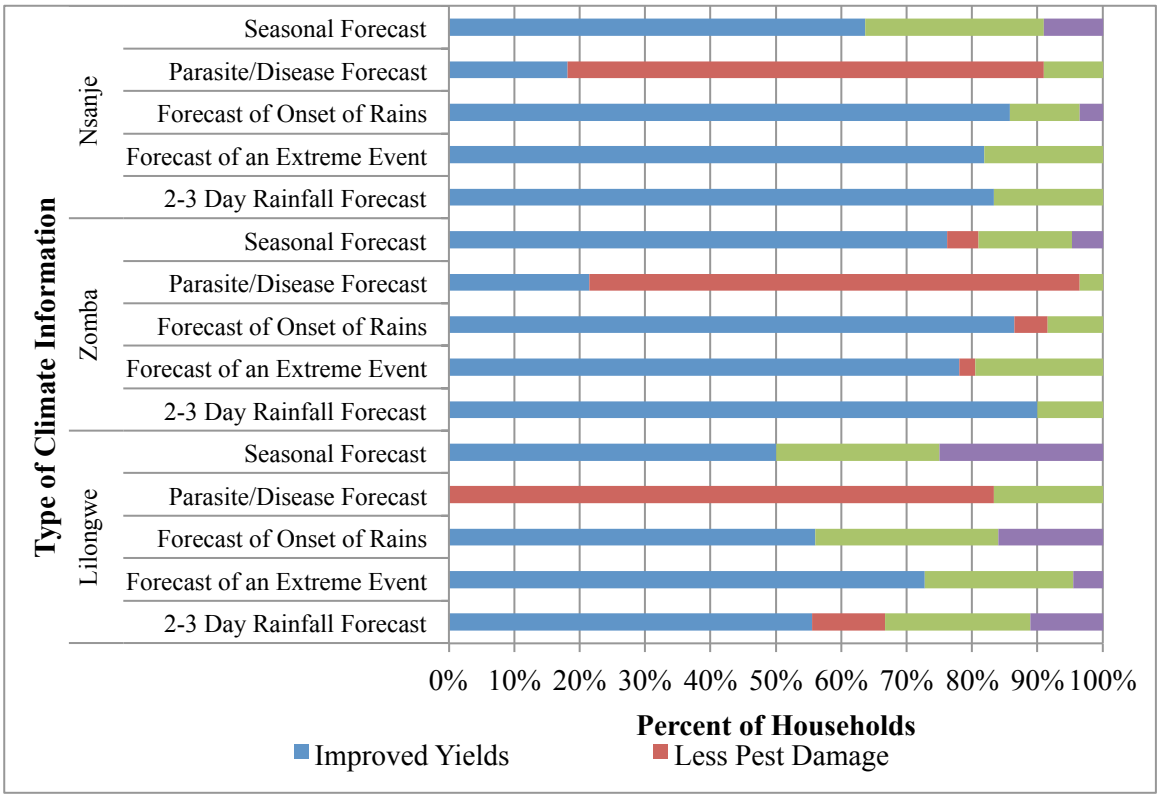
		Information received with advice (percent of households)			Ability to use the advice (percent of households)		
		Lilongwe	Nsanje	Zomba	Lilongwe	Nsanje	Zomba
Forecast on extreme events	Male	43	77	63	56	38	67
	Female	*44*	*64*	*55*	*17*	*64*	*47*
Forecast on onset of rainfall	Male	59	65	64	69	63	79
	Female	*63*	*64*	*58*	*43*	*80*	*80*
Seasonal forecast	Male	39	70	43	38	48	56
	Female	*25*	*75*	*41*	*33*	*67*	*50*
Daily weather forecast	Male	35	39	27	66	23	37
	Female	*25*	*50*	*12*	*0*	*75*	*25*
Forecast on pest and diseases	Male	37	68	60	38	53	42
	Female	*75*	*50*	*40*	*20*	*17*	*33*

Figure 18. Women's control of agricultural resources within the household.



The largest perceived impact of receiving climate and weather information regardless of the type of information was improved yield (Fig. 19). Other non-negligible related impacts were less crop damage, and soil health improvement. Dissemination of information on pest and diseases led to reduction in pest damage as expected in all districts.

Figure 19. Perceived impacts of climate information currently received by farmers.



According to the households interviewed, the trend in the supply of climate information did not change last year (2013) compared to the year before (2012). Indeed, 50 to 60% of the households interviewed in all districts declared that the supply of climate information has stayed the same (Fig. 20). Further, an overwhelming majority (>90%) did not attend any training on climate information (Fig. 21). As for key informants' awareness of any climate training in their community in the past year, about 80% in Lilongwe and Zomba said that there has not been any training in the community while the same proportion of households in Nsanje gave an affirmative answer.

Figure 20. Household Received More or Less Agricultural Information in the past year.

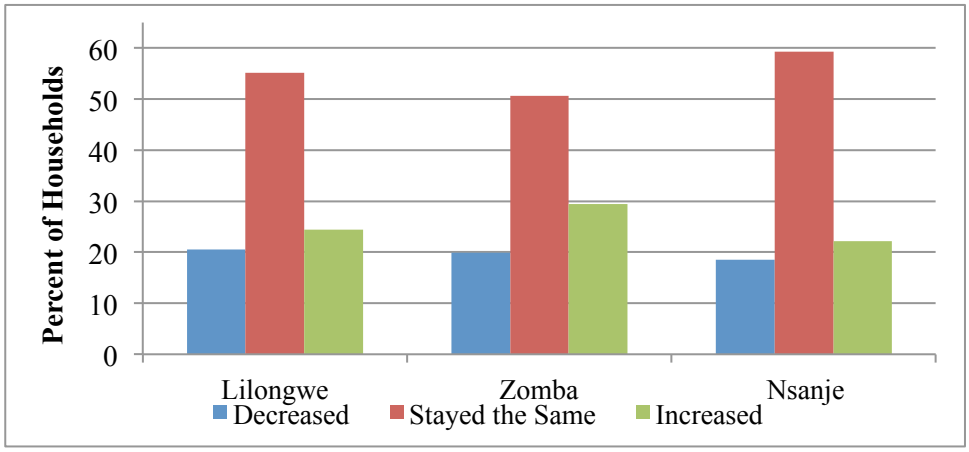
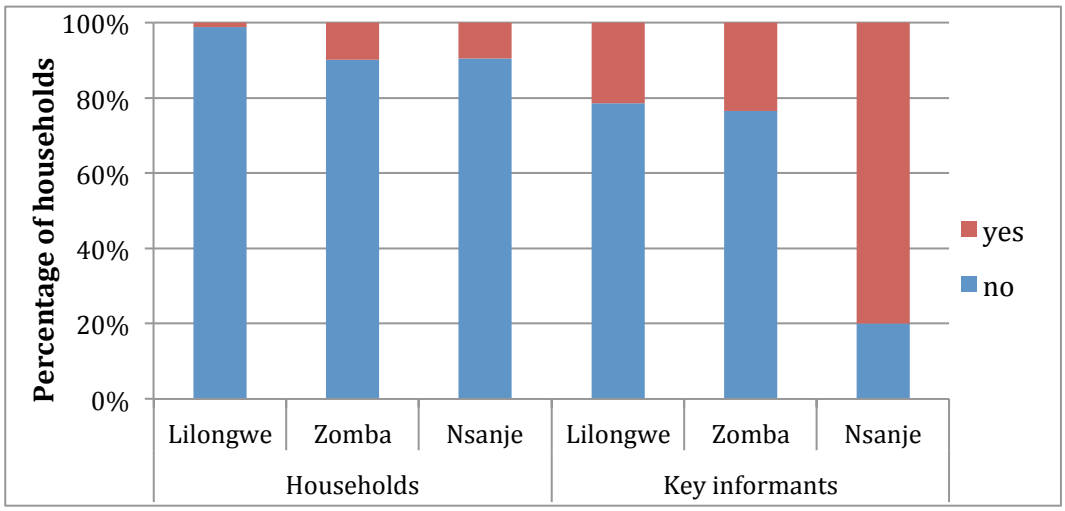
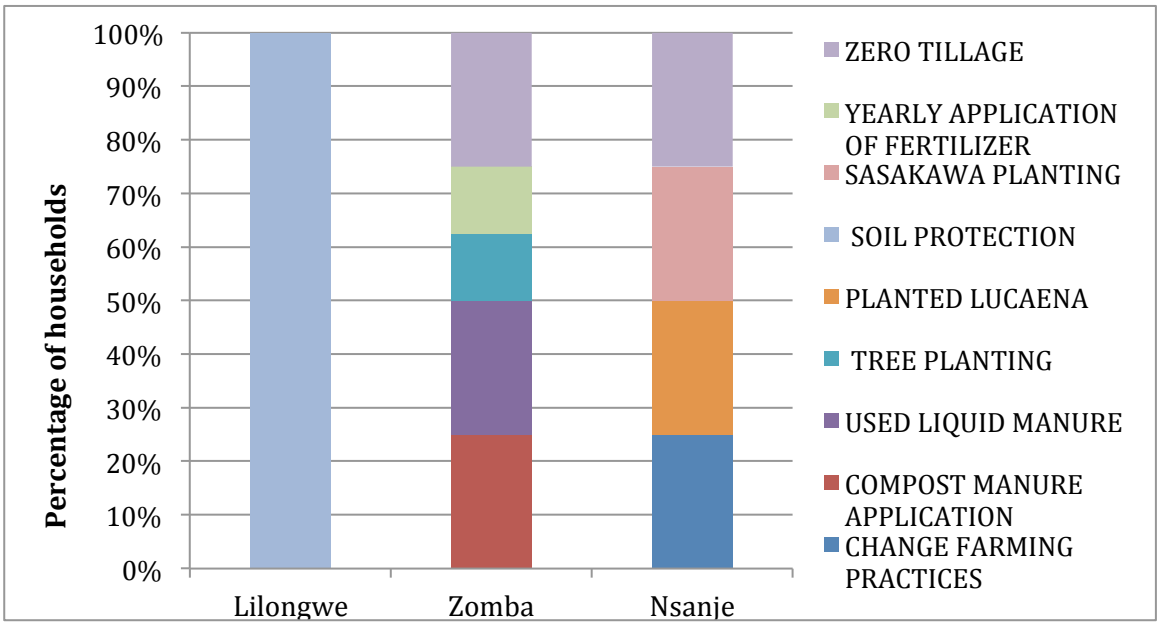


Figure 21. Household attendance and key informants awareness of climate training in the past year.



Among the few respondents who attended the training, about 70% of households reported modifying activities after training. The highest proportion was 33% in Nsanje, followed by 21% in Zomba with the fewest modifications being done in Lilongwe district – 9%. Some households reported not modifying their activities since they had inadequate land on which to try out the ideas, lack of time during which to try out the ideas, the ideas were just newly learnt, and no specific reason for others. The most common ways in which agricultural activites were modified in Lilongwe was the planting of soil protection plants, while in Nsanje and Zomba changes include compost and manure application and zero tillage, new farming practices (Fig. 22).

Figure 22. Ways in which households modified activities after attendance of training on climate information.

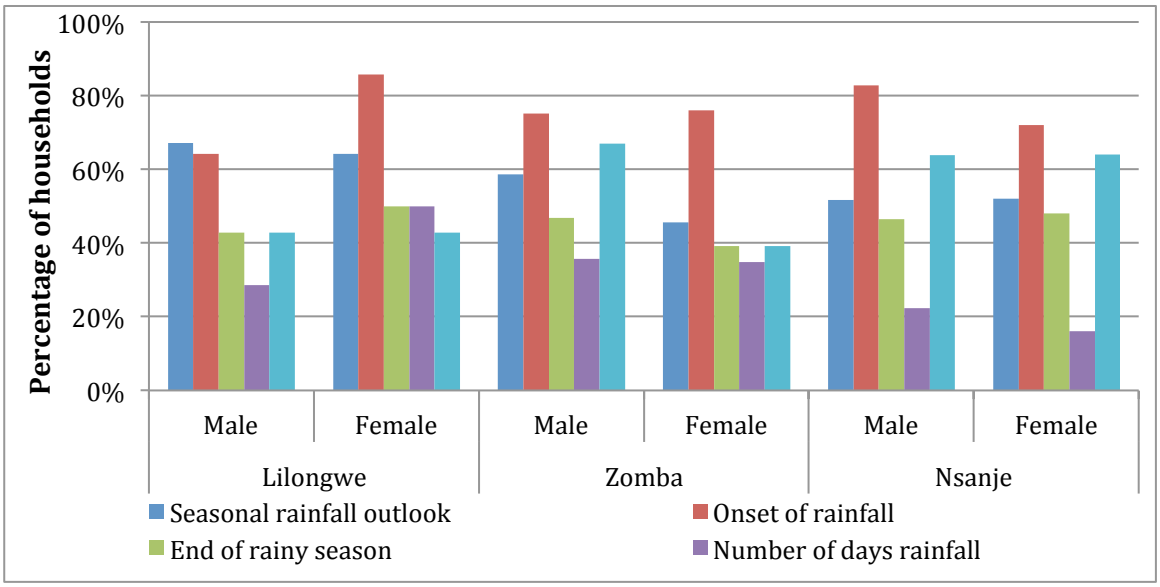


Types of Climate Information that Farmers Want

This section reports results disaggregated by gender on farmers' preferences of climate information, the lead times, format and messengers for channelling the information. Figure 23 presents climate information that households wished to receive ranked from the 1st most cited through to the 5th one. In all districts, seasonal rainfall outlook, onset of rains, extreme weather events, end of the rain season and number of days of rainfall are the five most important climate information farmers would like to receive. However, the relative importance of these types of information for men and women diverges slightly. In all districts, forecast on onset of rainfall is reported as the first most important climate information women would like to receive. In Lilongwe, 86% of female household heads interviewed would like to receive this information while in Nsanje and Zomba these proportions are 72% and 76%, respectively. For male household heads in Nsanje and Zomba, forecast on onset of rainfall is the first most important climate information they would like to receive, as reported by about 80% of the respondents in these districts. But in Lilongwe, seasonal rainfall outlook is the first most important climate information 67% of men wished to receive. In this latter district, forecast on onset of rainfall is the second most frequently reported climate information, men and women prefer. In Zomba and Nsanje, probability of extreme events is the second climate

information most preferred by both men and women. These aforementioned districts lie in the Shire River Basin and are very prone to climate extreme particularly flood. So, forecast on extreme events is perceived as essential to both agricultural activities and people's lives and will be critical for the adoption of preventive measures against the climate disasters. The interviews with key informants have also revealed that forecast on extreme events is of utmost importance to better manage climate related risks in their community.

Figure 23. Five main types of Climate Information farmers would like to receive.



Farmers' preference of the climate information lead-time is illustrated in Figure 24. Men and women reported the same preferences for the lead time, with a similar pattern across districts. An average of 60% of both female and male respondents across districts would like to receive the climate information at the beginning of the agricultural season. The second most preferred lead-time is "as soon as the forecasters know about the event" as reported by on average 22% of respondents. A proportion of 14% of the interviewees selected "a month before the forecast event" as their third preferred lead-time to receive the climate information. Results from key informants are in line with these preferences.

Figure 24. Preferred Lead Time for Climate Information recommended by households and key Informants.

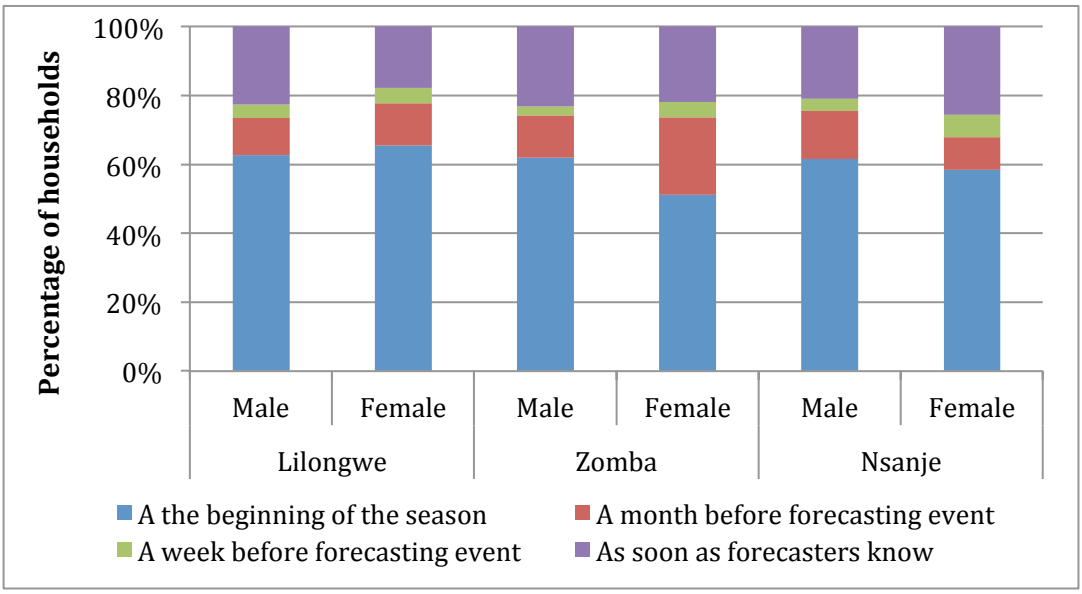
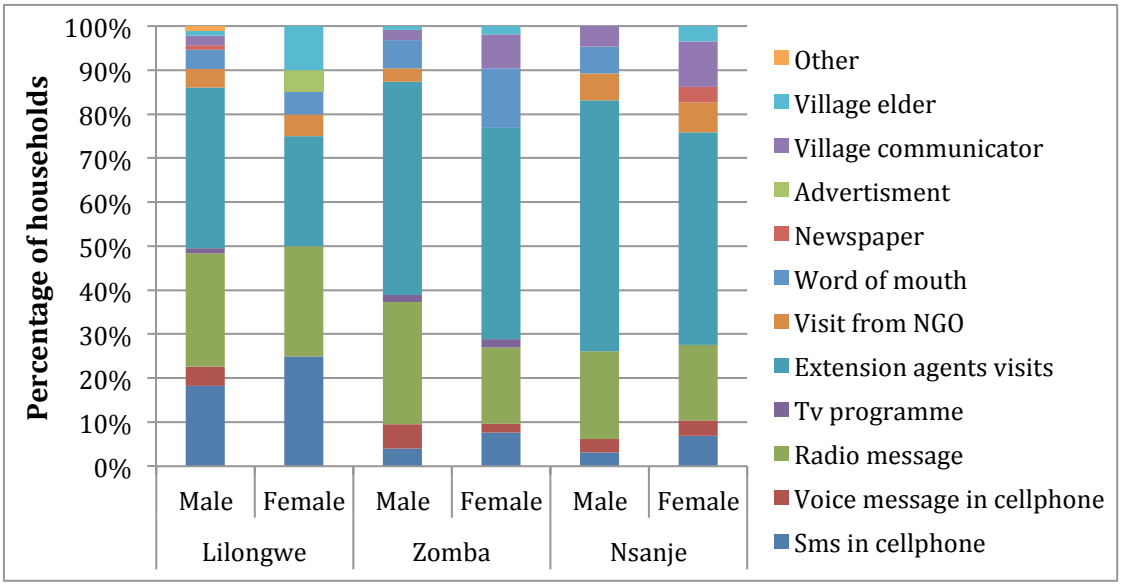


Figure 25 shows the format through which households and key informants would like to receive the information. Male and female respondents revealed the same desired format for the provision of climate information. Visits from extension agents have been cited as their first preferred format to receive climate information, particularly in Nsanje and Zomba. Half of the respondents have chosen "visits from extension agents" in these latter districts while in Lilongwe around 30% have chosen this format. The second most frequently cited format is radio message as reported by an average of 20% of respondents. Lilongwe exhibits the highest percentage (26%) of interviewees who have selected radio as their second choice. SMS in cell phone is the third choice across districts. The same pattern is also observed in key informants. The use of SMS cell phone to deliver climate information is already experienced in Nsanje district. The meteorology department communicates climate information using cell phone calls and SMS to community leaders and NGOs. NGOs send SMS to all community members who have registered for their services. This system tends to be used mostly for warning households on the risk of flood.

Figure 25. Preferred format for climate information that key informants recommend.



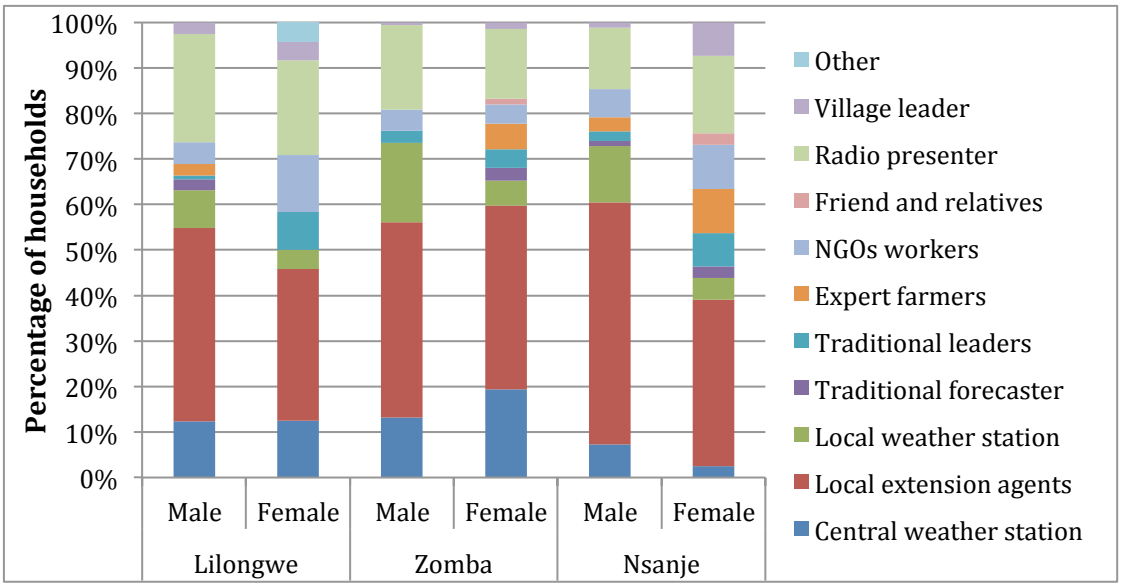
The preferred messengers most cited by the farm households are consistent with the preferred format (Fig. 26). So, local extension agents and radio presenters are by order of importance the most preferred messengers for men and women interviewed as reported by on average 41% and 18% of respondents, respectively. Other significant messengers include central and local weather stations as well as NGOs workers. In Lilongwe and Nsanje, the percentage of women (10%) who would like to receive climate information through NGOs is twice higher than that of men (5%). In Lilongwe and Nsanje, many households do not have access to government extension workers and have to rely on NGOs for the supply of agricultural services.

Ways Key Informants Want Climate Communication Improved

Key informants have suggested a number of ways to improve climate information communication in their community (Fig. 27). These ways include regular visits from extension workers, translation of posters and handbooks, use of mass media such as radio, community meetings, localized climate information, and practical demonstrations. In Nsanje and Zomba, key informants have more often suggested increased visits (29%) and training of extension workers (17%) will be very effective in improving climate information communication. They have also identified practical demonstration (14%) and media (11%) as strategies to improve communication. Other ways include localized climate information through local weather stations, use of media and community meetings. According to key

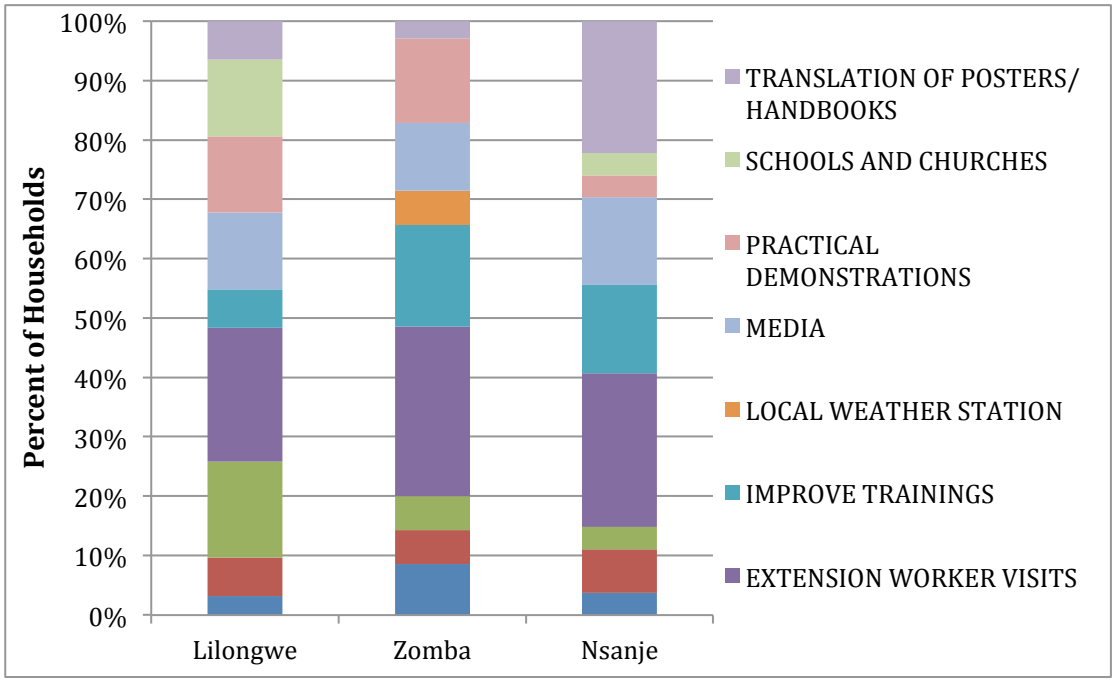
informants, the meteorology department and government extension services should have more effective linkages. Government extension workers are sometimes limited in providing farmers with the most up-to-date climate information. They thought this could be improved through better coordination and linkages between these arms of government. Further, they have declared that community meetings can be very effective ways to disseminate information because in the villages surveyed there is usually a big turn up for community meetings, especially called by village chiefs.

Figure 26. Preferred messengers for climate information that key informants recommend.



For key informants in the surveyed sites in Nsanje, frequent visits from extension agents (26%) and number of training (15%) of extension agents and staffs from the weather station should be increased. At the time of the survey, the local climate information centre had two members on its staff, and it was indicated that only one had some relevant training. They believe also that it is essential to establish community radios and to improve local climate information by employing more trained staff. The respondents felt that the language employed in the formulation of climate information made it difficult to understand the messages being conveyed. So, 22% of key informants suggested that posters and handbooks should be translated in local language.

Figure 27. Ways key informants would like to see climate information communication improved in their community.



Discussion and Conclusion

The findings on climate information in Malawi showed that households have access to climate information with sometimes very basic agricultural advice but most of the households interviewed do not use these forecasts for their agricultural decision making. Indigenous knowledge and personal experience are rather the main sources of information that trigger farmers' agricultural decision making. These results raised the issue of reliability and relevance of climate information for the farm households surveyed. Scientific climate information is not used by the sampled farm households because they perceived this information as less reliable and not locally relevant to inform their cropping activities. Farmers need to be advised on improved cropping systems and agricultural technologies to minimize crop failure. Indeed, they have indicated that in addition to information on climate, they would like to receive additional information on crop management and improved technologies. Also, ensuring effective supply and availability of farm inputs (fertilizer, seeds) at the market will contribute to enhance farmers' ability to act on the information received. Women have access to climate information but to a lesser extent than men. The reason may

lie in the fact that they own less communication asset, particularly radio and may be often too busy with the household chores. In addition a limited number of women are able to use the advice bundled with the climate information because of their lower control of productive resources and training.

Both men and women have reported that forecast on onset of rainfall, seasonal outlook, probability of extreme weather events, end of the rainy season and number of days of rainfall, are the five most important climate information they desire to inform their agricultural decision making. Onset of rainfall and forecast on extreme weather events were the most preferred climate information in Nsanje and Lilongwe. Knowing the onset of rainfall allows farmers to plan ahead, to identify the right timing for planting, what and where to plant which are very critical for a successful harvest and food security. Zomba and Nsanje are located in the shire river basin and farmers are very vulnerable to extreme climate events, mainly flood. So, no wonder that forecast of extreme events is on top of the most preferred climate information. Farmers would like to receive climate information at the beginning of the cropping season and well ahead of the forecasting event, preferably as soon as forecasters know about the event or months ahead. This is because they make most of their agricultural decisions before the cropping season and early knowledge of the climate information will enable them to effectively use this information in the cropping season. Preferred format and messengers are radio and extension workers. Radio represents the main source of scientific climate information for farm households particularly in Lilongwe characterized by wealthier households with more communication assets. However, government extension agents were reported as an essential source of climate and agricultural information for farm households in Nsanje and Zomba. NGOs were also frequently acknowledged as sources of information in Nsanje and Lilongwe where government extension workers are not always available to provide services to farmers. So, in addition to radio, extension workers can represent effective means to communicate climate information.

The baseline data collection in 2014 in Malawi took place in Lilongwe, Zomba and Nsanje. Communities surveyed in Lilongwe were located at the edge of urban areas, in suburban villages. They derive their livelihood mainly from wage-labour activities. In Zomba and Nsanje, farm households involved predominantly in agriculture were interviewed. Analysis of the data shows that households interviewed have access to some extent to scientific climate

information and use their own indigenous knowledge for their livelihood decision making. This information is basically forecast on onset of rainfall, extreme events and daily weather predictions. This information is often not coupled with agricultural advice. Radio is the main channel of climate information communication, followed by NGOs extension workers. No wonder these two sources are also the preferred formats for diffusion of information cited by the respondents. The most common climate information that farmers wish to receive are forecast on onset of rainfall, frequency of extreme events, distribution of rainfall over the agricultural season, and end of the rainy season.

Several key insights can be derived from this analysis and inform the design of climate services activities in the districts targeted. First, diffusion of climate information to households should rely preferably on radio and extension workers both from government and NGOs. Second, training of key informants, particularly extension workers in understanding climate forecast concepts and integrating them in agricultural activities is essential for effective dissemination of climate information services. Third, supply of the markets with farm inputs will enable farmers to better act on the climate information received. Fourth, climate service products delivered to farmers should include forecast on onset of rainfall, frequency of extreme events, distribution of rainfall over the agricultural season, and end of the rainy season. Fifth, traditional indicators should be valued and integrated to the conventional climate forecasts to promote farmers' use of scientific climate information in conjunction with their own indigenous knowledge. Finally, dialogue between national meteorology services, extension agents and farmers will represent effective platform for relevant and useful climate services for end-users.

References

Tall A, Davis A, Agrawal, S. 2014. Does climate information matter? Evaluating climate services for farmers: a proposed monitoring and evaluation framework for participatory assessment of the impact of climate services for male and female farmers. CCAFS Working Paper no. 69. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Maxwell D.G. 1995. Measuring Food Insecurity: The Frequency and Severity of "Coping Strategies". IFPRI FCND Discussion paper no. 8. International Food Policy Research Institute, Washington, D.C.

Maxwell S., Frankenberger T.R.1992. Household Food Security: Concepts. Indicators, and Measurements: A Technical Review, United Nations Children's Fund (UNICEF) and International Fund for Agricultural Development (IFAD), New York and Rome.

Msangi S., Rosegrant M.W., You, L. 2006. Ex post assessment methods of climate forecast impacts. Climate research, 33(1):67-79.

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR

CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic initiative of CGIAR and Future Earth, led by the International Center for Tropical Agriculture (CIAT). CCAFS is the world's most comprehensive global research program to examine and address the critical interactions between climate change, agriculture and food security.

For more information, visit www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

CCAFS is led by:

CIAT

Strategic partner:

futureearth research for global sustainability

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Norad

Research supported by:

CGIAR Fund

Danida

European Commission

IFAD

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC

IICT

UKaid from the British people

Australian Government
Australian Centre for International Agricultural Research

Irish Aid
Ireland's commitment to a world without poverty and hunger

Ministry of Foreign Affairs of the Netherlands

Government of Canada
Gouvernement du Canada

NEW ZEALAND MINISTRY OF FOREIGN AFFAIRS & TRADE
MANATŪ AORERE