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ARCC Small Grants Program

COMPILATION OF THREE CLIMATE CHANGE RESEARCH REPORTS: GHANA, KENYA, AND BURKINA FASO

MARCH 2014

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ARCC

African and Latin American
Resilience to Climate Change Project

This publication was produced for the United States Agency for International Development by Tetra Tech ARD, through a Task Order under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract Core Task Order (USAID Contract No. AID-EPP-I-00-06-00008, Order Number AID-OAA-TO-11-00064).

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AFRICAN AND LATIN AMERICAN RESILIENCE TO CLIMATE CHANGE (ARCC)

MARCH 2014

PREFACE: ARCC SMALL GRANTS PROGRAM

ABOUT ARCC

The African and Latin American Resilience to Climate Change (ARCC) Program is a three-year USAID program implemented by Tetra Tech ARD under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract. ARCC promotes adaptation to climate change and integration of adaptation into economic investments, in order to support sustainable, climate-resilient growth. One of ARCC's objectives is to increase knowledge development and management around climate change adaptation. In support of this objective, ARCC implemented an innovative small-grants program that engaged with African research organizations to build local capacity to carry out climate change adaptation research.

ARCC GRANTS PROGRAM

The ARCC grants program was born out of the collaborative efforts of the United States Agency for International Development (USAID) and the African Climate Policy Centre (ACPC). USAID envisioned the grants program as an effective mechanism for improving the research capacity of African organizations while contributing to the body of knowledge around climate change adaptation. ACPC anticipated that it could enhance its member organizations' ability to conduct evidence-based research, which could then be used to improve programs and influence policy.

In April 2013, ARCC awarded grants to three African organizations: Multi-Features and Capacity-Enhancing Services (MFCS), in Ghana; Multiface Research and Development Centre (MRDC), in Kenya; and *Association pour la Gestion de l'Environnement et le Développement* (AGED), in Burkina Faso. Over the period of one year, ARCC and ACPC worked closely with these organizations to provide targeted technical and financial assistance throughout each phase of the grant process, from initial conception through the dissemination of the final research reports. Although the primary objective was to improve climate change adaptation research capacity and generate knowledge, the three grant recipients also improved their administrative capacity through ARCC's coaching in how to manage the grants.

FINAL OUTPUTS: CLIMATE CHANGE ADAPTATION RESEARCH REPORTS

The following pages include the three final research reports produced by MFCS, MRDC, and AGED under the ARCC grants program.

MFCS's research identifies not only strategies and practices used by smallholder farmers to adapt to climate variability in the Transition Zone of Mid-Ghana, but also approaches to improve household security in a changing climate. The study identifies appropriate technological options to improve the adaptation practices that smallholder crop producers use in the "breadbasket" region of Ghana in response to the impacts of climate change-induced rainfall variability.

MRDC's research analyzes household and community experiences and perceptions on climate change impacts due to floods, and expectations on policy interventions in Bunyala Sub-County, Western Kenya.

In particular, the research looks at how indigenous traditional knowledge can be used to improve adaptive capacity, how flooding impacts men, women and children, and the capacity of existing institutional structures to address risks to climate-related floods. It is hoped that the study findings will contribute to strengthening Kenyan disaster risk management policy and planning by increasing awareness of the impacts of frequent flooding in the Budalangi plains on the shores of Lake Victoria.

AGED's research looks at household and community experiences and perceptions on climate change impacts caused by droughts in the Sahel region of Burkina Faso. The study identifies key practices used by smallholder farmers in response to the impact of recurrent droughts, as well as the factors that determine their adaptive choices. The target study populations were smallholder farmers — including crop producers and agro-pastoralists — and pastoralist communities in the provinces of the Sahel region, whose livelihoods predominantly depend on rainfall.

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FINAL RESEARCH REPORT

CLIMATE CHANGE AND AGRICULTURAL ADAPTATION MEASURES IN THE TRANSITION ZONE OF MID-GHANA

MARCH 2014

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MFCS GHANA

ACKNOWLEDGEMENTS

The authors would like to thank Tetra Tech ARD for initiating the African and Latin American Resilience to Climate Change (ARCC) program which provided the opportunity for the grant. Many thanks to the United States Agency for International Development (USAID) for the financial support provided. To the ACPC who provided technical assistance by reviewing our reports and making suggestions for improvement, we say thank you. We are very grateful to the project team that completed the activities under the grant: Dr. Kwadwo Owusu Principal Investigator, Mr. Joseph Bandanaa, Research Officer, Mr. Saani Nassam Iddrissu, Finance and Administrative Manager, Dr. Charlotte Wrigley-Asante, Gender Expert, Dr. John Jatoe, Agricultural Expert, and Dr. Erasmus Owusu, Community Development Expert. Special thanks to all our field assistants who were part of the data collection and data entry. We say thank you to all project focal persons in the communities – assembly members, chiefs and elders. Finally, to all farmers and all representatives of local institutions who provided information to support the study report, we say Ayeekoo.

This report was prepared by:

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Cover Photo: Farmer in his maize farm near Wenchi, Ghana

CLIMATE CHANGE AND AGRICULTURAL ADAPTATION MEASURES IN THE TRANSITION ZONE OF MID-GHANA

MARCH 2014

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ACRONYMS AND ABBREVIATIONS

AARC	African Adaptation Research Centre
ACPC	African Climate Policy Center
ADB	Agricultural Development Bank
AEA	Agricultural Extension Agent
AFD	Agence Francais Development
AfDB	African Development Bank
AMJ	April, May, June
ARCC	African and Latin America Resilience to Climate Change
ATPS	African Technology Policy Studies Network
B4C	Building Capacity to Meet the Climate Change Challenge
CBO	Community Based Organization
CIDA	Canadian International Development Agency
COCOBOD	Ghana Cocoa Board
EPA	Environmental Protection Agency
ESM	Ejura-Sekyedumase Municipality
FAO	Food and Agricultural Organization
FASDEP	Food and Agricultural Sector Development Policies
FC	Forestry Commission
FGD	Focus Group Discussion
GIZ	Gesellschaftfür Internationale Usammenarbeit
GMet	Ghana Meteorological Agency
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
JAS	January, April, September
JFM	January, February, March
JICA	Japan International Cooperation Agency
MEST	Minister of Environment, Science and Technology
METASIP	Mid-Term Review of the Medium Term Agricultural Sector Investment Plan

MFCS	Multi-Features and Capacity-Enhancing Services
MiDA	Millennium Development Authority
MoFA	Ministry of Food and Agriculture
MoWAC	Ministry of Women and Children's Affairs
NGO	Non-Governmental Organization
PLACE	Prosperity, Livelihoods, and Conserving Ecosystems Indefinite Quantity Contract
RTIMP	Root and Tuber Improvement and Marketing Projects
SRID	Statistics Research and Information Directorate
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
WFP	World Food Program
WM	Wenchi Municipality

EXECUTIVE SUMMARY

INTRODUCTION

This one-year, small grant on "Climate change and agricultural adaptation measures in the Transition Zone of mid-Ghana" began in April 2013. The grant was awarded to Multi-Features and Capacity-Enhancing Services (MFCS) by the African and Latin American Resilience to Climate Change (ARCC) project, a United States Agency for International Development (USAID) -funded Task Order implemented by Tetra Tech ARD under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract Core. The grant was implemented by MFCS, a non-governmental organization (NGO) based in Accra, Ghana, with guidance from the United Nations Economic Commission for Africa - African Climate Policy Center (UNECA-ACPC), situated in Addis Ababa, Ethiopia.

Ghanaian food security depends largely on the smallholder agricultural systems of the Transition Zone found in the middle of the country, known as Ghana's "breadbasket." Specifically, the study focused on two of the fifty administrative local government areas that fall within the Transition Zone of mid-Ghana: the Ejura-Sekyedumase municipality (ESM) in the Ashanti region, and the Wenchi municipality (WM) in the Brong-Ahafo region. A total of six communities (three within ESM and three within WM) were targeted.

This award supported one year of research to identify strategies and practices used by smallholder farmers to adapt to climate variability and change in the Transition Zone, and identify approaches to reinforce improved household and food security in a changing climate. The main objective of the study was to identify appropriate technological options to improve the adaptation practices that smallholder crop producers use in the "breadbasket" region of Ghana in response to the impacts of climate change-induced rainfall variability. The research questions that guided this study are:

1. What technological options do smallholder crop producers use to adapt to climate change impacts in the Transition Zone of Mid-Ghana?
2. How are adaptation practices used by smallholder crop producers perceived to contribute to improved household food and income security? and
3. How have local institutions supported households to adopt adaptation practices?

RESEARCH METHODOLOGY

Several weeks of field work were undertaken to gather information on what farmers know, what farmers do, and what local public and private institutions do to support households in the face of the climate change. Methods for data collections and analysis consisted of a combination of qualitative methods (focus group discussions and validation workshop) and more quantitative methods (household and institutional questionnaire surveys). Household questionnaires were administered to 612 respondents, targeting households primarily engaged in farming. A total of 25 institutions (5 private, 19 public, and 1 civic) completed questionnaires distributed to them. In addition, 10 focus group discussions (FGDs) were conducted and two validation workshops were held after survey data had been collected and analyzed.

SUMMARY OF FINDINGS

This study looked agricultural adaptation measures being used by farmers in the Transition Zone of mid-Ghana, and institutional support being provided to communities in the area. About half of the respondents indicated that they were solely dependent on farm income, clearly demonstrating the importance that rainfall has on their livelihoods. Furthermore, this study found that the majority of farmers were commercially oriented farmers, selling more than one-half of harvested produce. With about half of respondents cultivating two hectares or less, and the majority cultivating under four hectares, the small farm size makes households have to take great care in determining their choices of what and when to plant. As such, any changes in weather patterns, such as rainfall variability, can cripple household food and income security and have devastating implications on livelihoods.

The major crops grown are maize, groundnut, cassava, beans/cowpeas, and yams, which comprise 58 percent of crops; followed by plantain, cashew, cocoyam, cocoa, and (to a lesser extent) vegetables. The major vegetables are pepper, okra, tomatoes, and garden eggs. The majority of the crops are grown during the major season, which peaks in May/June. Cowpeas and maize are the key crops that are also grown in the minor season which peak in September/October. The crops frequently mentioned as affected by changing weather conditions (erratic rain, drought, floods, and strong winds) are maize, yams, beans/cowpeas, and vegetables.

The vast majority (99 percent) of households indicated that there had been significant changes to the weather patterns in the last five years. The primary perceived changes in the weather pattern among the respondents were (in descending order): the late onset of the rainy season, reduced rain during the rainy season, erratic rainfall during the rainy season, persistent drought, and uncertain onset of the rainy season. Moreover, they identified an increased incidence of bush fires, pests and plant diseases, deforestation, a decrease in soil fertility, and an increase in soil loss. The literature interview indicated that many of these latter occurrences are exacerbated and/or indirectly attributable to changes in rainfall and climate variability. Respondents also reported that floods and droughts caused crop failure, death of livestock, food shortages, decreased household income, damage to building/property, and poverty/indebtedness/hardship. The majority of farmers agreed that changes in rainfall intensity decreased crop production.

The household survey found that about 45 percent of the respondents made changes in their agronomic practices as a key measure to avoid losses related to changing climatic factors. However, during the FGDs, it appeared that the majority of farmers were adapting or changing their agronomic practices in one way or another in response to the changes in the weather patterns. It is these farmers and the agronomic practices they are using to adapt to climate change that this study primarily focuses on. In addition, this study found that several off-farm (or non-agronomic) practices were being used, particularly to cope in the short term. These practices included engaging in off-farm activities, relying on remittances, selling less harvest, and increasing storage.

Adaptation Practices Used by Farmers

The majority (95 percent) of farmers said they have made changes to farming practices in the last five years. The most commonly cited changes included using herbicides/pesticide (85 percent) and chemical fertilizer (73 percent); practicing land fallowing (63 percent); using new crop varieties (46 percent); introducing livestock (43 percent); practicing soil/water conservation measures (17 percent); practicing tree planting (12 percent); and using ecosystem services more intensively, such as hunting and collecting products from the forest (10 percent).The use of herbicides/pesticides is attributed to high incidence of weeds, pests, and diseases; erratic rainfall; and the desire to increase output/income. The use of chemical fertilizers is in response to poor soil fertility, the desire to increase output/income and cope

with the occurrence of erratic rainfall and drought, and the response to increased demand of new crop varieties. The demands that using new crop varieties bring include the need to purchase seed on a regular basis, adopt line planting, and increase plant density, among others. The adoption of land fallowing and soil/water conservation measures is in response to a reduction in soil fertility and the occurrence of erratic rainfall and drought. The use of a new crop variety, introduction of livestock, and use of ecosystem services were also attributed to the farmers' desire to increase output/income, deal with the occurrence of erratic rainfall and drought, and increase household food consumption. The practice of tree planting is mainly due to the occurrence of erratic rainfall and desire to increase income. In general, all of the above practices were perceived to be effective by the majority of respondents.

This study went further by specifically questioning participants about certain types and use of agronomic practices. This information helped build the knowledge base on how farmers are responding to changes and what practices are more commonly used than others. The most frequently mentioned agronomic practices (in descending order) were: soil improvement with inorganic fertilizer (75 percent), early planting (56 percent), early harvesting (51 percent), planting on raised ridges (51 percent), cultivating a crop two or more times (50 percent), mixed cropping (47 percent), mulching (46 percent), late planting (41 percent), use of late maturing varieties (41 percent), use of drought resistant varieties (40 percent), late harvesting (40 percent), use of early-maturing varieties (33 percent), planting in valleys (10 percent), and irrigation (9 percent). The major reasons reported for non-adoption of adaptation practices by farmers were inadequate information, lack of knowledge, and the lack of funds to meet the demands of purchased inputs that many of the practices require. More members in ESM communities than in WM communities tended to adopt adaptation practices such as improved seed and chemical fertilizers.

Women's empowerment and participation in decision making at home and at the community level was higher than anticipated. This may be due to increased participation of women in off-farm activities, including petty trading, as a key adaptation strategy. However, men tended to have easier access to agricultural resources such as land, information, agro-chemicals, and improved seed as compared to women.

Household Food Security

The majority of the households surveyed (82 percent) bought less than 50 percent of their food from the market, implying that food self-sufficiency is important to the responding households. Households are generally food secure in that the majority of adults and children eat more than two meals a day. Although most adults and children eat more than two meals a day, half of the respondents experienced food shortages during the lean period of the past year when crops were yet to be harvested. A few farmers have also attributed food shortages to crop failure or poor harvest/yield, weather-related problems (erratic/poor rainfall and drought), bush fires, and poor storage. This study found that farmers that adopted herbicide/pesticide, chemical fertilizer, land fallowing, livestock, and tree planting reported increased household food consumption. However, this study clearly found that due to the large dependence on crop production for household consumption, household food security is extremely vulnerable and at risk due to climate change. In particular, since it was reported that households experience periods of decreased food consumption during the year, this can lead to negative coping practices, such as the selling valuable assets, decreased nutrition, etc., that can further exacerbate households resilience to cope with shocks.

HOUSEHOLD INCOME

As it was the case for household consumption, the majority of farmers perceived that adoption of herbicide/pesticide, chemical fertilizer, land fallowing, livestock, and tree planting resulted in increased household income. Farmers perceived that the adoption of fish farming and intensified use of ecosystem

services did not change household income much. Nevertheless, the majority of respondents said they would continue with the latter practices, most likely as they are strategies for improved food security and contribute to household consumption.

THE ROLE OF LOCAL INSTITUTIONS

Of the institutions surveyed, the only local institutions that reported supporting households to adopt adaptation practices were public sector institutions; none of the private and civic organizations said they were involved in such efforts. Those perceived to be most important were the district agricultural development unit, the district assembly, and the fire service. Although the services provided by local institutions are generally perceived as satisfactory by farmers who utilize them, some farmers said they had limited access to the services due to lack of knowledge and inadequate information on the services, and lack of funds to meet the demands of purchased inputs that new services require. The major ways it was suggested that local institutions can support households to adopt adaptation practices are:

1. Continuous strengthening of the capacity of the Municipal Assembly and other public departments, who are mandated to support households improve their capacity to mobilize resources; and
2. Improved networking by public institutions to engage with the private and civic institutions, as well as the households, to develop and implement climate change adaptation strategies effectively.

1.0 INTRODUCTION

1.1 BACKGROUND

Agriculture remains the main source of livelihood for a significant majority of the rural population in Ghana. Majority of agricultural producers are smallholders, with production mostly rain-fed and highly exposed to the impacts of climate change and climate variability. Recent studies have highlighted significant inter-annual rainfall variability with clear effects on agricultural production (Oguntunde, Friesen, va de Giesen, and Savenije, 2006). The onset of the rainy season has been shifting forward in the year across the country.

In the Transitional Zone of mid-Ghana, Owusu and Waylen (2012 and 2013) attributed the changing rainfall regime to the impacts of global climate change. They noted that the short dry spell (July–August) and the minor rainy season (September–October) have undergone significant changes. In addition, the minor rainy season was associated with high risks of crop failure due to erratic rainfall, even though it has the potential benefits of reducing post-harvest losses through sun-drying of grains. Laux, Kunstmann, and Bárdossy (2007) showed that there is a statistically significant forward shift of 0.4 to 0.8 days/year in rainfall patterns, while the end of the rainy season remains fixed in areas around the Volta basin of Ghana. According to regional climate model projections, this trend of forward shifts will become more pronounced and climatic patterns more unpredictable and erratic than they were in last decades. Laux et al. (2007) predicted additional shift in the onset of the rainy season of almost 10 days is predicted from the 1991–2000 period to the 2030–2039 period. The end of the rainy season does not still seem to change. In addition to the onset of the rainy season, within-season drought spells are also assumed to become more recurrent. All these changes in climate patterns come, and will continue to come, with many implications for crop production people livelihoods, especially in rural areas. Laube, Schraven, and Awo (2012) reported that climate change and land degradation have led to decreasing yields and crop failures in Northern Ghana and have caused further impoverishment of Ghana's poorest region.

Faced with increasing pressure on their agricultural livelihoods, local farmers have adopted a number of coping and adaptation strategies. Diversification techniques within agriculture, including on-farm practices such as planting different crops, differently located farm types, intercropping, animal husbandry, and hunting and gathering, have helped local farmsteads to adapt to a difficult environment (Laube, 2007). Other practices, including off-farm adaptation strategies, are also helping people to cope with the unexpected adverse effects of climate change. These practices include petty trading, migration, and the promotion of solidarity practices that result in the redistribution and reciprocity of resources in times of need. However, many of the adaptation practices that have emerged as a result of climate change are mostly untested and may not be effective for all farmers and in all situations.

Therefore, the aim of this study was to analyze the adaptation practices developed by local communities in order to identify the most successful practices that improve smallholder crop producers' resilience to climate change. Recognizing the important role that smallholder agriculture plays not only for the resident population in the Transition Zone, but also for a significant proportion of the country's population, this study seeks shed light on how food security and sustainable livelihoods are impacted by climate change.

1.1.1 Utility of the Study

It is expected that smallholder farmers of the Transition Zone of Ghana will use the findings of this study to reduce their vulnerability and improve their resilience to the adverse effects of climate change. The promotion of smallholder adaptation practices by the government at all levels will also be enhanced by utilizing the project findings on best adaptation practices. The wider research community and practitioners of community-based adaptation will be able to utilize the findings to ensure their interventions are sensitive to climate change and promote increased resilience, and enhance food security and improved livelihoods of the smallholder agricultural producers. Given the importance of the Transition Zone to food security in Ghana and the fact that the zone cuts across West Africa, this study also seeks to help Ghana and the sub-region to become more food secure.

1.2 OBJECTIVES OF THE STUDY

The objective of the study is to identify the appropriate practices that smallholder agricultural producers are using to adapt to the impacts of climate change, especially the climate-induced changes in rainfall patterns.

Specific objectives include:

1. Understand (or study) the existing farmers' coping practices in response to changes in rainfall patterns in order to identify gaps and entry points; and
2. Analyze the perceived effectiveness of the existing coping practices in building resilience to climate change and improving agricultural livelihoods.

1.3 RESEARCH QUESTIONS

The major research question answered in this study are

1. What technological options do smallholder crop producers use to adapt to climate change impacts in the Transition Zone of Mid-Ghana?
2. How are adaptation practices used by smallholder crop producers perceived to contribute to improved household food and income security? and
3. How have local institutions supported households to adopt adaptation practices?

1.4 ORGANIZATION OF REPORT

The report is organized into nine sections. Following this first section, Section 2.0 presents a summary of the literature reviewed. In this section, the general climate conditions, future climate projects, farmer perceptions of climate change and responses, and level of institutional support to households are presented. Section 3.0 describes the methodology, including the approaches and methods of data collection and analyses. Section 4.0 presents the key findings on adaptation practices, beginning with a summary of the general characteristics of the respondents and followed by a detailed description of the adaptation practices farmers use. Section 5.0 presents key findings on the farmers' perception of how adaptation practices have improved household food security, consumption, and income. Section 6.0 discusses how local institutions (public, private, and civic organizations) support households to utilize adaptation practices. Section 7.0 provides a brief overview of gender dimensions and other social exclusion issues in climate change adaptation that were reported. Section 8.0 provides the conclusions to the study and Section 9.0 presents the recommendations.

2.0 LITERATURE REVIEW

This section provides a review of existing literature to understand the extent to which earlier studies have documented key issues in climate change and agricultural adaptation in the Transition Zone of Ghana. The literature review covers the following areas: climate change, farmers' perception and vulnerability, response by farmers, response by institutions, and gender issues.

2.1 CLIMATE CHANGE IN GHANA AND THE TRANSITION ZONE

2.1.1 General Climate Conditions

Ghana is located in West Africa on the Guinea Coast. It lies on the south-central coast of West Africa between latitudes 4°5'N and 11°5'N and longitude 3°5'W and 1°3'E. The climate of Ghana is tropical and strongly influenced by the West African Monsoon. The rainfall seasons of Ghana are controlled by the movement of the tropical rain belt (also known as the Inter-Tropical Convergence Zone [ITCZ]), which oscillates between the northern and southern tropics over the course of the year (McSweeney, New, and Lizcano, 2008). Areas south of the ITCZ come under the monsoon flow from the Atlantic Ocean and receive rain while areas to the northeast come under the influence of the hot and dusty air from the Sahara Desert (known as the "Harmattan"). Areas south of latitude 8°N (including the Transition Zone of Mid-Ghana) enjoy double rainfall maxima while those above it receive a single maximum (Owusu and Waylen, 2009). The two rainy seasons in the south peak in May/June and September/October. The single rainy season in the north occurs from May–November (McSweeney et al., 2008). The country then comes under the influence of the Harmattan from December–March, when the rains begin in the south and gradually migrate with the movement of the ITCZ until they reach the northern parts fully in May.

The Transition Zone of Ghana occupies an ecotone between the tropical forest in the south-west and the Guinea Savanna areas of the north. It runs from west to east from approximately 5°N to 8°N in accordance with the regional rainfall pattern. Wenchi and Ejura-Sekyedumase municipalities located within the zone experience mean annual rainfall of around 1,300 mm. The major rainy seasons begins in late March/early April and runs until mid-July. This is followed by a short dry spell in July–August and the minor of September–October, which precedes the November–March long dry season. According to the Statistics Research and Information Directorate (SRID) of the Ministry of Food and Agriculture (MoFA)(SRID, 2001), the major rainy season has an excess of 200 growing days while the minor season has only around 60 growing days. However, in a good year, the total rainfall amount in the two seasons is about the same. The rainfall regime is associated with a high degree of variability at the onset of each rainy season and particularly so at the beginning of the short dry spell (Owusu and Waylen, 2013).

2.1.2 Climate Change and Future Climate Projections

Changes in climate and increased climate variability that have had negative impact on livelihood in all the five agro-ecological zones of Ghana have been observed in the last two decades. The Ghana Environmental Protection Agency (EPA), using 1960 as the baseline, concluded that the mean annual temperature in Ghana has increased by 1◦C across the country (Agyeman-Bonsu et al., 2008), representing an average rate of increase of 0.21°C per decade. Temperatures are generally high in Ghana and inversely follow the rainfall pattern with the lowest temperatures recorded in the south.

Seasonal variations in temperature in Ghana are greatest in the north, with highest temperatures in the hot, dry season in April, May, and June (AMJ) at 27–30°C, and lowest in July, August, and September (JAS) at 25–27°C. Further south, temperatures reach 25–27°C in the warmest season in January, February, and March (JFM), and 22–25°C at their lowest in JAS (McSwenney et al., 2008).

From 1960 to 2003, the frequency of hot days has increased by 48 days per year and cold nights have reduced by an average of 13 days per year (McSweeney et al., 2008). Over the same period, rainfall decreased across all agro-ecological zones, with a slight increase post-2006 (McSweeney et al., 2008; Owusu, Waylen, and Qui, 2008). In the Transition Zone, a major challenge has been declining rainfall totals, increased variability, and shifts in the rainfall pattern in recent decades. Global changes in climate, natural variability, and changes in land use and land cover have been cited as the main causes of the changes in rainfall. Estimates by the Ghana Meteorological Agency (GMet) indicate that the situation could worsen as rainfall is projected to decline by 2.2 percent by 2020,, 8.8 percent by 2050, and 14.6 percent by 2080 (Minia, 2004), even though other models are not certain in long-term projections.

The study area is the nation's breadbasket, making it crucial to the food security of Ghana despite the fact that production is almost completely rain-fed. According to MoFA (2003), only 0.08 percent of Ghana's arable land is under irrigation. Rainfall variability in the study area, therefore, has a significant impact for crop yields and food security in Ghana. Owusu and Waylen (2012) observed that rainfall in both Ejura and Wenchi have seen a reduction in both the major and minor rainy seasons and an infilling during the short dry spell. The implications for rain fed agriculture is that post-harvest loss increase (as the rains occur during harvest) during the major rainy season and there is a high risk of crop failure during the minor rainy season as the onset of the rain delays and early termination occurs.

2.1.3 Farmers' Perceptions of Climate Change

Many studies have documented the perception of farmers to climate change and climate variability in Africa (Mertz, Mbow, Reenberg, and Diouf., 2009; Thomas, Twyman, Osbahr, and Hewitson, 2007; Maddison, 2007). Farmers have a very clear memory of the years dominated by extreme climatic conditions and other significant events leading to disturbances of their production. In a study of 11 African countries including Ghana, Maddison (2007) sought to review how farmers perceived changes in climate, how they respond to climate constraints, and what they saw as barriers to adaptation. The major findings were that significant numbers of farmers believe that temperatures have already increased and that precipitation has declined. Other studies have variously described perceived climatic changes as late onset of rains, early cessation of rains, and consistently decreased duration or length of the rainy season with increased number of dry spells (Akponikpè, Johnston, and Agbossou, 2010). In their study of the perception of farmers in the Sahel, Mertz et al. (2009) concluded that households are aware of climate variability, and identify wind and occasional excess rainfall as the most destructive climate factors. They also found that communities have high awareness of climate issues.

2.1.4 Farmers' Vulnerability to Climate Change

The United Nations' International Strategy for Disaster Reduction (UN-ISDR) defines "risk" as comprising biophysical and social vulnerability components (UN-ISDR, 2006). It has also been observed that farmers are vulnerable to shocks resulting from unexpected events such as flooding; seasonal variation (particularly timing and amount of rainfall); and long-term trends, e.g., increased mean temperature (Acquah and Onumah, 2011). As noted earlier, crop farmers expressed heightened concerns about erratic rainfall patterns as these increase uncertainty about planting regimes and may induce diseases and pests leading to mass crop failures. In fact, Kemausuor, Dwamena, Bart-Plange, and

Kyei-Baffour (2011) note that farmers' vulnerability to climate risks in Ghana arise from abrupt changes in season, droughts, reduced rainfall, increased temperature, and floods, for both the crop and livestock.

Kalame et al., (2011) have summed up the climatic risk to agriculture in the Transition Zone as droughts, erratic and late rains, temperature rise, windstorms, and bushfires. Erratic and late rains result in poor crop growth and poor tree seedling regeneration in some cases. Studies that examined farmers' perception of climate change suggest that most farmers perceive changes in various aspects or elements of the weather over time. For example, Djagbletey et al. (2012) report perceptions of increased temperature, reduced and erratic rainfall, and increased drought periods among farmers in the Ashanti region. Similar findings reported by earlier studies include reduced flow in streams and rivers, prolonged rainfall shortages and drought that lead to crop failures, and shortage in water resources (Gyampoh, Idinoba, and Amisha, 2008; Gyampoh, Idinoba, Nkem, and Amisha, 2007). A review of climate and climate change in Ghana and the Transition Zone is useful in identifying the nature of change occurring now and the future projections. It also places in perspective the way smallholder farmers perceive climate change, the way their activities are vulnerable to climate change, and what they are doing to decrease their vulnerability to climate change. The literature shows that smallholder farmers draw on different measures to support their livelihoods. For example, planting vegetable crops (such as tomatoes and onions) using nearby rivers for irrigation against risks associated with droughts is a common practice among farmers in the Transition Zone (Yaro et al., 2010).

2.2 SMALLHOLDER FARMERS' RESPONSE TO CHANGES IN CLIMATE: AGRONOMIC PRACTICES

Many studies have investigated climate change and adaptation with a focus on the crop sub-sector of the Ghanaian economy and have enumerated adaptation or coping strategies to various climatic stressors. This section reviews different adaptive practices or strategies reported as being used by crop farmers in Ghana generally, and in the Transition Zone in particular. This portion of the review focuses on farmers' adaptation to climate change and variability in Ghana with emphasis on various agronomic and household-level strategies or practices in use, especially in the Transition Zone. Adaptation considers how farmers respond to both long-term changes as well as anticipated changes in climatic or weather conditions and make adjustments (in the short term) in their practices and approaches in order to avoid or minimize the adverse effects of such changes.

In general, on-farm or agronomic adaptation practices employed by farmers can be grouped into two categories: crop management and soil and water management practices. This study defines best practices as tried and proven climate change adaptation practices, i.e., methods or techniques used by crop farmers in the Transition Zone to stabilize or increase their crop yields for improved incomes and food security.

2.2.1 Crop Management Adaptation Practices

Sagoe (2006) investigated the consequences of, and adaptation responses to, climate change in root crop production in Ghana. The study identified and discussed various adaptation options for cassava, cocoyam and yam production to climatic change in Ghana. Using a participatory/rapid appraisal approach, the study selected a district in each of the 10 regions of the country for participants. Findings of the study pointed to potential reductions in cassava and cocoyam productivity as a result of climate change, and increases in wholesale prices. Yam or cocoyam production require new forest land for production, possibly exacerbating deforestation. The study noted that in response to adverse climatic changes farmers adopted plant and soil management strategies. Crop management practices such as crop diversification and multiple cropping were used to increase yield. Other practices identified were improved farming technologies, such as planting more than two types of varieties of root crops on the

same piece of land, planting improved varieties that are nutrient efficient and drought tolerant, and adjustments to planting dates.

Other adaptation measures are manifested in the diversity of resource management and cropping systems, which are based on indigenous knowledge of management of the fragile and variable environment, local variety of food crops, intercropping, and agroforestry systems. For instance, to offset crop failure arising from rainfall variability and unpredictability, farmers cultivate several hardier (or drought-tolerant) types of the same crop species. A study by Kuwornu, Al-Hassan, Etwire, and Osei-Asare (2013) investigated smallholder farmers' perception of the effectiveness of adaptation strategies and farmer perceptions regarding long-term climatic changes, adaptation measures and their determinants. The study concluded that crop diversification, mixed cropping, crop changing, and changing planting time were some of the crop management practices employed by farmers. Acquah and Onumah (2011) indicate that, in the Shama Ahanta East Municipality in the Western region of Ghana, farmers' level of adaptation was found to be relatively high with majority of the farmers using changing planting dates (93 percent), tree planting (34 percent), and planting different crop varieties (94 percent) as the major adaptation measures to climate change impacts. Elsewhere in the Western region, Ahenkan and Boon (2010) indicate that farmers, as strategies to the changing climate, are cultivating a variety of improved hybrids of cocoa, maize, cassava, and cereals that have shorter gestation periods and thrive well under the current prevailing climatic conditions. The study also revealed that planting economic trees and adopting sustainable farming systems were coping strategies adapted by some of the farmers. Tachie-Obeng, Akponikpè, and Adiku (2012) identified delayed planting and the use of medium heat-tolerant maize variety to increase maize yield in the Transition Zone. They concluded that the heat-tolerant maize varieties produced substantial gains in crop yield with longer grain-formation period under near-future climate change when compared to delaying sowing dates.

Amissah, Kyereh, and Agyeman, (2010) in a study in eight communities in the Transition Zones identified that coping strategies, such as early vegetable and yam cultivation (which entails early preparation of land between December and February), to be a factor that contributes to reduced risk of wildfires. They identified measures such as preservation of trees to suppress weed growth and reduced accumulation of dry weeds to reduce the threat of wildfires. Planting of vegetable crops such as tomatoes and onions using nearby rivers for irrigation are also common practices used to mitigate risks associated with droughts in the Transition Zone (Yaro et al., 2010).

2.2.2 Soil and Water Management Adaptation Practices

Farmers combine multiple adaptation practices as they deem fit. For example, Kuwornu et al., (2013) also identified changing location of crops, mulching, and enhancing soil organic matter as soil and water management practices used by farmers to adapt to climate change, in addition to the various crop management practices already mentioned above. Similarly, Sagoe (2006) indicated that, in addition to various crop management practices, farmers also used soil organic matter enhancement, mulching, fertilizer applications, and application of irrigation water as adaptation strategies to climate change. According to Acquah and Onumah (2011), application of irrigation water (23.5 percent), soil conservation (30.6 percent), and water harvesting (73.5 percent) were some of the main adaptation measures used by the farmers. Laube et al., (2012) investigated the issue of how small-scale farmer-driven development of shallow groundwater irrigation in the Atankwidi and Anayere catchments of the Upper East region of Ghana could be used to reduce poverty and adapt to changing environmental conditions (including climate change). Their study adopted anthropological field research, quantitative socio-economic surveys, farm observations, and hydrological monitoring of surface and groundwater resource approaches. To guarantee a valid simple random sample, all households of the Anayere and Atankwidi catchment were identified in a satellite image and listed accordingly. Based on the list, a random sample of 150 farm households were drawn for the study. The aim was to find farmers

representing different farming areas, clans, age groups, and genders within particular farming areas, as well as the different types of irrigation methods (bucket and pump irrigation) used. Findings from their study indicate that farmers use risk-mitigating patterns of production; agricultural production diversification; and different coping strategies in the case of disaster.

As observed by Stanturf et al. (2011), farmers reported during the validation workshop that there is a shift toward cultivation in low-lying areas, marshy areas, and river valleys where soils retain more moisture; increased irrigation development through construction of small dams or dugouts; and harvesting of water to grow rice and vegetables. Even though soil and water conservation practices may be seen as cost effective and easy to apply, the returns on investment take longer to accrue; this could explain the low adoption of these practices.

Other soil and water (moisture) management strategies employed by farmers were intercropping to reduce weeds, retain soil moisture, and intensify production; mulching yam mounds to prevent desiccation; planting legumes as cover crops between grains to reduce soil and water runoff; enhancing soil fertility by adding organic amendments (such as agricultural waste, animal droppings, or compost); retaining crop residues in fields; and banning burning. Mechanical measures include contour tillage, grass strips, earth bunds, and stone lines across slopes. Other measures are intercropping fast-growing trees with yams to prevent soil degradation and increase wood products. In some cases dry season vegetable crops are grown in floodplain fields that often are hand watered.

In the Ashanti Region, Djagbletey et al. (2012) observed that planting on raised ridges, irrigating crops with water from streams, cropping around streams, and farming during the minor rainfall season were the coping strategies adopted by farmers towards climate change. In Northern Ghana, Mabe, Sarpong, and Osei-Asare (2012) noted using chemical fertilizers, extending farming into marginal lands, and cropping in moist valley bottoms as some of the soil and water management practices.

2.2.3 Gender and Adaptation Strategies

Although often excluded or underrepresented in decision-making and policy processes regarding climate change (United Nations Development Programme [UNDP], 2009), women are active agents who have developed locally adapted, appropriate, and sustainable coping strategies and responses. Work done by the Regional Institute of Population Studies, University of Ghana, on integrating gender issues into climate change adaptation discussed how women are more vulnerable than men in an array of challenges associated with climate change. The conclusion was that women deserve to be targeted with climate change adaptation strategies (African Adaptation Research Centre [AARC], 2011).

The choice of wells, boreholes, and water harvesting as essential adaptation strategies for females was attributed to their typical role of providing water for the family and the significant amount of time spent daily in hauling water from distant sources. The choice of wells and boreholes as the second-most important strategy chosen by males indicated the importance of water in the communities. Among male fisher folk, the preferred adaptation options during periods of drought were fish pond, fish culture, and crop insurance. The choice of fish ponds during drought could create alternative livelihood outcomes for them. During periods of flood, post-harvest technology and crop insurance were the second- and third-most preferred adaptation strategies for female farmers. This was because women tend to lose their major sources of income and food due to bad harvests during periods of floods, thus post-harvest technology could assist in processing and preserving the scant food available. Male farmers more often preferred upland cultivation compared to female farmers. This was attributed to the facts that, traditionally, women have often-limited access to and ownership of land, and their usufruct rights to land are usually contingent on inheritance or the continued goodwill of a man.

Similar differences in preferences in adaptation practices between men and women have been documented by other authors (Chaudhury, Kristjanson, Kyagazze, Naab, and Neelormi, 2012; Dietrich, 2008; Cudjoe, Atidoh, and Burkett, 2011). Others have also explored the causes for these preferences (Djoubi and Brockhaus, 2011; Chaudhury et al., 2012) and have concluded that principal causes include access to resources, internal household power dynamics, and a host of locally specific socio-cultural attributes.

In many traditional societies in Ghana, women have access but may not necessarily control critical resources, such as land, forest, or trees. An assessment of the Ghana Gender and Agricultural Development Strategy revealed that, traditionally, women have access to farm lands through matrilineal family systems, patrilineal family systems, and/or through marriage, but they have less control over this resource (Duncan and Brants, 2004; Opare and Wrigley-Asante, 2008). This has made women's access to land more insecure than that of men, particularly when women have obtained such land from a husband who continues to control decisions about use of such land and sometimes demands such land back (Kabuthi, 2010).

2.3 INSTITUTIONAL SUPPORT FOR SMALLHOLDER FARMER ADAPTATION TO CLIMATE CHANGE

Because adaptation to climate change occurs locally, it is critically important to understand the role of local institutions in shaping adaptation and improving the capacity of the most vulnerable social groups. This section reviews the role of institutions in enhancing the capacity of households and communities to adopt practices and strategies to address the impacts of climate change. Institutions that support adoption of agronomic and ecosystem practices need to be identified and their strengths and weaknesses in providing assistance, facilitation, or promoting the practices assessed. This section categorizes institutions, relates activities of the institutions to households' adoption of best practices, and describes how others have suggested that institutions provide support to households.

2.3.1 Categorization of Institutions

Institutions are defined here as "the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction" (North, 1990). Uphoff (1986) simply considers institutions as rules that guide conduct in a system and shows that they operate at different levels: international, regional, national, and local. Uphoff (1986) contends that local institutions should connect with supra-local ones to manage major activity areas in development effectively, including natural resources management and agricultural development. Thus, the role of institutions in supporting climate change adaptation is crucial.

Agrawal, Chhatre, and Hardin (2008) specifically outlines a possible framework for viewing the relationship between adaptation due to climate change and the role of institutions in facilitating external support for adaptation. Three types of institutions are suggested: public, civic, and private. Their work shows how these institutions mediate and shape adaptation practices (mobility, storage, diversification, communal pooling, and exchange), and contribute to livelihood outcomes for households through external interventions (information, technology, funds, and leadership). It is contended that all three types of institutions play a crucial role in shaping adaptation to climate change by:

- Connecting households to local resources and collective action;
- Determining flows of external support to different social groups; and
- Linking local populations to national interventions.

The work of Kirsten, Karaan, and Doward (2009) on institutions leads to the understanding that decisions, transactions, and welfare impacts that determine behavior and outcomes are shaped by three elements: formal economic institutions and rules; culture, values, and conventions; and social networks. They argue that situations that require provision of public goods (such as information, infrastructure, and law and order) should be treated by collective action. Collective action arises when people collaborate on joint action and decisions to accomplish an outcome that involves their interests or well-being (Sandler, 1992). In a study by Egyir, Ofori, Antwi, and Ntiamoa-Badu (2013), it was observed that households participating in economic networking, such as farmer-based organizations, link up with other community-based organizations (CBOs), non-governmental organizations (NGOs), research organizations, or government institutions to access credit and information for natural resource management. The collective action approach to supporting households to address the challenges of changes in climatic factors cannot be overemphasized.

How the various institutions work alone or together to support households to adapt to climate change has been documented by several studies. In South Africa, Newell (2008) studied the possibilities and limitations of civil society actors who perform accountability roles in contemporary politics of climate change. His study compared traditional strategy of public accountability of governments and UN bodies for agreed actions on climate change to governance of the private sector through civil society oversight. He suggested that there are key challenges for future climate advocacy, and argued that success in enhancing the accountability of public and private actors on the issue of climate change has been highly uneven and reflects both the effectiveness of the strategies adopted and the responsiveness of the target actors and institutions. In Ghana, the EPA (2007), Yaro et al. (2010), and Adjei-Nsiah and Kermah (2012) are among researchers in the Transition Zone who have observed that the nature of climate change, impacts, and adaptation mechanisms call for interventions by multiple stakeholders or institutions which can promote adaptation and adoption of effective practices, especially among smallholders. Collective and coordinated actions in which institutions link up to achieve sustainable local outcomes have been supported by many researchers (Uphoff, 1986; Ashley and Carney, 1999; Gertler and Wolfe, 2004; and Kirsten et al., 2009).

Unfortunately, institutions do not always promote adoption; they may also serve as barriers. Institutional barriers to adaptation relate to how the organization and structure of interactions, both formal and informal, influence how individuals are permitted and able to adapt to climate variability and change. Institutions play a large role in determining the processes that govern and regulate access and entitlement to key assets and capital needed to adapt to existing or anticipate climate stimuli (Jones and Boyd, 2011). Various institutions can be seen to overlap and may serve to either enable or restrict an individual's capacity to adapt successfully.

2.3.2 Contributions of Local Public Institutions

Public institutions are for governance or administration. They use state funds to provide basic information, infrastructure, and services (including law and order) to communities. Their activities are controlled by the state (Gertler and Wolfe, 2004; Kirsten et al., 2009). They might provide services from which non-payers cannot be excluded. In Ghana, public institutions concerned with governance are the metropolitan, municipal, or district assemblies and those concerned with administration are the ministries, departments, and agencies (www.Ghanadistricts.com).

The practices that these institutions support are those that have been scientifically proven to work well in a wide range of circumstances, including agronomic and other management practices. Public/government institutions tend to focus on their statutory mandates and so may support the institutions that are mandated to deal directly with households rather than deal with households themselves. In Ghana, the lead ministry for environmental management is the Ministry of Environment,

Science and Technology (MEST). The agency with direct responsibility for environmental matters is the EPA. Their mandate is to formulate policies and enforce laws on environmental protection and carry out research studies. They provide secondary support activities, such as capacity building for CBOs. In 2007, the EPA carried out a study to determine pathways of adaptation for the transitional and forest zones of Ghana for the short, medium, and long runs. The study suggested that institutions should be promoting on-farm practices related to agronomy (drought-resistant crops and trees, land and water management) as well as off-farm services that result in awareness creation, early warning systems, conflict management, and commodity value addition.

Adjei-Nsiah and Kermah (2012) observed that public institutions such as GMet, MoFA, Ghana Cocoa Board, and the Forestry Commission (FC) are relevant government agencies that have a stake in climate change and adaptation in communities studied in the Wenchi Municipal. In one project, MoFA and FC provided tree crop seedlings, particularly cocoa, to farmers. Farmers were also trained in cocoa agronomy aimed at increasing forest vegetation through integration of shade trees in the cocoa system. A study by Egyir et al. (2013) in two regions of Ghana (Brong-Ahafo and Central) assessed how access to capital influenced adoption of modern coping strategies (agronomic practices such as application of agrochemicals, fertilizer, improved seed, and mechanization for soil and water management) by households in forest protected areas. Local institutions were considered as the physical and social capital needed to enhance households' capacity to adopt. The study used the logit model to show that the likelihood of adoption of modern coping strategies by farmers who had access to physical capital was higher than those who lacked access. They observed that government institutions such as the MoFA and the FC have partnered with informal institutions such as clan heads, family heads, and community leadership groups to implement forest protection regulations. In each of the districts visited, they observed that there were government departments that were mandated to link framers to markets and provide them with information that improves their business management and bargaining power.

Social services are important in determining the internal resistance of communities to hazards (Moser, 1998). Moser concluded that the provision of such services is the responsibility of governmental institutions that are mandated by law to do so. However, the research shows that services are not always available, or the linkage between household and service may not always be effective. Through field studies using community group discussions, the African Technology Policy Studies Network (ATPS) identified agricultural extension services as key to information dissemination and climate change adaptation. However, in terms of ecological distribution, farmers in the Transition Zone of Ghana seemed to have little interaction with government Agricultural Extension Agents (AEAs) as compared with other zones (ATPS, 2011).

2.3.3 Contribution of Civic Institutions

Civic institutions are voluntary organizations that include service organizations and membership organizations. Service organizations may be faith-based or benevolent societies called non-governmental organizations, media houses that provide free air time for discussion of development issues, and other civil society organizations. Civil society organizations provide oversight and accountability roles (Newell, 2008) and platforms that highlight conditions, constraints, and impacts. Membership organizations are NGOs that patronize their own services. They include formal, semi-formal, and informal farmer organizations and cooperatives, trading groups, and CBOs. Members of such groups benefit from information, credit, infrastructure, and other services obtained and offered by the group.

The role that NGOs play in infrastructure development and information dissemination for climate change adaptation and mitigation was documented by the project "Building capacity to meet the climate change challenge (B4C)" at the University of Ghana (B4C, 2012). In the Effutu, Gomoa, Sekyere Central, Mampong, and Ejura-Sekyedumase districts, they used key informant interviews in the collection of

information on local NGOs, basic functions, activities in climate change, and key challenges. They showed that NGOs provided advisory services to community leadership groups, farmers, women, and youth. They organized fora and sensitized members of the communities on reducing deforestation and water pollution and engaging in alternative livelihoods such as livestock keeping (including bees), handicraft, and agro processing. However, these studies do not explore the extent to which these institutions have been effective in enhancing capacity of the communities and households to cope with the impact of climate change.

There are many civic institutions in Ghana that are concerned with processes and arrangements that enhance climate change mainstreaming. Many of them are provided financial support by development partners such as the World Food Programme (WFP), Canadian International Development Agency (CIDA), the African Development Bank (AfDB), Agence Francais Development (AFD), the Gesellschaft für Internationaleu sammenarbeit (GIZ) and Japan International Cooperation Agency (JICA), among others (MoFA, 2013). Allah-Mensah (2004) observed that some civil society organizations (NGOs and CBOs) encourage participation in local politics and decision-making of women to contribute to and benefit from climate change discussions, mitigation and adaptation measures. They provide training services for the women to play important advocacy roles for the internal resistance of rural communities to climate hazards.

The study by Yaro et al. (2010) observed that NGOs provide a range of services (provision of inputs, training in agronomy, and advocacy) to support households in climate change adaptation. In Boayini, the Presbyterian Agricultural Station provided the latest varieties of seeds (Bambara beans, beans, maize) and also supported farmers with training programs in planting and other farm management practices. In Tetauku, CARE International supported the Zuri Organic Vegetable Farmers Association with resources to provide support to the community members who were interested in organic farming. The Ghana Association of Conservation of Nature provided acacia trees and created fire belts to prevent fire from destroying the forest. In Anyakpor, in the coastal savannah zone, the Adventist Relief Agency provided farmers with fertilizer to improve their soil.

2.3.4 Contribution of Private Institutions

Private institutions include corporations, partnerships, and sole proprietorship companies that target profit as they offer services. However, the phenomenon of corporate social responsibility and sustainable supply chains has led for-profit organizations to consider social activities that provide services to support physical infrastructure or environmental soundness (Hill, Ainscough, Shanks, and Manullang, 2007). Adaptation activities may relate either to ensuring the resilience of business operations or the provision of technologies or services that assist in the adaptation in vulnerable communities (www.unfcc.int). The work of the United Nations Framework Convention on Climate Change (UNFCCC) has documented good practices and profitable climate change adaptation activities being undertaken by private companies (sometimes in partnership with NGOs or the public sector) (www.unfccc.int/adaptation). They include capacity building, education, and training; provision of resources to support food, agriculture, forestry, and fisheries; support for science research, assessment, monitoring, and early warning; and interventions in water resources.

Vulnerability to climatic risks has been associated with inadequate financial and institutional support (Beg et al., 2002; Bockel, Phiri, and Tinlot, 2011; Stutley, 2010), as well as availability of natural resources where many societies still rely on them for rural livelihoods (Denton et al., 2000). It is clear that the private sector in Ghana is providing significant support to climate change adaptation. Financial institutions noted for providing finance for "sustainable development projects" and climate innovation projects, and entering into carbon financing, were Eco bank, Standard Chartered Bank, Stanbic, Barclays Bank, and the investment company E+Co. Studies by Ignitia AB and Ignitia Ghana Ltd. in 2012 revealed

that, with the advent of climate change, the increasing global warming and varied rainfall is causing cocoa production to decline. In the same year, the company implemented a knowledge transference project where cocoa farmers and organizations were introduced to "state-of-the-art weather forecasts as well as near real-time information" (www.ignitia.se). In 2010, MEST documented private sector involvement in climate change work in Ghana (MEST, 2010). Most of the companies provided information services to create awareness. Others provided equipment for renewable energy, water filtration and irrigation, biogas, and conversion of waste to energy. The companies identified were Tropical Energy Resources, Enterprise Works, Environment Technology Ltd., Biogas Technologies West Africa Limited, and Deng Limited. However, how the companies contribute to small initiatives at the community level has not been well documented. In addition, there is vast potential for livelihood support schemes to be implemented at the community level, for example through the provision of financial services, infrastructure projects, or transfer of new technology. The documentation of the presence and effectiveness of such interventions is not clear.

2.3.5 Institutional Coordination

Understanding the effective coordination of the institutions working in the study area will be a critical element in identifying institutional strengths and weakness of providing assistance, facilitation, and promotion of adaptation practices. Most studies on institutional support for climate change adaptation call for institutional coordination, collaboration, and networking. The work by EPA concluded that while the Agency has played a critical leadership and championing role in climate change management by improving capacity at the district, NGO, and community levels, climate risk and the implications of climate change for vulnerability and development have yet to be fully appreciated by central government ministries. They observed further that there is "not yet an adequate cross sectoral approach to these issues, which have tended to be seen as sectoral environmental issues" (EPA, 2007). This could be due to inadequate capacity (both technically and financially) at all levels of the national development planning processes.

The Yaro et al. study, "Social Dimensions of Adaptation to Climate Change in Ghana" (2010), contends that both NGOs and state institutions are cash-strapped; as a result, they provide ad hoc and piecemeal services. They suggest that the best way of making these institutions useful in building the adaptive capacity of communities would be to collaborate and integrate their functions. A recent study by MoFA (2013), "Mid-Term Review of the Medium Term Agricultural Sector Investment Plan[METASIP]," showed that the programs to promote the sustainable management of land and environment objectives of the Food and Agricultural Sector Development Policies (FASDEP) were coordinated by multiple stakeholders at the district level. The Yaro et al. study also identified the public sector as the lead infrastructure provider that enhanced household adaptation in the agro-ecological zones in Ghana. However, they observed that there was poor public sector provision of education, health, infrastructure, and aid in all of the communities visited. Indirect impacts of climate change, such as diseases and polluted water, were difficult to handle in district hospitals, compounded by the inability of villages to provide adequate and safe water due to their lack of manpower, equipment, and financial resources. The study suggested public-private partnerships in order to improve access to assets by households and help them to adapt to climate change.

2.3.6 Gender and Institutional Initiatives

The issue of why institutions mainstream gender in the design, planning, implementation, monitoring, and evaluation of climate change adaptation projects has been explored by a number of agencies (www.mowacGhana.net; www.undp-gha.org; www.ug.edu.gh/rips; www.who.int; www.gender-climate.org; www.g-rap.org; www.careclimatechange.org; www.unep.org). In Ghana, the Ministry of

Women and Children's Affairs (MOWAC) recognizes that there have been key successes in the promotion of an improved development of a gender strategy on drought, desertification, and early warning systems in Ghana (MOWAC, 2012). In a study in Ghana, Uganda, and Bangladesh, Chaudhury et al. (2012) posed the question: "What institutional arrangements exist, or need to be strengthened, in order to improve equitable access to benefits from climate related interventions?" They used focus group discussions (FGDs) (men, women, and youth) to obtain information from farmers and concluded that government extension agents and NGOs are key drivers of change with respect to adoption of new agricultural practices, the climate smart agriculture. The organizations collaborate to provide agricultural information and advice to both men and women.

Work by Mensah-Kutin (2010) on gender and climate change issues describes efforts by women's organizations to engender climate change negotiations through working together as a constituency. It is recalled that Agenda 21 of the United Nations Conference on Environment and Development (or "Earth Summit"), through the activism of civil society organizations, adopted a gender perspective in all development and environmental policies and programs (www.g-rap.org). The United Nations Environment Programme (UNEP) works on gender dimensions of climate change and provides tools for assessing climate change at the local level.

It is noted that the literature had not been explicit on how local institutions consider gender in project design and implementation.

2.4 GAPS IN THE LITERATURE ADDRESSED BY THIS STUDY

Many studies have looked at various adaptation measures under crop, soil, and water management practices. However, there is limited information on the impact of these measures on reducing the vulnerability or building resilience of the households to the impacts of climate change. It is plausible that the measures and strategies described in previous studies are selected without sufficient empirical guidance on their efficacy to address the impacts of climate change. This study focuses on building evidence on the impact of these measures based on experiences of the smallholder farmers and expert opinions and perspectives from various groups of technical experts.

3.0 METHODOLOGY

3.1 STUDY AREA

The study took place in two areas: Ejura-Sekyedumase Municipality in the Ashanti region and Wenchi Municipality in the Brong-Ahafo region in the Transition Zone of mid-Ghana. The total land area of the Transition Zone is estimated to be in excess of 6.5 million hectares (Owusu and Waylen, 2013). The study area supports both crops and livestock, which are mainly done on the mixed farming basis. The zone is generally characterized by mixed or sole cropping of maize, legumes, cocoyams, or yams (Adjei-Nsiah and Kermah, 2012). The main ruminant livestock types are cattle, sheep, and goats. Cassava is a major crop in the zone that is normally inter-cropped with maize, plantains, and other vegetables. The zone remains the nation's breadbasket, making it crucial to the food security in Ghana (Owusu and Waylen, 2013). Many authors have concluded that land use and degradation have created the Savanna-forest mosaic known as the Transition Zone (for example Kalame et al., 2011). However, it must be emphasized that even though the Transition Zone is highly degraded by human activities, the mixture of woodland and Savannah in this zone is naturally occurring.

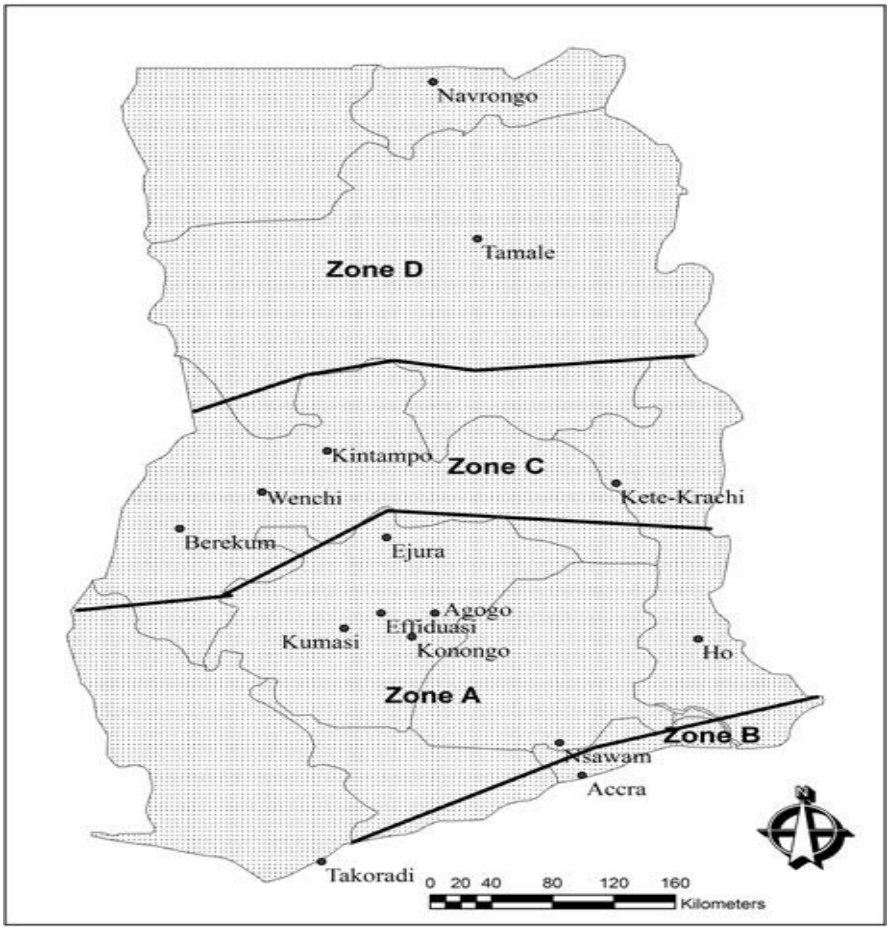

Figure 3.1: Agro-Ecological Zones of Ghana showing the Transitional Zone (Zone C) based on Ghana Meteorological Agency Classification.

3.2 SAMPLING AND PILOTING APPROACH

3.2.1 Individual Survey and Focus Group Discussions

Initial reconnaissance survey of the six selected communities by the Multi-Features and Capacity-Enhancing Services (MFCS) research study team found out from the Assembly Persons (local government representatives at community level) that there were over 1,000 households in each of the communities. Hence the Assembly Persons as well as Agricultural Development Units officers guided the determination of sample size. For the individual farmer survey, a stratified random sampling technique was employed to separate women from men. A gender-based stratum is justified on the grounds that women tended not to be heads of households, have small size farms, engage in mixed crop/intercropping, and engage in retail marketing during the periodic market days. If women are not purposefully targeted, their numbers will be small and their opinions and interpretations will not be given proper attention. Gender sensitivity and social exclusion was a central theme of the study; hence, the study was designed to ensure participation by women farmers, very old farmers, and minority groups (migrants, non-Christians, non-Akans, non-wage earners, and tenants).

A total of 600 individual farmers were targeted for interviewing, but 612 were interviewed with a semi-structured questionnaire. Some of the household survey questions addressed more than one issue. Apart from the general characteristics of respondents, the following were discussed:

- Adaptive practices used by smallholder crop producers;
- Contribution of adaptive practices to improved household food security;
- Contribution of adaptive practices to improved household income;
- Local institutions that support households to adopt adaptation practices;
- Ways in which local institutions can support households to adopt adaptation practices; and
- Gender dimensions and other social exclusion issues as they relate to climate change.

Among the six communities, Sekyedumase had the highest population; Baabasso and Anyinaso had the lowest. Proportionate sampling size was applied (see Table 3.1 on the next page). In order to ensure random selection, each community was divided into four quadrants and every tenth house in a quadrant was visited. Only adults (above 40 years of age) who owned farms were marked for selection because it was understood that farmers under 40 years would not have been able to identify their experience of climate changes in the region, since climate change is a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators (www.climatechange.gc.ca).

For the focus groups, any adult farmer willing to participate in the discussion was welcome. The community representative (Assembly Person) assisted in organizing the members of the focus groups. An interview guide was used to guide the discussions, which were facilitated by members of the research team.

The data collection for the FGDs took place from September 1–25, 2013, and involved 12 enumerators and three supervisors. All of them were trained on the different tools for collecting data, including household surveys, FGDs, and institutional survey. These different tools were pre-tested and were updated based on the results of the pre-test. Some privacy rules were observed in order to preserve the anonymity and the confidentiality of the information provided by the respondents.

TABLE 3.1: COMMUNITIES VISITED AND SAMPLE SIZE

Region	Locality	Community	Sample Size for Survey	Sample Size for FGD	Sample Size for Organization
Ashanti	Ejura-Sekyedumase	Anyinasu	M=30 F=51	F= 12 M=13	14
		Babasso	M=40 F =41	A= 23 *(F=11 and M=12)*	
		Sekyedumase	M=47 F=83	A= 29 *(F=7 and M=22)*	
Brong-Ahafo	Wenchi	Akrobi	M=61 F=45	F= 10 M= 10	11
		Awisa	M=46 F=57	F= 13 M= 10	
		Nkonsia	M=60 F=51	F= 10 M= 10	
Sub-Total			612	140	25
Grand Total					777

Note: M=Male; F= Female; A= All

3.2.2 Institutional Survey

A total of 25 institutions were included in the institutional survey. Survey respondents were selected by the institutions themselves. As a result, a few middle managers as well as frontline staff responded, in addition to the intended senior managers (Table 3.2). The few frontline staff included credit, customer service, and business advisory officers, and well as tutors and information officers who were actively involved with projects. A semi-structured questionnaire was used to guide the interview. All the questionnaires were completed and returned by September 30, 2014.

TABLE 3.2: POSITION OF RESPONDENTS OF INSTITUTIONAL QUESTIONS

Position of Respondent	Number	Percentage
Senior Managers	13	52
Middle managers	7	28
Front line staff	5	20
Total	25	100

3.3 SOME CHALLENGES ENCOUNTERED

A few challenges were encountered during the implementation of the study:

1. Two of the consultants could not cope with the timeline changes during training and field work; hence they were not fully present all the time. In order to expedite action on field activities, the project manager (a researcher by profession) and research officer joined the consultants and principal investigator to undertake all activities: training, interviewing, and report writing. Air transport for the technical team was included to facilitate movement in and out of the field since the original dates for field work shifted and coincided with University work of consultants, research officer, principal investigator, and project manager.

2. The focus group discussions were planned to include mixed group and separate groups for males and females in all six communities. However, the mixed group was carried out in only two communities and the separate group discussions for males and females were carried out in four communities. This was because it was observed that it became difficult to organize separate groups

after the first interviews of mixed groups in two communities. The responses obtained were adequate so no new arrangements were made for further visits. Two validation and dissemination fora were organized in Sekyedumase (Ejura Municipality) and Nkonsia (Wenchi Municipality) to clarify issues that were not well understood.

3. There were few issues in how the key informant interviews for institutions were arranged. The officers-in-charge at the local level who implemented projects were consulted and asked to complete questionnaires. Yet consulting the local officers-in-charge turned out to be inadequate since officers-in-charge at the headquarters should have been consulted first. Organograms for private organizations were overlooked. It was assumed that there was decentralization, as was the case with the public sector institutions, but this was not the case. Consulting first with headquarters staff still would not have been effective since the arrangements for doing so could not have been completed in time.

3.4 METHODS OF DATA ANALYSES

Preliminary data cleaning was carried out in the field and final data cleaning in the MFCS office in Legon, Accra. Data entry was managed by six assistants. The process took four weeks to complete. SPSS version 20 was used. The approach to analyzing the data followed five steps:

1. Outline of major titles and subtitles;
2. Sharing of the write-up among the writers;
3. Determination of graphs and tables of individual variables and cross tabulations required;
4. Deadlines set for rough draft; and
5. Deadlines set for synthesis report discussion meeting.

To guide technical report writing, the major and specific research questions were revisited and analytical models identified.

3.5 DESIGN OF THE ANALYSIS OF RESULTS

3.5.1 Determining Adaptation Practices Used by Smallholder Crop Producers

For describing adaptation practices used by smallholder producers, farmers' opinion of perceived effectiveness of practices adopted was obtained using the Likert scale (1 = very effective, 2 = fairly effective, and 3 = not effective). Descriptive statistics, mainly relative frequencies, were used to summarize the different practices by location. It was expected that practices will relate to biological, chemical, mechanical, and management technologies.

3.5.2 Determining How Adaptation Practices Contribute to Improved Household Food Security

For the purposes of this study, household food security is defined as availability of staple food to meet food needs of household members. Thus, practices that farmers identified as having increased or stabilized yield were listed and ranked. The perception of farmers concerning how household food consumption changed with the use of a practice was measured (1 = increased, 2 = decreased, 3 = no change). Descriptive statistics were used to assess the extent to which practice contributes to food availability (yield).

3.5.3 Determining How Adaptation Practices Contribute to Improved Household Income Security

For the purposes of this study, income security was considered as the volume of marketable surplus obtained from application of an adaptation practice. Practices that farmers perceived as having increased or stabilized household income were therefore identified. The perception of farmers concerning how household income changed with the use of a practice was measured (1 = increased, 2 = decreased, and 3 = no change). Descriptive statistics were used to assess the extent to which practices contributed to income security.

3.5.4 Determining Local Institutional Support for Households Adaptation

Local institutions were categorized as public, civic, and private organizations. Those mandated to provide capacity building services related to climate change adaptation were listed for farmers to indicate actual service provided. Others (private and civic) whose primary and secondary objectives relate to agricultural and rural development were also identified. The assessments were based on farmer perception and institutional perception. The proportion of farmers who identified any institutional support was used to assess the extent of households' awareness of support services and response of institutions to household needs. It was assumed that support services provided should result in capacity development. Such services were categorized as:

1. Technical knowledge (business advice, education, and technology transfer);
2. Materials (including inputs, food/cash/subsidies/microfinance, or credits); and
3. Infrastructure.

Farmers' perceptions of effectiveness of services were then determined through scores on agreement of satisfaction with service (1 = satisfied, 2 = somewhat satisfied, and 3 = not satisfied).

Another satisfaction issue assessed from the farmers' point of view was frequency of access (once to more than three times per year). From the institutional point of view, type of service, frequency of access, as well as mode of communication were measured. Scores on satisfaction issues that reflect perceived effectiveness should be two or more for a three-point Likert scale. All support services that obtained a significant score were considered effective. An assessment of barriers to adoption of the effective services was also carried out using rank analysis based on mean scores; the lower the mean score the more important a constraint.

3.5.5 Gender Dimensions and Other Social Exclusion Issues

It was hypothesized that there are differences in how males and females perceive the impact of changes in climatic factors. Hence the types of practices adopted, satisfaction with services provided by local institutions, level of access to resources, and barriers to the adoption of institutional support will differ. These differences were ascertained through disaggregation of data (cross tabulation between gender and the variables). Farmers' opinions were also analyzed on the role that the different genders play in decisions to determine livelihoods activities engaged in, ownership and use of land, household issues, how men and women participate in decision making, and whether changes in climate factors affected men and women differently.

3.5.6 Determining Best Adaptation Practices

The major intended output of the study was to determine the best adaptation practices that farmers should be encouraged to adopt to ensure sustainable food and income security. A decision tree analysis as employed by Aerts, Lasage, and Droogers (2003) was used to identify best adaptation practices for mainstreaming. This method for evaluating adaptation strategies was modified to identify the most effective adaptation practices in use in the Transition Zone of Ghana. Two decision trees were used to identify the adaptation practices that ensure food security and farm-based income through increases in crop yields, and protection of the natural resources and the environment. For the first tree, farmers' opinions were sought on how practices changed status of food and income security. For the second tree, opinions of both farmers and institutions were sought on whether environmental concerns were an issue in decisions to use practices and services introduced to farmers.

The tree statements for the first decision:

What measures were taken to avoid losses due to drought/floods (Agronomic/non-agronomic); if agronomic, rank effectiveness related to yield, food consumption, and income (increase/decrease/no change). If majority (>50 percent) of respondents selected increase as a response to the last question, then practice is considered best.

The tree statements for the second decision:

What practices or services were introduced (technology/non-technology); if technology/innovation related, why did you not practice/access (environmental concerns/other concerns).I If negative environmental impact is not frequently mentioned (by more than 50 percent of respondents), then practice is considered best.

4.0 KEY FINDINGS ON ADAPTIVE PRACTICES

4.1 GENERAL CHARACTERISTICS OF RESPONDENTS

This section describes the general characteristics of the survey respondents, including individual farmers, focus groups, and key informants from institutions.

The dominant groups were female farmers (60 percent) in Ejura-Sekyedumase Municipality (ESM) and male farmers (52 percent) in Wenchi Municipality (WM). The majority of the respondents were less than 61 years old (94 percent), illiterate (61 percent), married (70 percent), Christian (81 percent), and native to their districts (67 percent) (Table 4.1).

TABLE 4.1: PERSONAL CHARACTERISTICS OF RESPONDENTS

Variable	Ejura N (%)	Wenchi N (%)	Total N (%)
Gender			
Male	117 (40)	167 (52)	284 (46)
Female	175 (60)	153 (48)	328 (54)
Age			
40-50	169 (58)	149 (47)	318 (52)
51-60	108 (37)	148 (46)	256 (42)
61-70	14 (5)	23 (7)	37 (6)
>70	1 (0)	00 (0)	1 (0)
Literacy			
Literate	116 (40)	121 (38)	237 (39)
Illiterate	176 (60)	199 (60)	375 (61)
Marital Status			
Married	210 (72)	217 (68)	427 (70)
Not married	82 (28)	103 (32)	185 (30)
Religion			
Christians	235 (81)	261 (82)	496 (81)
Muslims	32 (11)	34 (11)	66 (11)
Traditional	20 (7)	21 (7)	41 (7)
Others	5 (2)	4 (1)	9 (2)
Residential Status			
Native	187 (64)	224 (70)	411 (67)
Migrant	105 (36)	96 (30)	201 (33)

The dominant livelihood of those surveyed was farming. Full-time farmers represented more than 90 percent of individuals surveyed, indicating they make the largest livelihood group in the study area. Most farmers cultivate 2 hectares or less of land. As such, the study group of this research area considered small-scale farmers. (In Ghana, food crop farms of less than 2 ha are considered small-scale [MoFA, 2010].) Almost 70 percent of farmers sell more than half of their harvested produce. A total of 331

farmers (54 percent) own the first plot of land they farm on. Although more than 90 percent of individuals are full-time farmers, about half are not solely dependent on farm income (Table 4.2).

TABLE 4.2: FARMERS' FARM CHARACTERISTICS

Variable	Ejura N (%)	Wenchi N (%)	Total N (%)
Type of Farmer			
Full time	273 (93)	298 (93)	571 (93)
Part time	19 (7)	22 (7)	41 (7)
Experience in Farming			
Farming for less than 21 years	153 (52)	162 (51)	315 (52)
Farming for 21 years plus	139 (48)	158 (49)	297 (48)
Orientation of Farmer			
Commercial (sell >50% of harvest)	208 (71)	215 (67)	423 (69)
Subsistence	84 (29)	105 (33)	189 (31)
Total Farm Size (Ha)			
<2	161 (51)	187 (58)	348 (57)
>2	131 (49)	133 (42)	264 (43)
Land Ownership Status			
Own	159 (55)	172 (53.8)	331 (54)
Not own	133 (45)	148 (46.2)	281 (46)
Level of Dependence on Farm Income			
Only farm income	152 (52)	123 (38)	275 (45)
Farm income and others	140 (48)	197 (62)	337 (55)

With respect to household characteristics, the majority of farmers reported having less than six dependents (Table 4.3). A significant proportion of farmers in Ejura (52 percent) and a few in Wenchi (24 percent) reported having dependents who work outside of the home.

TABLE 4.3: FARMERS' HOUSEHOLD CHARACTERISTICS

Variable	Ejura N (%)	Wenchi N (%)	Total N (%)
Number of Dependents			
<6	147 (50)	190 (60)	337 (55)
>6	140 (48)	108 (34)	248 (41)
Missing	5 (2)	22 (7)	27 (4)
Farmers with female dependents in school	206 (71)	210 (66)	416 (68)
Farmers with male dependents in school	230 (79)	217 (68)	547 (73)
Farmers with dependents working outside home	128 (52)	69 (24)	137 (26)
Number of Times Adults Eat in a Day			
1	1 (.3)	1 (.3)	2 (0)
2	42 (14)	78 (24)	120 (20)
3	243 (83)	240 (75)	483 (79)
4	6 (2)	1 (3)	7 (1)
Number of Times Children Eat in a Day			
2	15 (5)	34 (11)	49 (8)
3	242 (83)	229 (72)	471 (77)
4	19 (7)	28 (9)	47 (8)
5	1 (.3)	00 (0)	1 (0)
Missing	15 (5)	29 (9)	44 (7)
Experience of Food Shortages in Home Last Year			
Experienced	179 (61)	119 (37)	298 (49)

Variable	Ejura N (%)	Wenchi N (%)	Total N (%)
Not experienced	113 (39)	201 (63)	314 (51)
First Mentioned Reason for Food Shortage			
Unharvested crops	53 (30)	39 (33)	92 (31)
Drought	55 (31)	27 (23)	82 (27)
Poor harvest	9 (5)	20 (17)	29 (10)
Crop failure	15 (8)	3 (3)	18 (6)
Bush fires	8 (5)	6 (5)	14 (5)
Financial difficulties	10 (5)	2 (2)	12 (4)
Others	29 (16)	23 (19)	52 (17)
Main Source of Food			
Own farm (nothing or hardly anything purchased)	83 (28)	126 (39)	209 (34)
Market	209 (72)	194 (61)	403 (66)
Everything	5 (2)	0 (0)	5 (1)
More than half	29 (10)	12 (4)	41 (7)
Approximately half	36 (12)	26 (8)	62 (10)
Less than half	139 (48)	156 (49)	295 (48)

4.2 ADAPTIVE RESPONSES AND PRACTICES USED BY SMALLHOLDER FARMERS

In Table 4.4, some of the measures farmers use in response to production losses from changing weather patterns are shown. These adaptive responses include: adapting new agronomic practices (45 percent), do nothing (39 percent), engage in off-farm activities (12 percent), praying (3 percent), relying on remittances (3 percent), decrease land size (2 percent), raise livestock (1 percent), and other (8 percent).

TABLE 4.4: MEASURES FARMERS TAKE TO AVOID LOSSES DUE TO CHANGING CLIMATE FACTORS

Variable	Ejura N (%)	Wenchi N (%)	Total N (%)
Change in agronomic practice	121 (42)	156 (49)	277 (45)
Nothing	102 (32)	135 (46)	237 (39)
Engage in off-farm activities	41 (14)	30 (9)	71 (12)
Praying	19 (7)	2 (.6)	21 (3)
Rely on remittance	3 (1)	14 (4)	17 (3)
Decrease land size	3 (1)	9 (3)	12 (2)
Raise livestock	6 (2)	00 (00)	6 (1)
Others	25 (9)	27 (9)	48 (8)

The following sub-sections discuss the top three of these adaptive responses more in-depth, specifically agronomic practices, responses made by farmers to "do nothing," and off-farm practices.

4.2.1 Agronomic Practices

The agronomic practices adopted by the farmers in the last five years to respond to changes in climatic factors include: applying herbicide/pesticides (86 percent), using inorganic fertilizers (73 percent), practicing fallowing (63 percent), using new crop varieties (48 percent) and introducing livestock (43 percent). Table 4.5 (next page) lists, in descending order, the major agronomic practices or technological options being applied by crop farmers.

TABLE 4.5: AGRONOMIC PRACTICES IN USE IN THE STUDY AREA

Adaptation	Ejura N (%)	Wenchi N (%)	Total N (%)
Soil improvement: inorganic fertilizer	236 (81)	223 (70)	459 (75)
Early planting	162 (56)	181 (57)	343 (56)
Early harvesting	140 (50)	178 (56)	318 (52)
Planting on raised ridges	132 (45)	180 (56)	312 (51)
Planting same crop two or more times	186 (64)	120 (38)	306 (50)
Soil water conservation/mulching	31 (11)	250 (78)	281 (46)
Mixed cropping	113 (39)	155 (48)	268 (44)
Drought resistant varieties	155 (53)	97 (30)	252 (42)
Late planting	137 (47)	114 (36)	251 (41)
Late maturing varieties	89 (31)	161 (50)	250 (41)
Late harvesting	108 (37)	136 (43)	244 (40)
Early maturing varieties	91 (31)	109 (34)	200 (33)
Planting in valleys/wetlands	30 (10)	33 (10)	63 (10)
Irrigation	22 (8)	34 (11)	56 (9)
Soil improvement: compost/manure	4 (1)	27 (8)	31 (5)
Rain water harvesting	3 (1)	2 (1)	5 (1)

Soil Improvements Using Inorganic Fertilizers

An overwhelming majority of respondents (75 percent) reported the use of organic fertilizers to improve yields. Fertilizer usage has become common as many of the traditional crops have given way to maize production in the Transition Zone. Maize, unlike the traditional crops (such as cassava, plantains, and cocoyams), requires artificial fertilization to improve yield. Many of the farmers reported that they get subsidies from the government to help purchase fertilizers even though they indicated that the system is not very efficient, since some farmers cannot obtain the total quantity needed or they are supplied the fertilizers later than expected.

In spite of their potential negative impacts on environmental, the use of chemical fertilizers is identified by about 90 percent of the farmers as the most effective adaptation option. Farmers reported that this is because the fertilizers provide a more immediate return on their investment. During FGDs and the two validation workshops, there was a consensus that improper handling and application of agrochemical was detrimental to both environmental and human health. According to the farmers, the best alternative was organic inputs; however, farmers reported they could not depend on this as an alternative because the inputs were not yet readily available in the market and self-production of organic inputs was deemed a waste of their time and not cost effective.

With respect to the use of chemical fertilizers as an adaptation strategy, more men than women reported resorting to the use of chemical fertilizers in the last five years in both municipalities. The FGDs revealed that, compared to women, more men tended to have access to this agricultural input, as they could afford to purchase these chemicals. Men have higher control of household finances so they are probably more easily able to access expensive agricultural inputs, such as fertilizers. During FGDs, it was observed that men also tended to include themselves more in agricultural development projects than women and they related more with agricultural extension workers who were also mostly men. This could also enhance their access to inputs which are supplied on in-kind credit basis. Other studies (Duncan and Brandt, 2004; Opare and Wrigley-Asante, 2008) have similarly found that men often have more access to agricultural resources than do women.

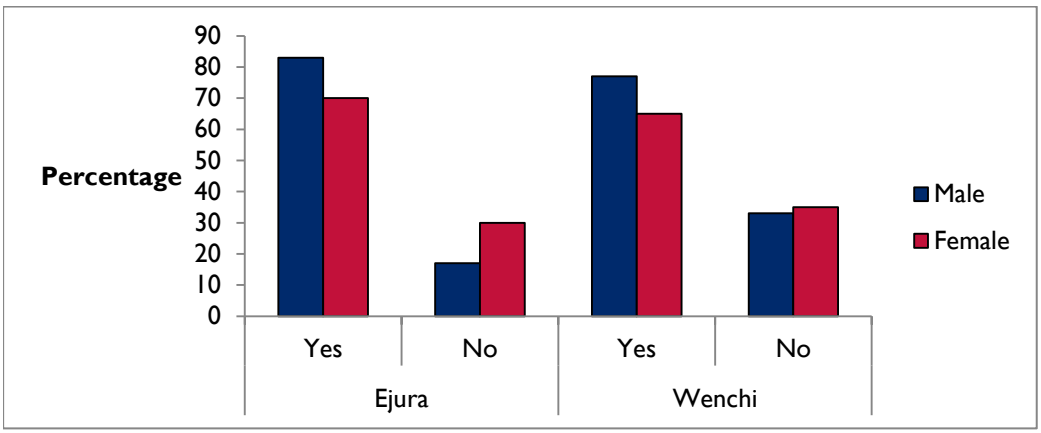

Figure 4.1: Farmers' response to use of chemical fertilizers over the last five years.

Early Planting

Early planting was mentioned by 56 percent of the farmers as a favored adaptation option. It is a management technique that is well known by farmers. This finding is not surprising given that there are consistent reports of increases in rainfall variability and early cessation of rainfall in the Transition Zone (Owusu and Waylen, 2013).

Early Harvesting

About 52 percent of the farmers (50 percent in ESM and 56 percent in WM) mentioned early harvesting as a favored adaptation option. During FGDs, and the validation fora, it was explained that this practice, a management technique that is well known by farmers, was used to avoid attack by pests as well as bush fires that occurred during the dry season that follows the minor cropping season. Early harvesting is also favored since cash-strapped farmers could gain income from early sales. For grains such as maize, early harvesting allows sun or industrial drying and storage. Two industrial drying facilities were observed in the ESM; one belonged to the Pen Food bank (privately owned) and the other a public-private-partnership named Millennium Development Authority (MiDA) Agribusiness Centre.

Planting on Raised Ridges

Planting on raised ridges (see also Djagbletey et al., 2012) is another option used by more than 45 percent of the respondents in both districts. The ridges help in improving soil moisture.

Planting Same Crop Two or More Times

The farmers also plant at different intervals within and across cropping seasons to hedge against crop failure due to variability in rainfall. This is a management technique that is well known by farmers. In Awisa, the research team visited a maize farm where the field had been divided into two and the crops planted in two-week intervals. The farmer explained that it was a common practice in the area and helps to protect them against dry spells at critical stages of the crop development. Sagoe (2006) observed farmers' practice of multiple cropping implies that their planting dates may vary depending on the nature of the crops.

Soil Water Conservation: Mulching

About 46 percent of respondents used mulching (78 percent in WM and 11 percent in ESM). Mulching is a soil and water conservation method that consists of laying a protective covering of organic material over the soil around plants to prevent erosion, retain moisture, and sometimes enrich the soil. Farmers

use materials such as leaves of harvested maize and other plants. WM is drier than ESM, hence the higher use among farmers there. This is a management technique that is well known by farmers.

Mixed Cropping

Mixed cropping here refers to practicing cereal-root/tuber intercrops or maintaining separate plots under different crops. About 44 percent of respondents adopted the practice, although it is an old management technique. A typical situation is where farmers cultivate cassava and maize on the same field; the maize is harvested after three months and the cassava after six months. This ensures that food availability is not compromised and there is sale of agricultural produce all the time.

Late Planting

Late planting is also is a management technique that is well known by farmers, although it is less favored because some farmers said it posed a risk when the rains terminate early. Other studies have noted that farmers in rain-fed agricultural systems vary their planting dates since they normally wait for the rains to come before planting (Buke and Lobell, 2010; Kuwornu et al., 2013 and Aquah and Onumah, 2011).

Late Harvesting

Late harvesting of crops such as maize is a management technique that is well known by farmers. Late harvesting is done late by farmers who want to obtain grain at low moisture content and spend less resource on drying for storage. About 40 percent of respondents adopted this practice. The practice appeared to be more marked in WM than in ESM.

Planting Early-/Late-Maturing and Drought-Resistant Crop Varieties

Over 30 percent of the respondents in both municipalities reported that they use crop varieties of either early- or late-maturing types or drought-resistant types. The adoption of crop types or the use of new varieties of existing crop types are important adaptation options (also observed by Acquah and Onumah, 2011). During the major rainy season, when the rains are more reliable and last for over three months, farmers are able to use this management technique and they cultivate late-maturing varieties that may yield more. They are, however, forced to use early-maturing varieties during the minor rainy season because of the short nature of the rainfall and the high levels of variability associated with this cropping period. Drought-resistant varieties are also popular among the farmers, especially in the ESM where 53 percent of the respondents used it. Adopting drought-resistant varieties is consistent with the farmers' perception that the amount of rain received during the cropping seasons has reduced. Tachie-Obeng et al. (2012) identified use of a medium heat-tolerant maize variety to increase maize yield in the Transition Zone.

In the use of improved crop varieties, more men (72 percent) than women (60 percent) in ESM reported using them. Similarly, in WM, more men (43 percent) than women (16 percent) reported using new crop varieties (Figure 4.2). This may imply that more men than women have access to new crop varieties. This deduction is supported by the findings by Swai, Mbwambo, and Magayanes (2012), which showed that men lead in using improved seeds of short-maturity and drought-tolerant crops. Why more farmers in ESM use the improved crop varieties than those in WM is not well understood. The research team suspects that the Crop Research Station in Ejura (the municipal capital town) may be contributing to better sensitization of farmers and hence the adoption.

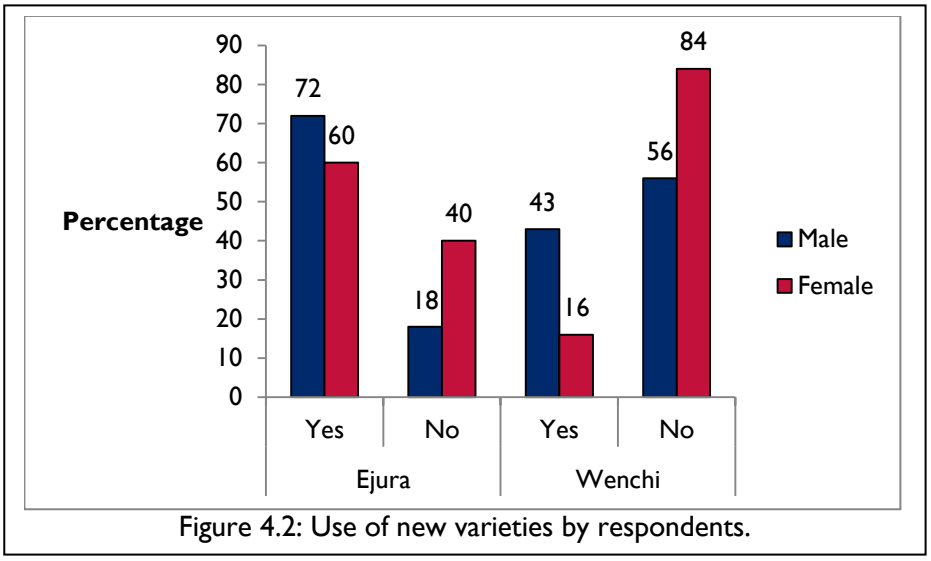

Figure 4.2: Use of new varieties by respondents.

Irrigation, Rain Water Harvesting, and Planting in Valleys/Wetlands

The adoption of irrigation and water harvesting techniques was the lowest among respondents in the study area. Less than 12 percent of respondents used irrigation in each municipality. The limited use of irrigation and water harvesting is consistent with practices elsewhere in Ghana. Agriculture in Ghana as a whole is almost entirely rain fed with only 0.03 percent of agriculture under irrigation (MoFA, 2003).

With respect to wetland planting, only 10 percent of farmers adopted the practices. Farmers reported during the validation workshop that some farmers shift towards cultivation in low-lying areas, marshy areas, and river valleys where soils retain more moisture. If these areas have water bodies, farmers use the water for irrigation during the dry season. It is also easier to increase irrigation development through construction of small dams or dugouts to grow rice and vegetables.

Compost and Manure

Less than 10 percent of respondents in both municipalities mentioned the use of compost or manure as an agronomic practice. These are considered as soil improvement as well as soil and water conservation measures which are biological in nature. They are deemed a sustainable and cost-effective adaptation measure (Kuwornu et al., 2013; Acquah and Onumah, 2011; Sagoe, 2006). However, their adoption has not been a popular practice among most smallholder farmers. We believe that, even though soil and water conservation practices may be seen as cost effective and easy to apply, the returns on investment take longer to accrue; this could explain the low adoption of these practices.

4.2.2 Do Nothing

The household survey revealed that 39 percent reported that they do nothing in response to changes they see in climate. During validation of the results, respondents explained that they "did nothing" to adapt or cope because they already use the new agronomic practices that others may have reported as a "new" adaptive response. According to our study, it appears that some farmers adopted adaptive measures faster than other farmers. The study was not able to delve into this further, but found this to be an interesting finding.

4.2.3 Off-Farm Practices

The adoption of off-farm, non-agronomic activities is also important adaptation measure. However, the findings suggest that there are few off-farm adaptation options being used in the study communities. Apart from petty trading, individuals also engage in the introduction of new livestock (such as rearing of snails, poultry raising, and grass cutter). Petty traders sell both household durables and consumables. The study found that none of the communities in WM had adopted fish farming as an adaptation practice. For communities in ESM, just under 6 percent of respondents in two communities, Sekyedumasi and Babaaso, had taken to fish farming.

In addition, there is low level (10 percent) of adoption of intensified use of ecosystem products, such as collecting wild nuts, mushroom, and spices; capturing fish in rivers; and hunting wild life. The high levels of environmental degradation reported by farmers may have reduced the provision of ecosystem products in supporting adaptation.

Farmer Perception of Effectiveness of Practices on Crop Yield

While some respondents perceived that the practices resulted in increased yield, others perceived that the practices led to decreased yield or did not cause any change with adoption. In Figure 4.3 (next page), it is shown that most of the respondents who expressed their opinions on how adaptation practices influenced yield indicated positive results. Obviously, planting same crop two or more times will result in more harvest; if planting dates are adjusted based or correct forecasts (early or late planting), and drought-resistant varieties are planted the chances of crop failure is reduced. Farmers reported that changes in planting dates did not give a consistent harvest: in most years, early planting was reported to increase yields, but not in others. In years that the rain onset is delayed, late planting is reported to be more useful. It is therefore clear that variations in planting dates will be more useful to improve yield if farmers are supported with an early warning system of seasonal rainfall forecasts. When farmers know beforehand what the rainfall pattern will be in a particular year, they will be able to restructure their calendar and apply different actions that will reduce risk of crop failure. We have noted already how planting on ridges and using inorganic fertilizers improved soil moisture content and fertility for good yields. According to the farmers, weedicide and chemical fertilizers are very popular in weed control, plant growth, and yield improvement.

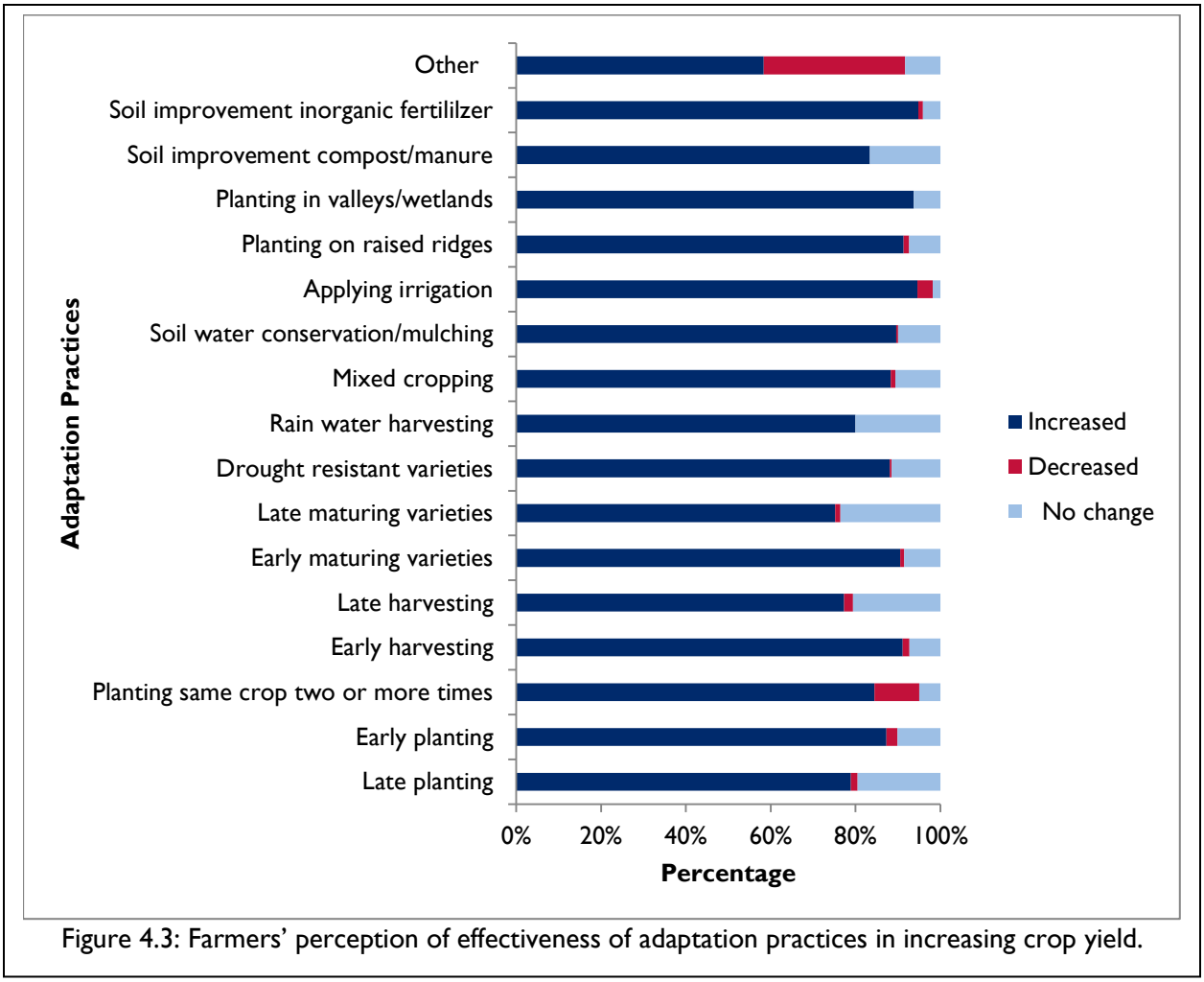

Figure 4.3: Farmers' perception of effectiveness of adaptation practices in increasing crop yield.

5.0 KEY FINDINGS ON THE CONTRIBUTION OF ADAPTATION PRACTICES TO IMPROVED HOUSEHOLD FOOD SECURITY, CONSUMPTION, AND INCOME

5.1 FOOD SECURITY AND FOOD CONSUMPTION

In this section, we look at the contribution of the various adaptation practices in improving household food security, consumption, and income. Households are generally food secure in that the majority of respondents said both adults and children eat two or more meals a day. Respondents described that their communities had been self-reliant in regard to food supply about two decades ago, when the rainfall pattern was more predictable and evenly distributed within the two cropping seasons. However, the respondents' observation was that in the last five years, climate change (particularly rainfall variability) and other additional stresses like soil degradation and competition for new farmlands has made them less food secure. Food availability seems to have been negatively affected by climate change and climate variability in the study area. The respondents noticed that rainfall in the past 10-to-15 years has reduced, the timing of the rains has become more unpredictable, and temperatures have increased. They linked the reduction in rainfall to the reduction in the sizes of their harvest (e.g., yams and cassava). During the FGDs, farmers also reported that some of the crops (like cocoa, plantains, and cocoyams) are becoming harder to cultivate in the Transition Zone, since their high-water requirements have not been met in most recent years.

Despite being food secure, about half of respondents agreed that there had been household food shortages in the last year. However, most of the respondents attributed this to the fact that crops were yet to be harvested (i.e., during the lean season). Others attributed food shortages to drought, crop failure, poor harvest, poor crop yield, and financial difficulties. Additional reasons included poor health of the farmer, weather-related problems (erratic/poor rainfall), bush fires, and poor crop storage.

The survey found that 95 percent of respondents produced crops for both consumption and sale, while only 4 percent produced solely for consumption. The survey also revealed a slight gender difference in

the aims of crop production, with slightly more male farmers (98 percent) producing for sale than female farmers (94 percent). In the survey, about 87 percent of men compared to 74 percent of women reported that they sold 50 percent or more of their produce after harvest. Men more often reported income generation as the motivating factor for engaging in farming than did women. In the communities, it was observed that women were more concerned about availability of food stuffs in the home, as they were responsible for household members' food and nutrition situation.

About 34 percent of households reported purchasing none or hardly any of their food from the market. Of those who did purchase food from the market, about half of respondents said that they purchased less than 50 percent of their food from the market. This indicates that household food consumption is largely dependent on household food production. As such, food self-sufficiency is important to households. The dependency between crop production and food consumption is an important one. Most respondents (77 percent) reported that they thought that their crop production had decreased in the last half decade, inferring that there was either less income generated and/or less food available to consume.

5.2 PERCEIVED EFFECTIVENESS OF ADAPTATION PRACTICES FOR INCOME AND FOOD SECURITY

The perception of farmers of how adaptation measures influence food security is positive in that many measures were perceived to increase yield. When the harvested crops are protected from post-harvest losses, then food availability at home and in the market will increase. Farmers growing crops will increase food security through availability; individuals not growing food for consumption will increase food security through increased accessibility of food in the market. The issues of affordability, utilization, and stability were discussed during focus group discussions. Prices are determined by the market and there are seasonal fluctuations following the usual high prices during the lean season and low prices during the bumper harvest. What was pursued by this study was the number of times adults and children eat per day. The results show that the majority of household members eat more than two times a day.

Most of the adaptation options in use were actually reported to help the farmers' food consumption, as shown in Figure 5.1. Farmers interviewed indicated that fertilizer application and the use of herbicides and pesticides are the most effective adaptation practices in improving consumption or food access. In addition, they were also seen to the most effective adaptation practices that helped them to improve their income as indicated in Figure 5.2. The focus group discussions and the two validation fora in the communities supported this finding, revealing that the use of these chemicals help increase production and therefore allow them to access food that they do not produce themselves, like rice purchased from the market.

Some of adaptation measures in common use seem to have mixed results for food. For example, farmers reported that changes in planting dates did not to give a consistent harvest—in most years, early planting was reported to increase yields, but not in others. In years that the rain onset is delayed, late planting is reported to be more useful. It is therefore clear that variations in planting dates will be more useful to improve yield if farmers are supported with an early warning system of seasonal rainfall forecasts.

Again, the use of inorganic fertilizers was reported by over 95 percent of respondents as increasing food availability in the study area. However, they reported that without the government subsidies, the price of fertilizers (70 Ghana cedis per 50kg bag, about $35.00 US), was too high. According to the farmers, weedicide and chemical fertilizers are very popular in weed control, plant growth, and yield improvement. In terms of food availability, the farmers reported that agro-chemicals help them to

increase the acreages they cultivate since it becomes less expensive to control weeds with chemicals than manual labor.

For food crops, fallowing and early planting and harvesting are reported to be very effective in improving food consumption and income. During the validation forum in Nkonsia, the Director of the Wenchi Municipal Agricultural Development Unit explained that fallowing for periods beyond three years allows soils to regain structure and texture and recover natural fertility; whether inorganic and/or organic fertilizers are applied or not, crop yields increase when such crops are cultivated. Early harvesting and early planting are reported by more than 70 percent of those who practice them as very effective in improving household income from agricultural adaptation. We noted that green maize, a delicacy, is harvested early by farmers to take advantage of the high price expected.

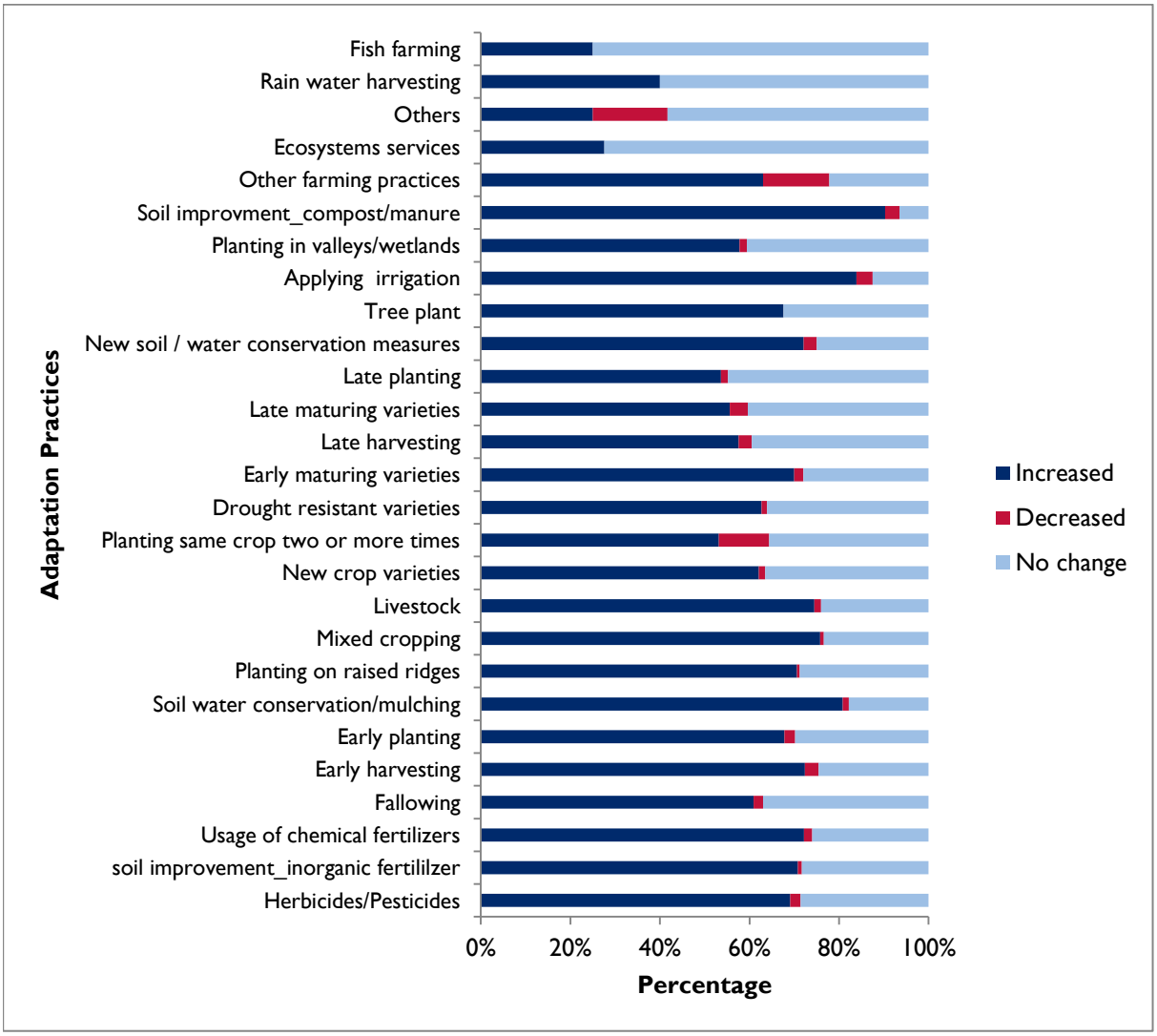

Figure 5.1: Farmers' perception of effectiveness of adaptation practices in increasing household food consumption.

The most interesting and consistent adaptation option that is ranked low by the farmers is the use of ecosystem products, such as wild nuts and animals for food. Less than 30 percent of the respondents

agreed that ecosystem products helped to supplement their food consumption outside of the basic grains produced on the farm.

FGD respondents indicated that farm household dependence on purchased food is growing; town walks revealed the market for imported products such as wheat (for bread and spaghetti, oils, sugar, rice, frozen meat and fish, and canned fish) is well developed even in rural districts.

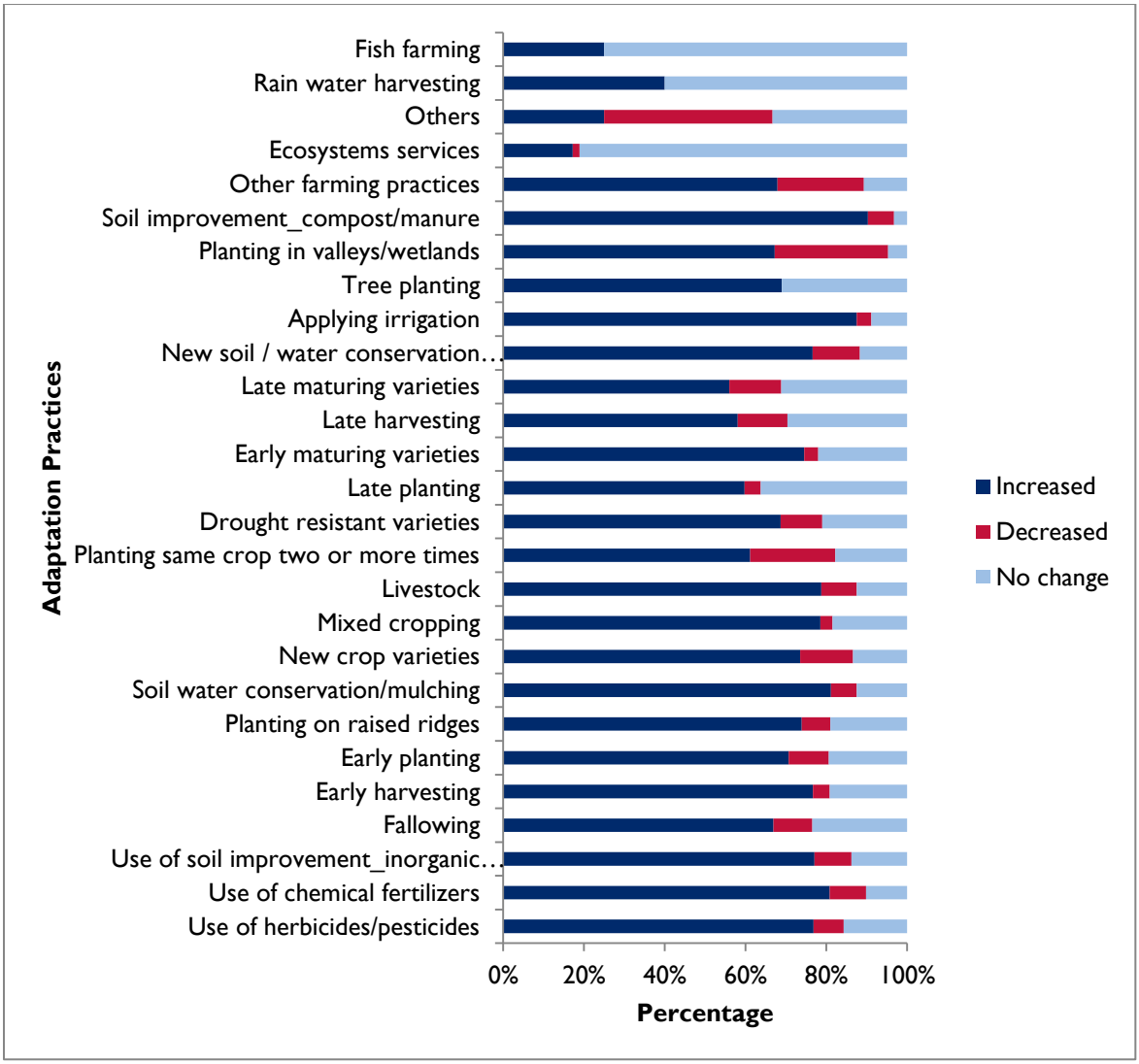

Figure 5.2: Farmers' perception of effectiveness of adaptation practices in increasing crop income.

6.0 LOCAL INSTUTIONAL INVOLVEMENT IN CLIAMTE CHANGE ACTIVITIES

This section provides detailed information about institutional participation in activities that support households to adopt adaptation practices. Section 6.1 details institutional perceptions, based on the institutional surveys that were administered. The following sections will provide information on farmers' perceptions of institutional services. The institutional perception survey was conducted between September 4–30, 2013, allowing officers to complete the forms in the capital towns of ESM and WM. Though not planned, the sample could be said to be proportionate by type of organization. It was found that the government institutions dominated in the provision of services that support households to adapt to climate change. This could be expected as private sector organizations at rural levels are usually few and are concerned more with for-profit ventures. Differences by municipality were slight. For all of the institutional surveys, the respondents were mainly senior management personnel, directors, and managers. The frontline staff included a secretary, credit officer, and customer relations officer.

A total of 19 public institutions were interviewed, including: the District Agricultural Development Units (also known as MoFA), the district assembly departments, Ghana Fire Service, Wild Life Division of Forestry Commission, Crop Research Institute (of Council for Scientific and Industrial Research), Ghana Health Service, a state-owned bank (Ghana Commercial bank), and Wenchi Farm Institute. Five private institutions were interviewed, including: a cashew processing factory, a grains warehouse, a rural bank, a savings and loans company, and a commercial farm. The only NGO that responded was the Society of African Missions of the Catholic Church, which operates a church and a grains bank in Ejura-Sekyedumase Municipality. None of the NGOs that were contacted responded in Wenchi Municipality.

A list of the names of types of institutions mentioned by farmer respondents included MoFA, the district assembly, and media houses (which operate at the municipal as well as from the regional and national capitals and include television and radio stations). Farmer organizations (FOs), which could more directly involve farmers themselves, do not appear to be a strong force. No formally registered farmer organizations with visible offices and activities were identified during community visits and FGDs. Specific public institutions named during FGDs and the institutional surveys included the Fire Service, Ghana Cocoa Board (COCOBOD), Wild Life Division, and Ministry of Health. The financial institutions mentioned included Agricultural Development Bank (ADB) (state-owned universal bank), rural banks (community savings and loans), and Opportunity International (private savings and loans company). The most frequently mentioned NGO was World Vision International and MiDA. However, MiDA is governmental; it was a five-year program (2007–2012) supported by the United States Millennium Challenge Account through an authority created by the Government of Ghana to improve commercialization of agriculture.

6.1 INSTITUTIONAL PERCEPTION OF CLIMATE CHANGE

All staff in all of the local institutions surveyed were aware of climate change and they were able to specify the nature of changes observed (see Figure 6.1). Institutions in both municipalities ranked erratic rainfall as the most-recognized change in nature. However, 18 percent of the total surveyed institutions in ESM recognized poor soil fertility as the second-most visible changes while 14 percent of institutions in WM ranked both persistent drought and frequent bush fires as the second-most visible changes. Many of the institutions also agreed that the changes in climatic factors were contributed by human activities such as bush fires and inappropriate use of agrochemicals. Hence, institutional support was necessary in for both mitigation and adaptation.

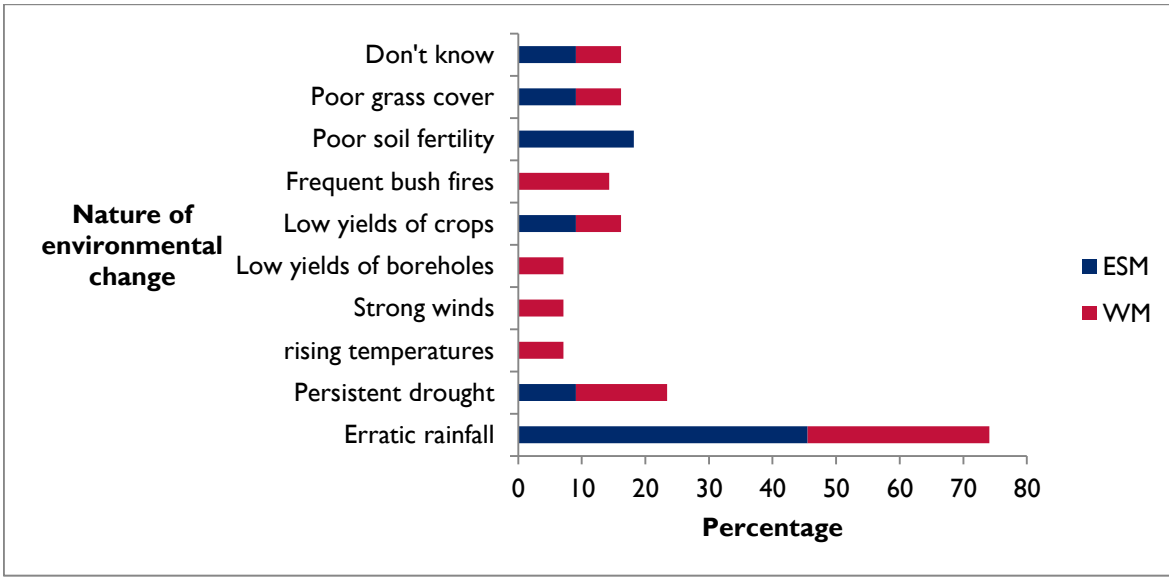

Figure 6.1: Nature of changes due to changes in climatic factors described by institutions by Municipality.

6.2 PROVISION OF SERVICES

The majority, more than 70 percent, of the institutions agreed that they were involved in activities that directly or indirectly supported households to address the effects of climate change and changes in weather. Specifically, as shown in Table 6.1, more than 90 percent of the organizations that participated in the survey in ESM and 71 percent in WM were involved either directly or indirectly in activities that support households to address the effects of climate change. Some of the organizations in both ESM (8) and WM (5) considered their activities as disaster management activities.

Compared to the private sector, government institutions in both municipal areas dominated in the provision of services that support households to adapt to climate change. This should be expected, as the research team previously noted, that private sector organizations at the rural level are usually few and are concerned more with for-profit ventures. None of the private and civic organizations said they were involved in such efforts. However, during the validation forum discussions, World Vision International specified activities engaged in as climate change related. The activities included technical, financial, and advisory support.

TABLE 6.1: HOW INSTITUTIONS ARE INVOLVED IN ANY TYPE OF ACTIVITY THAT SUPPORTS HOUSEHOLDS TO ADDRESS THE EFFECTS (ADAPT TO THE IMPACTS OF) OF CLIMATE CHANGE AND CHANGES IN WEATHER

Nature of involvement	Ejura N (%)	Wenchi N (%)	Total N (%)
Directly	3 (27)	4 (29)	7 (28)
Indirectly	7 (64)	6 (43)	13 (52)
Does not involve	1 (9)	4 (29)	5 (20)
Total	11 (100)	14 (100)	25 (100)

6.3 TYPES OF SERVICES

About 50 percent of the organizations believe that the government should take the central role in addressing peoples' vulnerability to climate change. This study's results indicate that government organizations led by the Agricultural Development Units (known locally as MoFA) and other local or municipal level agencies do so. The institutions are mandated to support household livelihoods development in general. Institutions with statutory mandates are better able to plan and obtain budgetary support to roll out programs than institutions without such mandates. When public institutions take the lead, they can by convention or legislation encourage private and civic organizations to follow suit.

A range of services (provision of inputs, training in agronomy, and advocacy) are provided by institutions to support households in climate change adaptation. These were confirmed by institutions themselves and by farmer respondents (Table 6.2). The methods of service provision by institutions include (in order of importance), lectures, demonstrations, extension activities (usually face-to-face discussions), group works, radio, and public address.

TABLE 6.2: TYPE OF SERVICES FARMERS RECEIVED FROM LOCAL INSTITUTIONS

Service	Frequency	Percent
Technology	229	49
Education	163	35
Credit	141	30
Business advice	77	17
Cash aid	16	3
Food aid	8	2
Infrastructure	3	1
Others	8	2

6.3.1 Education and Training

The majority of the organizations in both municipalities provided capacity building services to farmer groups to improve knowledge and skills in farm and environmental management. Others were involved in awareness creation campaigns (also observed by Adjei-Nsiah and Kermah, 2011). Campaigns could be short-or long-term; the institutions organized open-air sensitization fora or seminar-type ones that were directed at representatives of community-based groups. Training on fire volunteer squads and the bush fire campaign are the only projects implemented commonly in both areas. Other areas covered by specific projects included education and training concerned with rainwater harvesting as well as use of drought-resistant varieties of seed. Some of the organizations also engaged the households in afforestation, irrigation, and demonstration of components of Root and Tuber Improvement and Marketing Projects (RTIMP).

6.3.2 Cash Aid, Food Aid, and Credit

Cash and food aid and credit were among the least considered support areas. Only one organization in each municipality reported having them. Among the farmers, only 6, 7, and 22 reported having received cash aid, food aid, and credit respectively. Cash and food aid requires planned budgets by organizations and such hand-outs may not be sustainable or will likely reach few households. During the FGDs and validation workshops, participants mentioned that the practice is usually carried out during emergency situations and as a short-term strategy to aid households in coping with disasters.

During the validation fora several institutions reported having to consider farmers credit as bad debt due to under payment or non-payment. Some farmers also said they shy away from credit due to fear of indebtedness, high interest on borrowed funds, or inability to meet collaterals demanded. In-kind credit schemes were reported by the representatives of Agricultural Development Units in both municipalities. Here, farmers were provided seed maize, fertilizers, and pesticides and are made to pay back with cash or grain. A credit project under MiDA, which was implemented in 2007–2012, also provided short- and long-term loans to different categories of farmers who were members of farmer organizations and were trained in business plan development and financial management. In WM, one bank confirmed providing housing loan to households. The banks also provide loans for children's education at the secondary and tertiary levels. We note that most credit schemes are developed as poverty reduction or livelihood development strategies and not specifically as climate change adaptation strategy. The issue of credit to support demands of new technological packages introduced to smallholder farmers has been thoroughly discussed in the literature (Food and Agricultural Organization [FAO], 2011; Bockel et al., 2011; Stutley, 2010). The private sector can lead in this area. The different levels of financial institutions (bank and non-bank as well as rural, semi-urban, and urban based) should identify areas of technological packages that need financing during the short, medium, and long terms. When there are aspects of new technological packages that demand payments that are higher than can be absorbed easily by farmers, the local institutions should collaborate, plan, and introduce a subsidy system.

6.3.3 Infrastructure Improvement

Projects related to construction of infrastructure were considered long term and are mandates of local government (here Municipal Assemblies). Only one farmer mentioned infrastructure provision as support received. Infrastructure that was visible in the communities and which was confirmed as important for climate change adaptation included improved storage bins, bridges, drains, roads, market sheds and stores, and irrigation. In Akrobi in WM, the research team visited a newly constructed irrigation site that farmers used for vegetable production. Local vegetables such as okro and pepper and exotic ones such as cabbage and green pepper were cultivated by approximately 100 farm households who had been given an acre each to cultivate. In Ejura in ESM, an Agribusiness Centre had been constructed under MiDA to provide drying and storage services for grain growers and aggregators. Others such storage infrastructure was also provided by the private sector (Pens Food bank) and an NGO (Catholic Mission) in ESM.

6.3.4 Technology Transfer and Business Advice

Institutions have transferred various kinds of farm technologies or innovations as materials to smallholder farmers in order to address the effect of changes in climatic factors. At least one organization supported the promotion of one technological option that was biological, chemical, mechanical, or management in nature. Figure 6.2 (next page) shows that the key biological options considered were improved seed varieties (in terms of maturity and resistance to pests and drought); the key chemical options were chemical fertilizers, pesticides, and herbicides; the key mechanical options

were tractor and equipment and irrigation (soil and water management) and construction of improved storage bins; and the key managerial options were understanding the timing and type of planting, harvesting, and cultural practices such as use of cover crops, mixed cropping, multiple planting of same crop, and planting on ridges or in valley bottoms. The organizations that were mentioned included the Agricultural Development Units in both municipalities, Crop Research Institute (of CSIR) in EM.

Providing business advice may require cost sharing between provider and receiver, since some of the modules were developed by professionals who charge the institutions. Only a few (2 out of 25) organizations confirmed that they engaged in the service and less than 10 percent of the farmers admitted receiving the service.

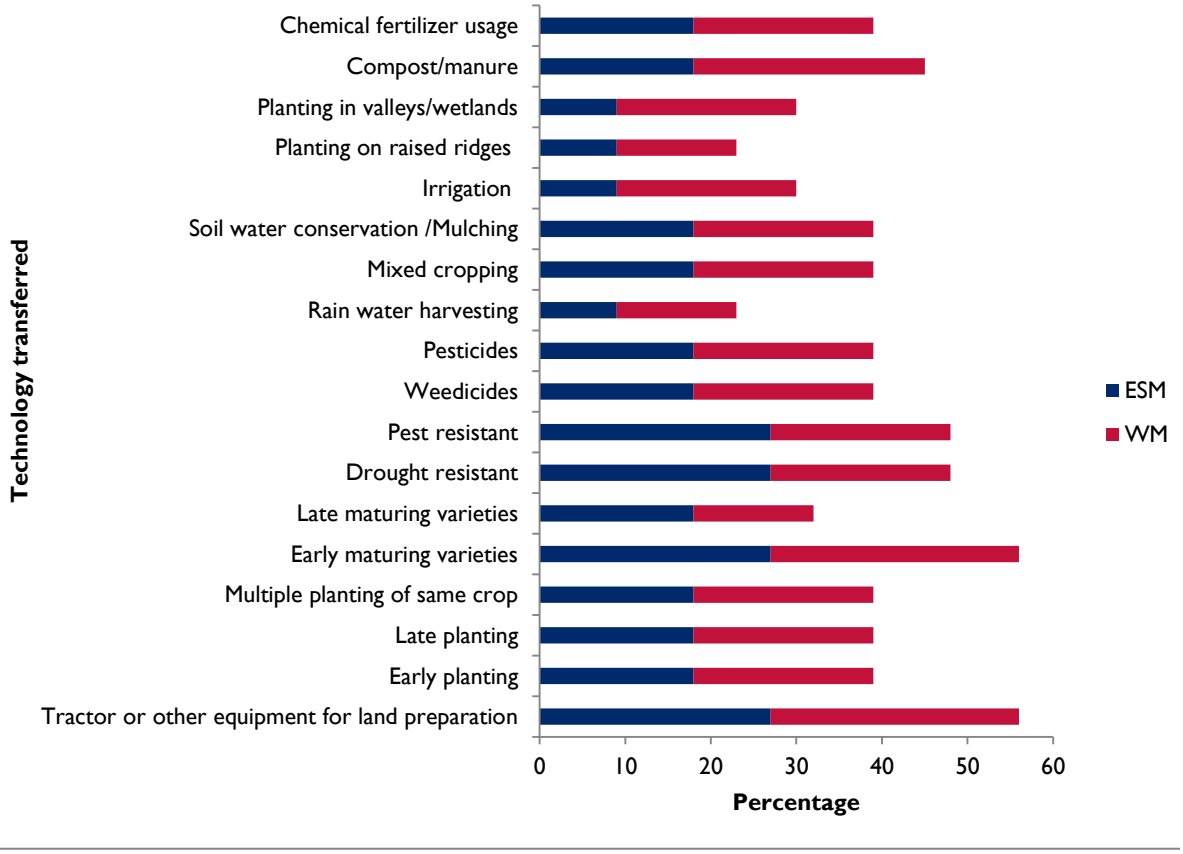

Figure 6.2: Kind of farm technologies or innovations institutions have transferred to smallholder farmers in order to address the effect of changes in climatic factors.

6.4 INSTITUTIONAL OBSTACLES FOR ADDRESSING IMPACTS OF CLIMATE CHANGE

Figure 6.3 (next page) shows that there are differences in what organizations perceive as the major obstacles for addressing impacts of climate change in a successful and sustainable manner. In WM, institutions noted that the major obstacles are, in order of importance: lack of awareness by local people, lack of enabling policies, and lack of commitment from local/regional government. In ESM, the major obstacles are lack of commitment from local/regional government, lack of enabling policies, and budgetary constraints.

This would help explain why a significant number (8 out of 25) of the organizations perceived that existing low-cost and new technologies/innovations currently in design to reduce climate hazards for smallholder farmers were not well-managed. These technologies are transferred by agricultural extension agents (of MoFA). Not only are they perceived as not being managed well by institutions, but farmers also see problems in the management of extension agents. During the validation workshop in Nkonsia, participants explained that the monitoring of farm households' use of agrochemicals by agricultural extension agents was not well done because of the low ratio of extension agents to farmers, and because of poor logistical support for the extension agents who needed to pay frequent visits to farmers in order to monitor activities and provide further sensitization on use of agrochemicals.

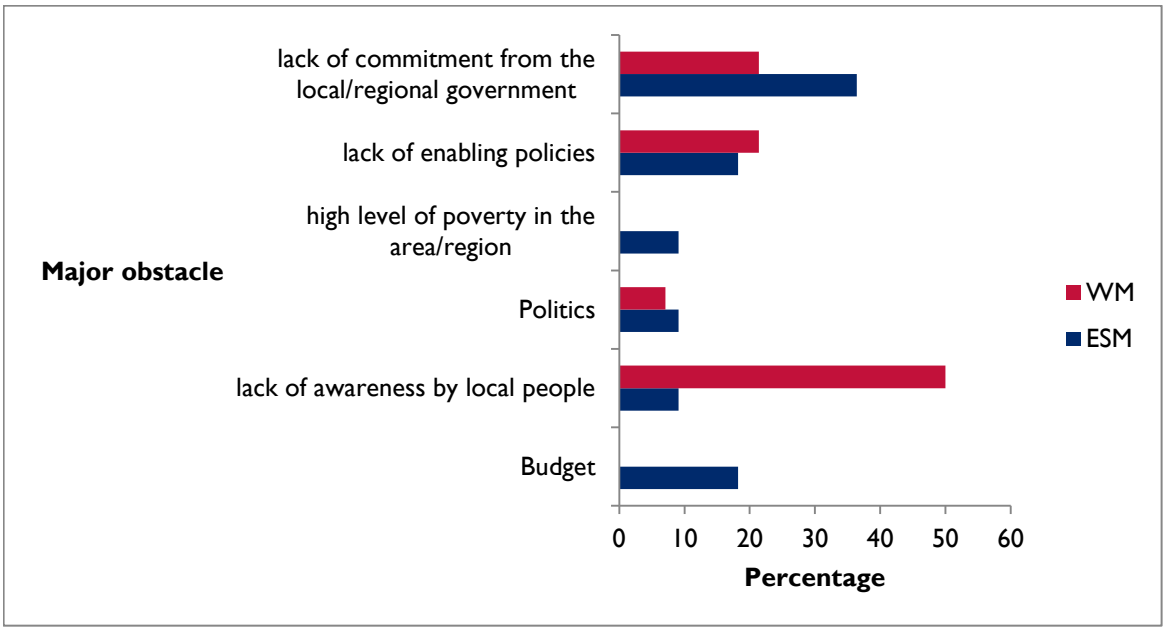

Figure 6.3: Perception of organizations of the major obstacle for addressing impacts of climate change in successful and sustainable manner

A significant number (12 out of 25) of the organizations agreed that there is strong coordination and networking among the various institutions (public, private, and intermediary) for providing efficient planning and implementation of projects/programs (services) to smallholder farmers; an almost equal number (13 out of 25) had no opinion or disagreed. Project coordination involves identifying stakeholders related to projects at the community level and ensuring that they meet, discuss, and implement monitoring and evaluation of planned actions together; share ideas on how to move projects forward; and that there is an effective communication plan. It is obvious that certain types of organizations coordinate more than others. This is not surprising, as organizations without mandates may attend meetings once in a while. This situation was mentioned during validation fora. It is clear that without institutional partnering and participation of households themselves, there will be limited success in the implementation of best practice climate change adaptation practices by households (Yaro et al., 2010). It was observed that many (18 out of 25) of the institutions have had a relationship with each other, although many (14 out of 18) of the respondents could not recall the exact nature of the relationship. It was explained that whenever community development projects are being designed, planned, and implemented, stakeholder sensitization workshops bring the various institutions together. Sometime, NGOs and financial institutions partner the agricultural development unit in reaching farmers with training programs.

Many of the organizations reported receiving complaints from farmers. Table 6.3 shows the separate ranking provided by male and female respondents. The five leading complaints cited were new practices hurt the environment, information provided is not enough, too much time is spent during meetings, inadequate credit is provided to meet new demands, and new practices are too costly. This is consistent with the study's other findings that lack of adequate information, lack of funds, and increased input cost (including labor) are the major problems that farmers say prevent them from accessing services provided by local institutions. We note that farmers complained about how some practices hurt the environment (e.g., pollution of water bodies with agrochemicals), yet farmers used them due to lack of readily available alternatives.

TABLE 6.3: COMPLAINTS THAT ORGANIZATIONS HAVE RECEIVED FROM HOUSEHOLDS THEY PROVIDE SUPPORT THAT IS INTENDED TO HELP ADDRESS THE EFFECT OF CHANGES IN CLIMATIC FACTORS ON THEM

Complaint	Mean Rank for Males	Mean Rank for Females	Overall Rank
New practice hurt the environment	10.88	10.02	1
Not enough information is provided	10.44	11.54	2
Too much time spent during meetings	11.17	10.40	2
Inadequate credit provided to meet new demands	11.65	9.58	2
New practices are too costly	11.35	11.69	5
Poor understanding of information provided	11.71	11.71	6
Too much time needed to implement new practices	12.13	10.42	6
Inadequate infrastructure	11.96	12.46	8
Distant location of facilities	12.21	12.00	9
Only select group of people are benefiting	11.85	12.85	9
New practices result in low product price	12.54	12.46	11

6.5 SELECTION OF BENEFICIARIES OF SERVICES

Figure 6.4 shows that most organizations consider economic activities of beneficiaries before an adaptation option is selected and delivered. Others use a first-come-first-served method. Only one organization, Wenchi Farm Institute, an educational institution in the Wenchi Municipality (Brong Ahafo region), reported selecting beneficiaries based on literacy levels. Young farmers who have completed basic education (minimum six years) are considered for hands-on vocational training in farm business.

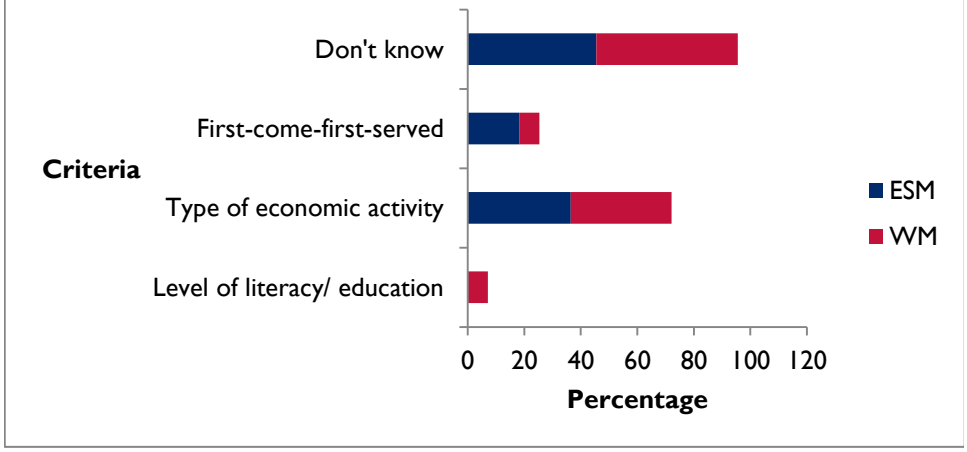

Figure 6.4: Criteria used by organizations to select beneficiaries.

There are other platforms created by MoFA that ensure that illiterate young adults can also participate in training programs that transfer technology to households. In this way, the poorest of the poor who are likely to be illiterate are not excluded from developmental projects that contribute to climate change adaptation.

Discrimination was not found to be practiced. The institutions identified as a part of the study dealt with persons of different genders, marital and residential status, and economic activities. The majority of the 612 farmers interviewed agreed that they know about support provided by public and private institutions to help cope with climatic factors such as droughts, floods, and other disasters. Slightly more males had received support than females, and slightly more respondents in Ejura than Wenchi municipality said they received support. The location difference may be due to nearness of Ashanti region to the National capital (Accra) than Brong Ahafo region. Most organizations' headquarters are in Accra and accessibility and nearness may influence selection of project site (Sant, 1995).

Allah-Mensah (2004) observed that some civil society organizations (NGOs and CBOs) encourage participation in local politics and decision-making of women to contribute to and benefit from climate change discussions, mitigation, and adaptation measures. Institutions provide training services for women to play important advocacy roles for the internal resistance of rural communities to climate hazards. In this study, the majority of the organizations said that their services were fairly well patronized by target beneficiaries (Table 6.4). Most of the officers confirmed that the target beneficiaries of organizational support largely participate in decision making for the development of services or program packages. It was only in Ashanti region that one company said beneficiaries did not participate in decisions to provide support packages.

TABLE 6.4: PERCEPTION OF INSTITUTIONS OF BENEFICIARY ACCESS TO SERVICES

Nature of Involvement	ESM N (%)	WM N (%)	Total N (%)
Very often	0 (0)	3 (21)	3 (12)
Often	4 (36)	4 (29)	8 (16)
Somewhat often	1 (9)	3 (21)	4 (16)
Don't know	6 (55)	4 (29)	10 (40)
Total	11(100)	14 (100)	25 (100)

6.6 USE OF SERVICES BY FARMERS

Majority of the farmers (518 out of 612) confirmed knowledge of the services provided by local institutions. About 80 percent said they obtained the services frequently and majority said they were quite satisfied with the services. This implies that the services being provided were quite effective. The most important service mentioned by about 76 percent of the respondents was education. Education is a capacity building method through which information on different technologies for farm adaptation and messages on mitigation are provided. Education programs are through workshops and fora and participants are lectured and given notes or made to discuss issues in small groups. We note that not all farmers were satisfied; these farmers (3 percent) complained about how agricultural extension agents worked, that the agents visited occasionally, and some farmers were not able to receive adequate technical and managerial information. A few farmers said they never used the services provided by local institution. The major reasons given were lack of knowledge (>45 percent) and inadequate information on the service (>42 percent). For technology and innovation, the demand on funds for purchased inputs and labor (>26 percent) were also key concerns. Quite a significant proportion of people also expressed concern that services are limited to specific people (>20 percent). A few others confirmed during FGDs

and the two validation fora that they do not access a service because the providers fail to provide the actual service promised them.

TABLE 6.5: FREQUENCY OF ACCESS AND SATISFACTION WITH THE SERVICES (PROGRAMS/PROJECT) OF ANY OF THE INSTITUTIONS IN THE LAST THREE YEARS

Variable	Frequency	Percent
How often?		
Very often	317	61.2
Often	97	18.7
Not often	99	19.1
Never	5	1.0
Total	518	100.0
Satisfaction with service?		
Yes	328	77.4
No	13	3.1
Somewhat	83	19.6
Total	424	100.0

6.7 INSTITUTIONAL FUNDING FOR CLIMATE CHANGE ACTIVITIES

Institutional funding is needed to boost the resource capacity of local institutions. The majority of the organizations agreed that, whether for the short- or long-term, the resource capacity of organizations to serve households is low. Even the public institutions with mandates are not fully supported by Government to roll out their planned projects. Resources needed include human, financial, and physical capital. Human capital includes professionalism and good attitudes. Financial capital includes funds for making payments of services and purchased inputs. Physical capital includes facilities, such as offices and furnishings; computers, and other office equipment as well as vehicles to improve mobility and motivation of workers.

In terms of budget allocation and fund raising, the majority of the institutional respondents said they did not know what was done at headquarters. However, many organizations do not allocate a specific proportion of their budgets for providing and or promoting climate change and adaptation services during annual planning periods. Three organizations allocated less than 10 percent and one allocated up to 70 percent of their budget to promotion of climate change adaptation among households. Apart from internally generated funds, external donors and other provisional emergency fund sources were areas through which funds are obtained for financing projects. We noted in the literature that, many local organizations are provided financial support by development partners, including WFP, CIDA, AfDB, AFD, GIZ, and JICA.

7.0 GENDER DIMENSIONS AND OTHER SOCIAL EXCLUSION ISSUES IN CLIMATE CHANGE ADAPTATION

Farmers' opinions were also analyzed on the role that gender plays in determining livelihood activities men and women are engage in, ownership and use of land, how men and women participate in decision making, and whether changes in climate factors affect men and women differently. As noted previously, women dominated as respondents in the survey.

7.1 GENERAL CHARACTERISTICS

In terms of illiteracy and migrant status, there were more illiterate women (73 percent) than men (36 percent). Although 33 percent of respondents were migrants, of those there were slightly more migrant men (38 percent) than women (29 percent). Both men and women were engaged in off-farm activities. However, more women (91 percent) than men (81 percent) were engaged in petty trading. This activity requires low capital investment and allows participants to trade in durable commodities. Women tend to trade in small volumes of commodities such as plastic containers, packaged foods and beverages (imported or locally manufactured), water, and grains with others in their communities. Men tend to trade in slightly larger volumes of hardware (simple tools and building materials) and packaged foods during market days, which are periodic.

7.2 HOUSEHOLD DECISION-MAKING

Women are often excluded and underrepresented in decision making and policy processes at the household level, and especially in regard to issues pertaining to climate change (UNDP, 2009). In this study, women's engagement in petty trading as a key adaptation strategy in all the communities appeared to have positively influenced the socioeconomic status of women, especially the decision-making role of women. In all the communities, both male and female respondents agreed that both husbands and wives participated in decisions on household livelihood activities. The increased education level and economic empowerment of women also came up during FGDs strongly as a factor influencing the increasing participation of women in household decision making. This situation has perhaps created more freedom for women to take independent decisions and assume more responsibilities in the affairs of the household. During the validation fora in the two communities, some respondents observed that in recent times, the mobile phone has made consultation with absentee adult members of households easy and so the practice of joint decision making is growing. The majority of both male and female respondents were of the view that participation of men and women in the decision making process translates as provision of information, engagement with one another, provision of resources, and being physically present to support one another.

According to male respondents, while husbands, as the heads of the households, could take decisions alone, wives did participate in decisions on household livelihood activities including decisions of land use after floods periods. This perception was confirmed by both men and women respondents. It was also clear from the results that adult children and adult family members contributed to decisions on household livelihood activities. When asked on who takes decisions on the ownership and use of land during floods, more than half of men and women respondents in almost all the communities reported that there are usually joint decisions by husbands and wives. In the WM, it was agreed that all members of the household participated in discussing issues of child education, health care, daily meals, and migration among other livelihoods issues. Some women respondents (10 percent) in Ejura (Anyinasu, Babasso, and Sekyedumase) reported that they took decisions on household livelihood activities alone. Some of the women who reported making decisions alone are possibly households heads and likely to be divorced (17 percent), widowed (23 percent), or single women (4 percent). When husbands of married women travel outside of home for three months or beyond, the wives are considered heads of household.

7.3 LAND OWNERSHIP AND USE

Decision making concerning ownership and use of land is done either by the husbands or done jointly by both husbands and wives (Figure 7.1). Joint decision making on land use appeared to be very high in the ESM as compared to the WM. This pattern could be attributed to the increasing economic contributions of women to the household budget, and the structural transformation of the Ghanaian society that has changed the status quo. In certain cases, other household members, such as adult male children and uncles, contributed to decisions on the ownership and use of land. This was particularly obvious in WM as confirmed by both the survey data and during FGDs. There are slightly more indigenes in WM (4 percent) than ESM (3 percent). During FGDs, it was discovered that communal land ownership where land is held by one person in trust of other members of the external family was common in both municipalities.

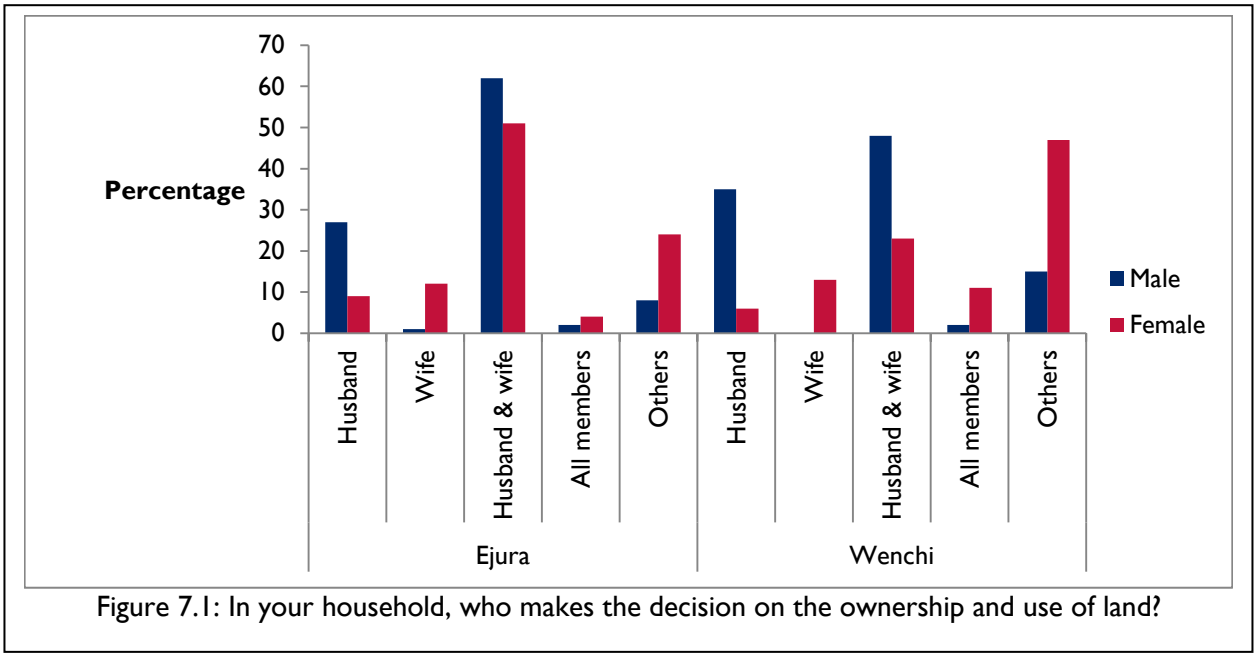

Figure 7.1: In your household, who makes the decision on the ownership and use of land?

7.4 FLOOD PREPARATION

Most men and women in all six communities were of the view that there was no particular group of individuals who were better prepared to deal with flood/drought events when they occurred. When asked on who takes decisions on the ownership and use of land during floods, more than half of men and women respondents in almost all the communities reported that there are usually joint decisions by husbands and wives.

8.0 CONCLUSIONS

In the Transition Zone of mid-Ghana, crop production is the main livelihood among smallholder farmers. Many of the farmers' agricultural crops depend solely on rainfall, as they do not have access to irrigation options. The main objective of the study was to identify appropriate technological options to improve the short-term coping and long-term adaptation mechanisms that smallholder crop producers use, given the impact of climate change induced rainfall variability. The research questions were:

4. What technological options do smallholder crop producers use to adapt to climate change impacts in the Transition Zone of Mid-Ghana?
5. How are adaptation practices used by smallholder crop producers perceived to contribute to improved household food and income security? and
6. How have local institutions supported households to adopt adaptation practices?

Two municipalities were studied and primary data was collected from 612 farmers and 25 officers of local institutions. The municipalities were Ejura-Sekyedumase in the Ashanti region and Wenchi in the Brong-Ahafo region. Simple descriptive statistics (frequencies and percentages) have been used to describe patterns and conditions.

The major findings were that farmers know and can describe the nature of changing environmental conditions and they consider the weather patterns as most important. Smallholder farmers in the Transition Zone of mid-Ghana have observed increased temperatures, reduction in mean rainfall total, and variation in the rainfall regime. The farmers have observed that the losses that have occurred due to the changing weather patterns resulted in crop loss and other damages. In order to avoid losses, farmers have adopted the use of yield-enhancing agronomic technologies. The major ones are inorganic fertilizers as soil improvement, altering planting and harvesting dates, and using improved varieties. Livestock production, tree planting, and off-farm activities such as trading are also important, though not vigorously pursued by the majority. Farmers perceived that the agronomic technological options are effective since they have resulted largely in increased crop yields, household consumption, and income.

The farmers also confirmed that local institutions that were dominantly public sector organizations provided some services that supported them as they adopted the adaptation measures. The major local institutions mentioned were the agricultural development units, media and financial institutions. NGOs and farmer organizations were less visible. Private sector institutions included those in the finance, storage, and processing industry. Both farmers and the institutions agreed that the major service provided was for capacity building, using education, training, and sensitization sessions to provide technical and other information on climate change mitigation to farmers. Technology transfer activities and credit schemes where farmers are provided with inputs to experiment and cash to support sustainable use of practice were minimal and infrastructure development such as irrigation was rare. There were limited gendered differences and social exclusion was non-issue. Slightly more males than females controlled resources that were needed for livelihoods development. Joint decision making is being pursued. Women are more empowered and contribute to decision making at all levels, both in the home and community.

The conclusions from the findings are that the technological options that smallholder crop producers use to adapt to climate change impacts are mainly agronomic practices that can be divided into three categories: chemical, biological, and management. The major chemical option used by the study group

was inorganic fertilizer for soil improvement and pesticide for weed control and pest management. The major biological option used was improved varieties of seed (early and late maturing and drought resistant). The major management options are altering of planting and harvesting dates, planting on raised ridges, and multiple plantings. Adaptation practices used by smallholder crop producers are perceived to be positively contributing to improved household food and income security. The majority of households reported perceived increase in food consumption and income when they used these adaptation practices. The support that local institutions have provided households to adopt adaptation practices is significant although the level of contribution of NGOs and private sector can be questioned. NGO presence was limited and private sector services (mainly credit provision) were not easily accessible to majority of farmers. Institutional support could thus be considered as moderately effective, requiring more room for improvement.

9.0 RECOMMENDATIONS

The following are suggestions towards the improvement of farmer understanding and practices of agronomic adaptations, as well as showing the gaps and entry points for institutional support and project implementation. Improvement in farmers' understanding should result in improved adaptive capacity and

9.1 RECOMMENDATIONS ON WHICH TECHNOLOGICAL OPTIONS TO PROMOTE

- The identified technological options (chemical pesticides and fertilizers, improved seed varieties, and changes in planting and harvesting) should be shared with the farmers and institutions that provided the information using various methodologies. These include a Municipal forum involving institutional representatives, chiefs, elders, and household members in the selected communities; radio broadcast via a well-known agricultural, environmental, or development-related program by a state-owned media house; and dissemination of a policy brief.
- The adaptation practices recommended the most in changing climatic factors are adoption of the crop-based technological options (agronomic practices). These should be more actively promoted among similar households in the Transition Zone using the agricultural extension services of MoFA and other platforms created by NGOs. Livestock production was also important although not vigorously pursued. Intensive livestock management will reduce the overdependence of farmers on crop income and so stakeholders are encouraged to facilitate farmers learning and investments. Tree planting was also mentioned as a measure that was effective but was practiced by few households. This practice can be promoted as climate change mitigation measure by local institutions. An important off-farm activity is petty trading but it was not vigorously pursued; when many more farmers, especially women, are taught how to invest in and manage these micro-enterprises, they will come handy when crop yields are low and farm income reduces.

9.2 RECOMMENDATION ON THE ROLE OF HOUSEHOLDS IN PROMOTION OF ADAPTATION PRACTICES

- The community-level farmer organizations need to be strengthened to provide continuous learning by farmers. Local government departments such as Cooperatives and Community Development should be supported by local as well as regional- and national-level NGOs and relevant private sector institutions to lead the organization and training of farmer organizations leaders and members in group dynamics and action planning and implementation. The latter will lead farmers to respond to calls by their leadership, relate to one another well, apply themselves to learning, and patronizing an organization's products and services.

9.3 RECOMMENDATIONS FOR INCREASED LOCAL INSTITUTIONAL SUPPORT FOR HOUSEHOLDS

The analyses shows that there is an opportunity for local institutions to support households to gain knowledge and adopt technological packages that can assist them in adapting to changing climate factors in order to improve their household food and income security. The three key factors that can influence the support that institutions provide households to adopt adaptation practices are: leadership, resource capacity building, and institutional networking/coordination.

- **Leadership:** The new knowledge identified from the institutional survey is that private sector and NGOs (including farmer-based organizations) are not visible as support institutions to agricultural household adaptation; the public sector is very visible. Hence, the public sector should recognizing their leadership role, take the lead, and ensure effective partnerships among the three types of institutions in order to ensure that there is appropriate use of the technological options.
- **Resource Capacity Building:** The new knowledge identified during FGDs is that both male and female farmers know of the nature of changes in climatic factors and the extent to which the changes make households poorer. The new knowledge identified from the individual household survey is that women are almost at par with men in the adoption of agronomic practices that improve yields, food consumption, and income. This means that every member of the agricultural household is needed to contribute to decision making in the face of the climate change challenge. Increased farmer knowledge and sustained empowerment of the different genders will lead to improved access to resources necessary for project implementation.
- **Institutional Networking/Coordination:** To improve the contribution of local institutions in support of household adaptation practices in the study area, the networking capacity of local government and non-government agencies should be strengthened so that local government agencies will encourage more NGOs and private sector companies to deliver the services expected of them. Effective networking requires identification of strengths and weaknesses development of joint work plans and periodic meetings to review community-based activities that support climate change adaptation (PC, District Director, Wenchi Municipal Agricultural Development Unit). Networking and coordination mechanisms that can be explored by all the agencies include the following: training in social research, learning collaboration skills, developing partnership agreements (simple Memorandum of Understanding), committing to periodic review meetings, and learning fundamentals of fundraising. The strengths of each type of institutions will be tapped as they coordinate support programs.

9.4 RECOMMENDATIONS ON MAJOR SCHEMES FOR INVESTMENT

There are two major infrastructural schemes that stakeholders are encouraged to pool resources and invest in. These are the credit and irrigation schemes.

- The issue of credit to support demands of new technological packages introduced to smallholder farmers has been thoroughly discussed in the literature. Farmers have difficulty in accessing credit. The private sector can lead in improvements required in this area. The different levels of financial institutions (bank and non-bank as well as rural, semi-urban, and urban based) should identify areas of technological packages that need financing during the short, medium, and long terms. When there are aspects of new technological packages that demand payments that are higher than can be absorbed easily by farmers, the local institutions should collaborate, plan, and introduce a subsidy system. Market access development will be needed to assure farmers of sale of produce, income generation, and savings that can be used to pay back loans.
- Irrigation schemes that are community based were not being largely pursued by the municipalities. They are well known not only as contributing to soil and water management but also as sources of crop diversification and continuous cropping. Individual small and micro schemes have been advocated but community-based schemes that ensure user participation in maintenance is most desirable, particularly among resource-poor households.

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FINAL RESEARCH REPORT

HOUSEHOLD AND COMMUNITY EXPERIENCES AND PERCEPTIONS ON CLIMATE CHANGE IMPACTS DUE TO FLOODS, AND EXPECTATIONS ON POLICY IN BUNYALA SUB-COUNTY, WESTERN KENYA

MARCH 2014

This report is made possible by the support of the American people through the U.S. Agency for International Development (USAID). It was prepared by Multiface Research and Development Centre (MRDC). The contents are the sole responsibility of MRDC and do not necessarily reflect the view of USAID or the U.S. Government.

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ACKNOWLEDGEMENTS

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Cover Photo: View of River Nzoia in Bunyala flood plain from Nahasiongo Hill, July 23, 2012. By Denis Opondo.

HOUSEHOLD AND COMMUNITY EXPERIENCES AND PERCEPTIONS ON CLIMATE CHANGE IMPACTS DUE TO FLOODS, AND EXPECTATIONS ON POLICY IN BUNYALA SUB-COUNTY, WESTERN KENYA

MARCH 2014

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ACRONYMS AND ABBREVIATIONS

ARCC	African & Latin American Resilience to Climate Change
BUCODEV	Busia Community Development Organization
Co-PI	Assistant Principal Investigator
CBO	Community Based Organization
CDF	Constituency Development Fund
DDMC	District Disaster Management Committee
FBO	Faith Based Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GIS	Geographic Information System
GoK	Government of Kenya
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
KII	Key Informant Interview
KNBS	Kenya National Bureau of Statistics
KMD	Kenya Meteorological Department
MRDC	Multiface Research and Development Centre
NAPA	National Adaptation Program of Action
NGO	Non-Governmental Organization
IGAD	Intergovernmental Authority on Drought
IPAC	Intergovernmental Climate Prediction and Applications Centre
IPCC	Intergovernmental Panel on Climate Change
ITK	Indigenous Traditional Knowledge
PI	Principal Investigator
SPSS	Statistical Package for Social Science
STI	Sexually Transmitted Infections
UN	United Nations
UNECA-ACPC	United Nations Economic Commission for Africa-Africa Climate Policy Centre

UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children Emergency Fund
USAID	United States Agency for International Development
WFP	World Food Program
WKCDD/FM	Western Kenya Community Driven Development and Flood Mitigation Project

EXECUTIVE SUMMARY

INTRODUCTION

This one-year small grant on "Household and Community Experiences and Perceptions on Climate Change Impacts Due to Floods, and Expectations on Policy in Bunyala Sub-county, Western Kenya" began in April 2013. The grant was awarded to Multiface Research and Development Centre (MRDC) by the African and Latin American Resilience to Climate Change (ARCC) project, a USAID-funded task order implemented by Tetra Tech ARD under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract. The grant was implemented by MRDC, a non-governmental organization based in Kisumu, Kenya, with guidance from the United Nations Economic Commission for Africa - African Climate Policy Center (UNECA-ACPC) situated in Addis Ababa, Ethiopia.

The aim of this study is to contribute to strengthening Kenyan disaster risk management policy and planning by increasing awareness of local and institutional practices in response to floods. The research questions that guided this study are: (i) How can indigenous traditional knowledge be integrated into interventions to enhance household and community resilience to flood impacts? (ii) What are the gender-related implications of floods? and (iii) How do existing institutions help households and communities deal with flood risks?

This study looks at the frequent flooding in the Budalangi plains on the shores of Lake Victoria in Kenya in Bunyala Sub-county, and is justified by research findings that indicate current coping strategies are ineffective despite interventions by NGOs and government. An understanding of local governance structures and institutional presence is particularly important because, under the new constitution in Kenya, the devolution of authorities to local government structures will have important ramifications. For example, there will be an increase in community participation in decision-making to address challenges to social and economic development in the context of climate change and climate variability. The research study area is Bunyala, Western Kenya, and the paper produces a compelling story that depicts real-life impacts of flooding on households due to climate change placed in the broader context of the community and local institutions.

RESEARCH METHODOLOGY

Methods used consist of a combination of qualitative methods (focus group discussions and key informant interviews) and more quantitative methods (questionnaire survey). Household questionnaires were administered to 418 respondents. Seven focus group discussions (FGDs) were conducted with 65 community members consisting of youth, women, and men. Key Informant Interviews (KIIs) were conducted with 12 individuals.

SUMMARY OF FINDINGS

The study looked at households in Bunyala Sub-county. It analyzed how they were adapting to flooding in the long-term, and what coping mechanisms they were using to respond to flooding in the short term. Because the majority of respondents in the study engage in subsistence crop production/farming as their main occupation, flooding is a particular concern for them and has a significant impact on household day-to-day livelihoods. The study found that a majority of respondents recognize changes in flood regimes and also experience severe impacts from floods. Furthermore, households experience food shortages caused by floods for about six months each year, during periods that correlate with rainy seasons.

Respondents use both coping and adaptation strategies/practices to deal with flood impacts. Short-term coping strategies often involve quick responses to the onset of floods and do not provide long-term solutions for household resilience to the negative impacts of floods. Furthermore, many of the coping practices used are often detrimental to household livelihoods by reducing their short-term and long-term resilience.

Households also report that wealthier household are better able to cope with the impacts of flooding, suggesting that poor households bear the brunt of flooding. Examples of coping practices used include temporary migration; relocation to camps and to homes of relatives and neighbors living outside of the flooded areas; spending less money on household requirements such as food, clothes and medication; rationing of food by reducing the quantity and number of meals for both children and adults; sale of household assets such as mobile phones and bicycles; and withdrawing children from school to help with domestic chores. It is clear that all of these practices leave households more vulnerable and are not sustainable solutions for household resilience to climate change. Since poorer households are more prone to the negative effects of yearly flooding, long-term, sustainable solutions need to be further explored and promoted by government and institutions.

Households have also been adopting long-term adaptation strategies and practices to combat the impacts of flooding. Many of the adaptation practices have involved using mechanisms to make household assets, such as homes, more resistant to flood damage. There has also been an effort to diversify livelihoods, to decrease dependence on farming. However, it should be noted that many of the practices are viable only for economically well-off households. Some of the adaptation practices households report using include planting trees around homesteads to keep out water to protect houses; construction of houses with raised foundations to prevent damage to houses and household goods; improving food storage using Indigenous Traditional Knowledge (ITK); formation of women's and community groups for sharing of skills and resources; leasing farm land in the Migingo area for growing maize and sorghum; purchase of land on higher grounds; diversification from farming into other areas such as fishing and business; and permanent migration. The last three options are examples of those practices only available to households that are economically well-off. Again, it is clear that the less economically well-off a household is, the fewer resources they will be able to use to prepare for floods. As such, coping mechanisms, such as reliance on assistance, become important for many individuals in the study area.

The findings on ITK indicate high-level awareness by individual and community members on rainfall and flood onset. The custodians of ITK are usually elderly men and sometimes elderly women. ITK on flood and rainfall prediction include sighting of a type of migratory stork (*magungu)* and a type of eagle *(Ikhwasi)* which indicate onset of the rainy season; wind patterns; coloration of water in the river, including foam and floating debris, which indicates flood onset; the behavior of animals such as frogs and toads; dark clouds in the direction of Mt. Elgon, which indicate rainfall and flood onset; appearance of safari ants in homesteads and riverbanks/dyke, which indicates flood onset; and shedding of leaves by the *Omudodo* tree, which heralds rains onset. ITK commonly used after flood events include fishing in flood waters by men, women, youth, and children using traditional traps made of reeds and sticks; the use of traditional herbs and cow-dung burnt in open fireplaces to deal with mosquitoes that affect both humans and livestock (some herbs are also used to purify drinking water and cure water borne diseases; for food storage and preservation, cereals are dried and stored in pots and gourds; meat and fish are dried and stacked then stacked above the fireplace for preservation through smoking; relocation of households using traditional migratory routes; and alternatives for constructing shelters such as using natural materials such as grass, sticks/branches of trees and reeds or residing in homes of relatives, friends and neighbours; and safety and security (this relates to informal arrangements by men and boys to patrol homesteads using boats and canoes). In many cases men remain behind in homesteads to guard household assets stored on the rooftops and in the eaves of houses.

Indigenous Traditional Knowledge (ITK), Gender Implications, and Institutional Responses to Floods

It was hoped that ITK would prove to make a positive contribution to disaster management strategies. The paper has identified ways in which ITK can be promoted and should be used in planning. However, the study found that there are many obstacles to the use of ITK. Primarily, the current use of ITK among households is limited due to a lack of access and trust in the viability of ITK. The study also found that individuals perceived that modern western education and technology denied ITK experts the chance to exercise their skills. Furthermore, they also perceived that modern education actually increased distrust and disrespect for elders by younger community members, limiting the intergenerational transfer of ITK.

Findings on general flood impacts show that women, men, and youth are affected by displacement from homesteads, destruction of crops and loss of income, food shortages, and increased incidence of waterborne diseases such as cholera, typhoid, and malaria. Women and men both face unique flood impacts. However, this study focused on some of the particular impacts and vulnerabilities faced by women. It was found that after flooding, households are often relocated to camps, or seek other temporary shelter. This primary coping strategy has specific implications for women, including pregnant mothers who cannot access maternal health clinics; lack of food leading to poor diet for pregnant and lactating mothers; loss of income-generating activities; increased risk of sexual harassment and exploitation at camps and risk of contracting sexually transmitted diseases; girls are taken out of school and greater prevalence of early marriage of young girls during times of floods. Furthermore, there is greater stress on the females' domestic responsibilities and ability to provide food, water, and fuel for their children, since men sometimes temporarily relocate outside of the camps.

There were strong perceptions of the negative impacts floods have on youth, particularly due to the negative behavior that became more prevalent when families were relocated to camps during times of floods. Perceptions of the impacts floods have on youth behavior include engaging in substance abuse, teenage sex, and prostitution; promiscuity of youth at camps, resulting in teenage pregnancies; increased sexual harassment of youth; early marriages among teenage girls; increased exposure/risk of HIV/AIDS and STIs; and inaccessible public facilities such as schools and village polytechnics leading to school drop-out, as young girls marry early and boys go into fishing and *boda-boda* (informal public transport business using motorcycles).

The public and private institutions that work in Bunyala provide assistance during flood events. These include government departments and agencies, NGO/CBOs, FBOs and international organizations. Private institutions are perceived as more effective in provision of assistance compared with public institutions. However, the effectiveness of public institutions is associated with structural interventions such as construction of dykes and dams. Generally, the main beneficiaries of assistance by institutions are women, the elderly, and children. Private and public institutions could be more effective by providing sustainable support programs rather than handouts. There are several recommendations geared towards institutions, both to strengthen coping mechanisms of households and increase adaptive measures.

RECOMMENDATIONS

The findings of this study have implications for policy makers and planners at both the county and national government levels. Several recommendations are presented below.

Indigenous Traditional Knowledge and Floods

There is potential for greater use of ITK in climate information and it is proposed that:

- Flood management should integrate modern scientific forecasting and climate modeling with ITK to strengthen understanding, dissemination, and use of climate information in the study area.
- ITK be integrated into current approaches (i.e., integration of ITK on flood prediction into *Early Warning Systems* for preparedness);
- ITK experts can be tapped as a means to disseminate climate information; and
- ITK on climate should be documented for posterity.

Gender and Floods

The gender dynamics of flood impacts represent a complex situation. Dealing with the gender issues of flood impacts requires a multi-pronged approach which combines public interventions, cultural/attitude changes, and community action. It is proposed that:

- Local communities be empowered through trainings/skills programs (new technology for farming) to improve small-scale agricultural productivity (small-scale irrigation for food production and income generation can be promoted);
- Education (adult and regular education) and vocational training to diversify livelihoods should be provided, along with other informal education and knowledge sharing; groups should be formed for the empowerment of women and youth;
- Women, as crucial contributors to food production and income generation, should be empowered to access resources such and money and land, and trained to develop decision-making skills. This can be achieved through training for women groups, and credit schemes to promote petty trade and small-scale businesses. Creating awareness of programs, such as the government's Women Enterprise Fund, should be promoted.
- Promotion of community education and attitude change towards women's empowerment, violence against women, and sexual exploitation.

Institutions and Floods

Households and communities in Bunyala Sub-county have limited capacity to deal with the negative impacts of floods. Improving their livelihoods requires interventions to address their coping and adaptation practices. Short-term coping practices, such as sale of land and household property, less expenditure on household requirements, and temporary relocation worsen the vulnerability of affected households to future flood events. Institutional investment in interventions to enhance household adaptation and resilience through long-term measures to improve the sustainability of livelihoods is crucial. However, as it currently stands, adaptation practices are not enough for households to adequately respond to floods. Therefore, coping practices also need to continue to be promoted while simultaneously strengthening long-term, sustainable institutional responses to help households adapt to climate change.

Short-term institutional interventions to improve household coping with immediate impacts of floods, should:

- Institutions should collaborate to set up emergency relief facilities for accommodating households displaced by floods, taking into account sleeping quarters/dormitories, and sanitary and medical facilities.

- Provision of learning facilities in camps or relocation settlement in order to ensure learning in primary, secondary, and tertiary institutions is not disrupted to the disadvantage of learners;
- Partner with communities to develop water storage facilities for domestic purposes to reduce incidence of waterborne diseases;
- Promote participation and decision-making by women in income generating activities such as small-scale agriculture and trade for income generation and livelihood diversification.
- Training of farmer groups and women's groups in modern farming techniques to not only improve agricultural productivity but also to enhance post-harvest conservation of food stocks.

The institutional interventions that seek to address adaptation strategies for long-term household resilience to flood impacts should:

- Develop mechanisms for collaboration between ITK experts and climate scientists to promote dissemination of viable ITK information related to floods, and to develop local flood prediction and early warning instruments for application to emergency preparation that take into account local resources and community participation;
- Strengthen potential of agricultural production in the Migingo area of Bunyala Sub-county through land adjudication and issuance of titles. This will provide incentive for modern commercial farming;
- Promote livelihood diversification initiatives to reduce reliance on subsistence agriculture and fishing -which are vulnerable to climate change and climate variability--in order to improve household food security and incomes;
- Promote flood-proof housing technology using locally available resources to reduce flood damage in homesteads;
- Build the capacity of relevant national and county government institutions to mainstream gender and climate change policies into institutional policies and activities.
- Implement integrated catchment management initiatives of the River Nzoia basin watershed to provide mechanisms for environmental conservation and management, as well as flood control, in order to limit the exposure of households and communities in low lying areas and floodplains to adverse flood effects. This could be achieved through public/private and community initiatives to address deforestation, soil erosion, and ecosystem conservation.
- Invest in structural flood control measures such as dams and dykes. This could be achieved through public/private investment in multipurpose dams for water harvesting, storage and production of electricity. This can be exploited for fish farming and small-scale irrigation projects that target local communities in the study area.
- Conduct floodplain mapping, land use planning, and enforcement of laws on land use, agriculture, and settlement. For example, homesteads should not be constructed in the flood plains, near dykes, or along river banks.

1.0 INTRODUCTION

1.1 STUDY BACKGROUND

This paper is the result of a grant awarded to Multiface Research and Development Centre (MRDC) by the African and Latin American Resilience to Climate Change (ARCC) program, a USAID-funded project implemented by Tetra Tech ARD. Under the ARCC project, grants were awarded to United Nations Economic Commission for Africa - African Climate Policy Centre (UNECA-ACPC) partner organizations in Kenya, Ghana and Burkina Faso. MRDC was selected as one grantee to conduct a one-year research project on "Household and Community Experiences and Perceptions on Climate Change Impacts Due to Floods, and Expectations on Policy in Bunyala Sub-county, Western Kenya."

1.2 GLOBAL CLIMATE CHANGE AND IMPACTS

Climate change has become evident worldwide through, for example, temperature and rainfall variations, as have climate change-related impacts, such as prolonged flooding, increased heat waves, increased length and frequency of droughts, sea level rise, and increased salinity (Rahman et al., 2007). In the context of climate change, the risk of floods will increase with increased frequency of extreme precipitation (Kundzewicz and Matta, 2007).

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007) noted that a warmer climate coupled with increased climate variability in rainfall patterns, such those induced by the El Niño phenomenon, will significantly increase the risk of floods in the poor countries of the world (IPCC, 2007; IGAD and ICPAC, 2007). The *El Niño* and *La Niña* phenomena are weather patterns that affect the major currents in the Pacific Ocean and also the southern Pacific and Indian Oceans, causing changes in normal weather patterns (GoK 2009; Mogaka et al., 2006). Neither developed nor developing countries are immune to the effects of climate change. Globally, natural disasters including drought, landslides, and floods occur with increasing frequency and intensity (IPCC, 2007).

According to The World Bank (2009), the last two decades have recorded six years with the warmest temperatures and highest rainfall variability in sub-Saharan Africa. Consequently, climate-related disasters such as floods and droughts have doubled in East and Central African regions within the last 25 years. Sub-Saharan African countries like Mozambique, Malawi, Kenya, Madagascar, and Ethiopia are more likely to experience unexpected extreme climatic events.

Floods in less developed countries, like Kenya, are likely to have a large negative impact on social and economic development, and in fact already have. The 1997/98 *El Niño* flood in Western Kenya was associated with one of the largest flood losses in the country in the last 50 years (Mogaka et al, 2006). The economic and financial losses associated with the *El Niño* floods were estimated to be in the range of up to US$800 million in Kenya (Karanja et al., 2002).

1.3 CLIMATE CHANGE IMPACTS IN KENYA

Kenya is highly vulnerable to climate variability, specifically drought, flooding (Mogaka et al, 2006), and sea-level rise (GoK 2012b). Research suggests that precipitation is expected to increase in some areas, with the largest rise in rainfall occurring in the highland and coastal regions. However, the arid and semi-arid parts of the county are projected to become significantly drier (GoK 2012b, Mango *et. al.*, 2007).

This trend is mainly attributed to an increase in surface temperature and potential evapotranspiration (GoK, 2012c).

Climate change and increases of atmospheric carbon dioxide may have a positive impact on agricultural production in western Kenya. This is mainly attributed to increased temperatures in medium- and high-altitude areas. This will expand the area with crop production potential, increase cropping intensity potential, and increase CO_2 fertilization. However, negative impacts may also occur due to pest and disease damage and the worsening of workable conditions due to increased wetness (Fischer and van Velthuizen 1996, Kabubo-Mariara and Karanja, 2007). The medium and low potential agro-ecological zones in Kenya will bear the brunt of the negative effects of global warming. The high potential zones are located at altitudes above 2050 metres above sea level; medium potential zones are found at altitudes ranging from 1000 – 2050 metres above sea level; and the low potential zones are located at altitudes below 1000 metres above sea level. The agricultural losses in the medium- and low-potential zones due to global warming are estimated at about US$178 per hectare (ha) by the year 2030, compared to losses of only US$32 per hectare in the high potential zones (Kabubo-Mariara and Karanja, 2007).

The Lake Victoria Basin in Western Kenya is the most flood-prone region in the country (GoK, 2007). The basin covers an area of about 194,000Km² and is bordered by the east African countries of Burundi, Kenya, Rwanda, Tanzania, and Uganda. On the Kenyan side, the catchment has an area of 46,229 Km² and receives inflows from five major rivers: Nyando, Nzoia, Sio, Sondu, and Yala. All of these rivers rise from the Rift Valley and western highlands. Rivers Nzoia and Yala experience yearly floods in their lower reaches, which affect the Bunyala plains in western Kenya. This area is located within Bunyala Sub-counrty, the study area for this research.

Many parts of the country also experience unexpectedly heavy rainfall in mid-April. This continues through the end of May (the "long rains") and from September to November (the "short rains") (Nyakundi et al., 2010).

The study area (Bunyala Sub-county, Western Kenya) is affected by two main natural hazards--floods and drought--which pose numerous challenges to livelihood support systems, especially health and food security. The first recorded flood incidence was in 1937. Subsequently flood incidences were recorded in 1947, 1951, 1957/58, 1961/62, 1963, 1975, 1977/78, 2002, 2003, 2006 and 2007 (Bunyala District Report, 2008). The government of Kenya has, therefore, recognized climate change as one of the most serious threats to its sustainable development and poverty reduction programs (GoK, 2012).

It can therefore be argued that in Kenya, floods have the potential to significantly disrupt the country's social and economic development due to the high costs associated with flood impacts. This study aims to highlight insights about real-life experiences of climate change impacts. Presently, there are substantial knowledge gaps on the impacts of extreme climate events facing communities. Most of these communities are not yet able to cope with or adapt to climate change impacts in a feasible way. This study looks at communities and their experiences in Bunyala Sub-county, Kenya, how climate change--through increased flooding--has affected their livelihoods, and what mechanisms they are adopting due to the latter.

1.4 CLIMATE TRENDS AND IMPACTS IN THE STUDY AREA

The climate trends in Kenya, particularly the Western parts of the country, will have a bearing on impacts of flood frequency and intensity. A study by Kenya Meteorological Department (KMD) on temperature and rainfall trends in Bunyala Sub-county showed that climate change has an effect on temperature and rainfall. This was based on analysis of temperature and rainfall collected over a period of 42 years (KMD). The results showed that this has led to increased stream flow, causing River Nzoia

to overtop its banks and dykes, causing floods in the plains. The Water Evaluation and Planning (WEAP**)** model was used to simulate river flow with acceptable accuracy during the reference period from 2001 and 2006.

The River Nzoia catchment is the wettest in Kenya, and the flow duration curve is typical of a catchment that suffers from rain-induced floods (Immerzeel and Droogers, 2009). The river discharge is lowest from January to March and relatively constant throughout the other months of the year, with a peak in May. Rain-fed agriculture is the largest water consumer (52% of total rainfall) in the catchment and urban water use is negligible. In total, 27% of total rainfall is discharged into Lake Victoria. Under the current climate, a total area of 18,943 ha is inundated with an average inundation depth of 4.9m. The current climate trend has for several years resulted in perennial floods in Bunyala, and this area presently experiences floods with increasing frequency and magnitude. This will result in destruction of livelihood activities and displacement of people (Immerzeel and Droogers, 2009).

The high flood discharge and excess of the carrying capacity of the river channel, naturally spills over the banks. In the flood plains (lower reaches) of River Nzoia, floods are often aggravated by high-water levels in Lake Victoria, and the back water effect from the lake causes widespread inundation for long durations (GoK, 2009a).

IMAGE 1: EDGE OF NOTHERN DYKE FROM NAKHASIONGO HILL, DECEMBER 2008

Credit: BUCODEV

The dykes in Bunyala Sub-county were constructed in the period between 1977 and 1984, with a return period of about 25 years. However, there are no routine maintenance arrangements, except occasional repairs of breached or severely damaged sections. Other complementary non-structural measures can be considered, including flood forecasting and warning, as effective methods of reducing risk to life and property. However, it is a complex process that requires proper awareness creation and education of both the forecasters and communities at risk of floods (GoK, 2009a).

1.5 FUTURE CLIMATE PROJECTIONS IN THE STUDY AREA

Climate change projections in the study area related to 2030 water resources show that the spatial distribution of rainfall will be almost unchanged compared with the present situation, but the northern part of both the Rift Valley and Ewaso Ng'iro North Catchment Area will be drier. As for the seasonal variation, more water resources will be expected in the rainy season and less water resources in the long dry season (June to August) in most of the country (GoK, 2012). The region extending from Lake Victoria to the Central highlands East of the Rift Valley will experience increases in annual rainfall (ICPAC, 2007). Therefore, if these projections are accurate, then there will be higher likelihood of increased intensity and frequency of floods in the region (Mango *et. al*., 2007; GoK, 2009). Based on a study by Immerzeel and Droogers, (2009) very significant increases in peak discharges are to be expected. It is further estimated that a flood that occurs once every 10 years will now occur once every two years by 2050; and a flood that occurs every 25 years will now occur once every two years by 2090. Both the flood extent and inundation depth are likely to increase (Immerzeel and Droogers, 2009). It is estimated that in 2050 a total area of 21335 ha will be inundated once every five years with an average inundation depth of 5.4 m.

Flooding is the greatest threat of climate change in the Bunyala plains. Flooding causes dyke breaks resulting in loss of infrastructure and displacement of thousands of people. Consequently, thousands of people living in the flood prone lowlands will be forced to move to higher ground and to adopt various coping and adaptation strategies to survive (GoK, 2009). While coping strategies, in particular, may be successful in the short term, they often have severe implications for longer-term livelihood sustainability when people are unable to recover from flood impacts. The resulting negative impacts due to inadequate and unsustainable coping mechanisms will worsen the poverty situation.

1.6 CHARACTERISTICS OF THE STUDY AREA: BUNYALA SUB-COUNTY

The study area is known as Bunyala Sub-county; formerly named Budalangi division of Bunyala District. The former Budalangi Division was made a district by the president of Kenya in 2007 and was named Bunyala District and retained the name until 2013. However, under the new Kenyan constitution promulgated in 2010 and after the first general election under the new constitution, the named was changed to Bunyala Sub-county and is now one of the seven sub-counties of Busia County. Bunyala Sub-county is the region in Kenya that has experienced the most intense floods in recent decades.

It is a low-lying area with a generally flat landscape that predisposes it to frequent flood events when river Nzoia overflows. The area's physical setting and increased runoff from degraded catchments are contributory factors to the recurrent flood hazards (GoK, 2009).

FIGURE 1: THREE DIMENSION DIAGRAM SHOWING TOPOGRAPHY

OF BUNYALA SUB-COUNTY

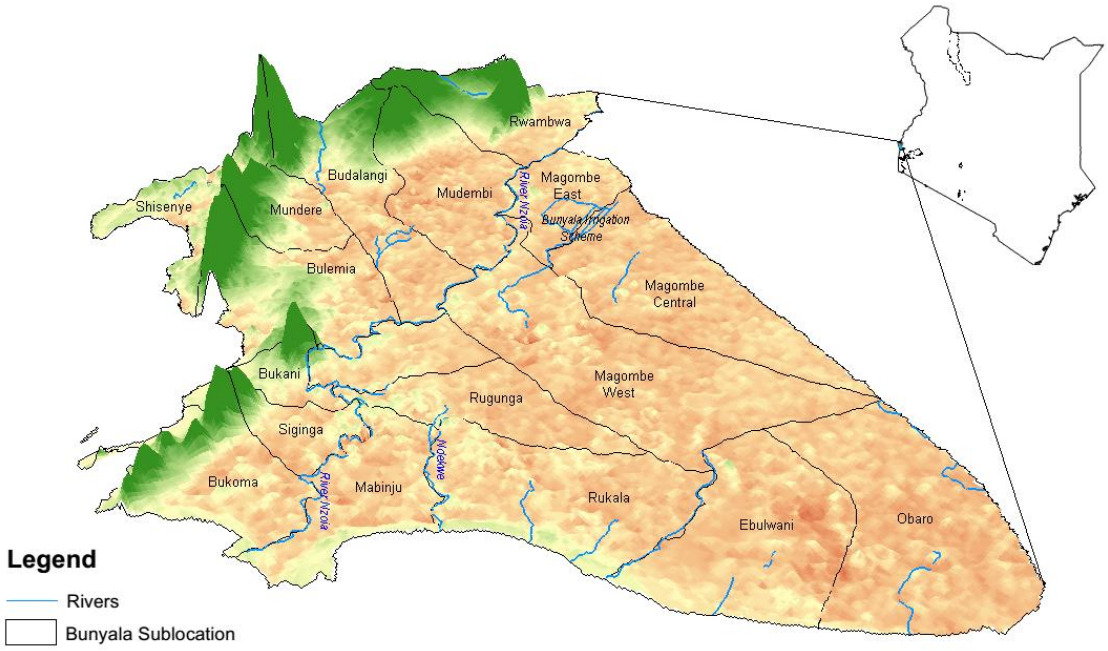
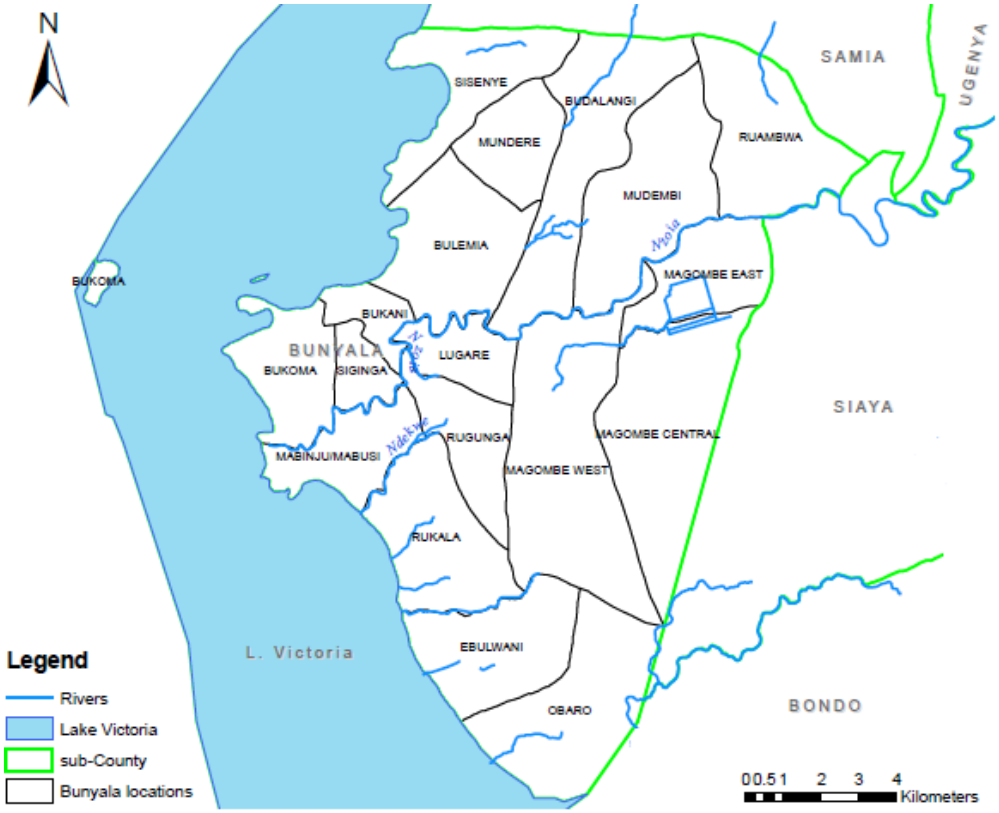


Diagram generated by Denis Masika using GIS

Bunyala Sub-county borders Samia to the North, Siaya to the East, Bondo to the South, and Lake Victoria to the West. It has six administrative locations: Bunyala Central, Khajula and Bunyala to the South of river Nzoia; and Bunyala East, Bunyala North and Bunyala West to the North side of river Nzoia. It has 18 sub-locations (Bunyala District Report, 2008). Data from the Kenya National Bureau of Statistics (KNBS) (2010) indicates the study area has an estimated population of 66,723, of which 31,718 are male and 35,005 are female, living in 15,245 households. In addition, it covers about 188.3 Km ^{2} and has a mean population density of 354 people per Km ^{2}. The data also indicate that the study area is inhabited predominantly by the Manyala, a sub-tribe of the Luhya, who practice subsistence farming, fishing, and non-farm activities such as petty trade (Bunyala District Report, 2008; KNBS, 2010). The study area has high levels of rural poverty, affecting approximately 46.5% of the population (KNBS, 2008).

FIGURE 2: LOCATION OF RIVER NZOIA IN BUNYALA SUB-COUNTY



The alluvial soils and annual rainfall of between 750 and 1,015 mm support small-scale agriculture as well as livestock keeping (Bunyala District Report, 2008). The area is a host to the Bunyala Irrigation Scheme, which cuts across the boundaries of Busia and Siaya counties and covers about 1,734 acres. The irrigation zone within Bunyala covers about 1,031 acres and is managed by the National Irrigation Board, which provides local farmers with water and other farm inputs for rice production. The irrigation scheme is intermittently affected by floods, which destroy paddies, stored rice, and irrigation infrastructure (GoK, 2009b; Opondo, 2013).

River Nzoia drains through the Bunyala plains into Lake Victoria and has a length of about 334 km, and a catchment area of about 12,900 km^2. It has a mean annual discharge of 1777 x 10^6 m^3/year. As its last 20 kilometers reach the mouth on the lake, the bed flattens to a slope of just 1-in-3400, and the river meanders through a wide flood plain. Here, the channel width increases to 70m and the height of the banks reduces considerably. This causes spilling of floodwaters over the banks and consequent flooding of large areas on either side (Nzoia River Basin Management Initiative (NRBMI), 2006).

The basin has the potential for growing a wide variety of crops and producing livestock, due to its good soil and gently sloping terrain. However, the high water table in the floodplain renders the area uninhabitable during much of the wet season. Population growth and pressure for land however, continues to push people to these flood-prone areas. The search for more agricultural land also spurs encroachment into Nzoia River wetlands. By settling in the flood plain areas, more people and households in Bunyala are at risk of flood hazards (Onywere et. al. 2011; Bunyala District Report, 2008).

1.7 OBJECTIVES OF THE STUDY

Vulnerable populations in developing countries suffer disproportionately from the adverse impacts of climate change, as their capacity to cope with extreme weather events and adapt to climate change is often limited. Today, there is increasing awareness in academic and policy circles that not all impacts of climate change can be addressed by mitigation and adaptation efforts by local people alone. The vulnerability of the households and communities at risk from floods is caused by a combination of physical factors, including exposure to floods, degree of protection from flood hazards, quality of infrastructure available, degree of access to resources, and ability or inability to avoid, withstand, or recover from the flood hazards. Socio-economic factors, such as acute poverty, high population density, lack of education, poor planning and management of agricultural and farm land, poor quality of agricultural inputs and technology and the absence of access to modern technological options to cope with the climate change and climate variability, increase the vulnerability of the population to floods. Occupation and livelihood activities also play a role. For example, fishermen, whose occupation requires them to live close to rivers and other water bodies, are more at risk than others and therefore, more vulnerable. Generally, communities also lack knowledge and access to adaptation measures that can help long-term resilience to floods (GoK, 2009).

In addition to climate change-exacerbated flood hazards described above, there is a complex interaction between social, economic, political, and environmental processes that impedes the capacity of households and communities to cope with and adapt to the impacts of floods. While a strategy for flood management in the study area must address the flood hazards themselves, it must also take into account other related national and local social, economic, and development policies. Flood prevention and mitigation efforts should be multi-dimensional and involve all stakeholders, but more particularly, the affected local communities, non-governmental organizations (NGOs), community-based organizations (CBOs), and public officials in government departments such as land, water, meteorology, fisheries, agriculture, and environment.

This study will therefore provide important information on how the respondents in the Bunyala Sub-county area perceive climate-related impacts, what adaptation and coping practices they undertake, what ITK exists and is applied, the gender dimensions of flood impacts, and the local institutional mechanisms that increase individual and community participation in decision-making.

This study seeks to help households, communities, and local level county authorities develop sustainable strategies for households to deal with the long term effects of floods due to climate change in Bunyala Sub-county, where 46.5% of individuals live below the poverty line (Kenya National Bureau of Statistics, 2008). This study also seeks to help relevant government departments, such as the Ministries of Land, Water, Agriculture, Fisheries, Environment, and Special Programmes, to design participatory policies and programs aimed at addressing the negative climate change impacts of perennial floods in Bunyala sub-County. Such policies will need to consider sustainability of livelihoods for poor and vulnerable households and communities.

The aim of this study is to contribute to strengthening Kenyan disaster risk-management policy and planning by increasing awareness of local and institutional practices in response to floods.

1.8 RESEARCH QUESTIONS

The research questions that guided this study are:

- How can indigenous traditional knowledge be integrated into interventions to enhance household and community resilience to flood impacts?
- What are the gender-related implications of floods?
- How do existing institutions help households and communities deal with flood risks?

1.9 ORGANIZATION OF THE REPORT

This report consists of five sections, excluding the executive summary: (1) introduction, (2) literature review, (3) research methodology, (4) study findings (parts 1 and 2) and (5) conclusions. The introduction comprises background information on the study area, including climate change impacts. The second section presents relevant literature exploring the three main topics covered by this study: indigenous traditional knowledge (ITK); Gender and Floods; and Institutions and Floods. Section three describes the research methodology while chapter four describes findings that answer the research questions. The final section discusses key findings, conclusions, and recommendations.

2.0 LITERATURE REVIEW

This chapter includes important information on the use of indigenous traditional knowledge for predicting and responding to floods, the gender-related implications of flood impacts, and the institutions that play a critical role in determining how communities and households respond to the impacts of extreme climate change-related floods.

2.1 INDIGENOUS TRADITIONAL KNOWLEDGE AND FLOODS

Indigenous traditional knowledge has been used historically by communities in Africa to deal with climate-related disasters such as floods and drought (Opere and Ogalo, 2006; UNEP, 2008). ITK is typically not universal within a community, but is rather confined to a few experts, such as elderly people, women, or 'progressive' farmers (McCally, 1995). The ITK on disaster prediction and early warning is based on keen observation of the behavior of animals, birds, insects, vegetation, trees, winds, air and water temperatures, and clouds. These are "home-grown" indicators within the communities (Opere and Ogalo, 2006; UNEP, 2008).

For example, the Nganyi Clan of Bunyore in western Kenya has a century-long history of predicting rains. Some of the practices they use include observing wind patterns, air temperatures, and clouds. Other practices involve observation of animal behavior, particularly that of birds and reptiles. In the Lake Victoria region, the arrival in large numbers of the common swallow (*Hirondo angolenss*) circling the sky is a sign of the onset of rains. The behavior of frogs (*Africana spp.*) and toads (*Bufo spp.*) indicate a change in seasons. The croaking of the amphibians indicates the onset of rains, while their absence signals the onset of a dry season (UNEP, 2008).

In many communities, elders, both male and female, traditionally have had the responsibility of predicting disasters and guiding individuals on the use of preventive and mitigating actions. For instance, elders in Kenya's communities in Rusinga, Mfangano, Kano, Budalang'i, Lamu, Kwale, and Makueni monitored the progression of hazards and gave advice, which governed the behavior of their communities (UNEP, 2008).

Indigenous traditional knowledge includes elements of preparedness for dealing with natural disasters (Opere and Ogalo, 2006). For instance, an assessment of ITK in Budalang'i community of western Kenya provides insights into some of the strategies for preparedness (UNEP, 2008). For example, homesteads had to have a dugout canoe for transport in case of heavy flooding; men dug trenches to control the water around homesteads and around farmland; and ploughing/cultivation was not permitted along the river banks and lake shore when heavy flooding was predicted.

To ensure food security during droughts and times of scarcity, ITK and "know-how" guided post-harvest processing, preservation, and storage of farm produce and other food products gathered from the wild. The role of elders, particularly in western Kenya, to advise and direct community members on the types of crops to plant, when to plant them, and where and how to plant, was crucial.

Below are further insights into some of the strategies espoused by elders and ITK experts:

- Land preparation should start in November-January when it is dry, based on observation winds and changes in fauna and flora;

- Harvesting maize, millet, beans, and peas should be done between July-August, when dry winds are experienced;
- After harvesting, cassava and sweet potatoes (which only need a little rain) should be planted for food reserve;
- Households should stockpile fuel wood for cooking and preserving food during the rainy season in April-August; and
- Households should catch and preserve fish by drying and smoking during the April-August rainy season (UNEP, 2008).
- Small-scale farmers in the Sahel conserve carbon in soils through ITK of zero tilling practices and cultivation. Similarly, agroforestry is effective in carbon sequestration, and agroforestry projects benefit from traditional knowledge of plants (Osunade, 1994; Nyong, *et. al.*, 2006).

In the area of adaptation to climate change, indigenous knowledge systems have been applied in weather forecasting, vulnerability assessments, and implementation of adaptation strategies. As was seen from the above example, the knowledge-base of farmers follows a specific language, belief system, and process, through which the local weather and climate is assessed, predicted, and interpreted (Kipkorir, *et al.*, 2011). Understanding the local people's perception of climate and the relevant ITK is critical for effective communication of scientific forecasts and the implementation of development/adaptation interventions in general.

ITK can add value to climate change studies in several ways. First, ITK creates a "moral economy" by identifying persons within a community's cultural context who provide decision-making processes to be followed based on observed indicators or relationships within climatic and environmental events (Adugna, 1996; Woodley, 1991). Second, ITK improves local level acceptance of scientific methods, as much indigenous knowledge that was once regarded as primitive and misguided is now seen as appropriate and sophisticated. Finally, ITK provides mechanisms for participatory approaches—a major requirement for the success and sustainability of any community intervention.

However, in contemporary society, the use of ITK faces many challenges. In particular, there is a lack of recognition of the need for indigenous knowledge in climate change mitigation and adaptation strategies. There is also a lack of understanding concerning how to integrate ITK into western scientific techniques.

At the same time, indigenous practices should not be seen as substitutes for modern techniques. Rather, the two should complement each other in order to produce "best practices" for mitigation and adaptation options. The interaction between these two different systems of knowledge can further create a mechanism of dialogue between local populations and climate change professionals, which can meaningfully contribute to the design of projects that reflect people's real aspirations aswell as actively involve communities (Nyong, *et. al.*, 2006).

2.2 GENDER AND FLOODS

Studies show that the impacts of flooding affect women more than men. For example, Hussein and Husain (2006) observed that women are disproportionately affected by floods as a result of economic and social dislocation of households, as they often have to cope with social and emotional upheavals resulting from flood effects, including death, disease, and food shortages, in the absence of men.

According to Brody, *et. al.,* (2008), in rural areas, women generally assume the primary responsibility for the subsistence of their families. However, women are often engage in unpaid work and are excluded from household decision-making. Girls are expected to help their mothers with household tasks and with caring for younger siblings. As a result, heavy rains and frequent floods (resulting from climate

change) increase women's workloads, because they have to spend more time looking for food, collecting water, and cleaning and maintaining their houses after flooding. All these leave women more vulnerable to changes due to external phenomena, including climate change. Furthermore, women are sometimes left alone in rural communities during flooding, while their husbands or male household heads work in urban areas or outside the community. This means that women are left to deal with the impacts of floods without support, causing an even greater burden. Hussein and Husain (2006) argue that sustainable flood mitigation can succeed only with the involvement of local communities and disaggregation of the specific roles of men and women in flood protection and mitigation strategies.

As they are often among the most vulnerable group in a community, women bear most of the burden of climate change impacts. Otiende (2009) attributed this to the lack of inclusion/involvement of women in decision-making processes and in flood risk reduction planning and implementation of activities. In addition, the patriarchal system of the communities in Bunyala means that decision making on matters that affect the community, like flood risk management, is mostly vested in elders, who are often older men in the community (Onywere, *et. al.*, 2011). Finally, women are faced with unique challenges such as limited access to resources (e.g., land, livestock, tools, and credit), lack of access to information, limited mobility, and limited roles in decision-making (Ngenwi, *et. al.*, 2011).

Adaptation initiatives that do not take gender aspects into consideration could unintentionally replicate or even perpetuate gender inequalities (Hussein and Husain, 2006). In the Bunyala Sub-county, for example, dykes have frequently been used as a mechanism to control flood waters. However, the unintended impacts of such measures on women have not been comprehensively assessed. It is therefore necessary to understand how such measures impact women, for example, how increased distances to fresh water sources affect productivity and the lives of women.

Otiende (2009) argues that the participation of women and other disadvantaged groups in the community in decision-making processes, including flood risk-reduction measures, is a critical part of ensuring the effectiveness of the strategies. The study suggests that public education and awareness campaigns should target women as key stakeholders in flood risk reduction measures. Community education programs on awareness and behavioral change have the potential to reduce human vulnerability to floods through understanding the nature of flood risks and how to minimize individual and household risk.

The UNDP (2012) emphasized that effective gender mainstreaming starts with a comprehensive analysis of the effects of climate change from both men's and women's perspectives. This helps ensure disaggregation of qualitative and quantitative data by sex, and encourages stocktaking and incorporating women's perspectives in project design and implementation. Additionally, the UNDP notes that it is important that women are adequately represented at all levels in the decision making process and that gender differences in capabilities to cope with climate change are addressed.

2.3 INSTITUTIONS AND FLOODS

Institutions play a critical role in determining how communities and households respond to the impacts of climate change. According to Argawal *et al.* (2008) the activities of local institutions influence the impact of external interventions in shaping adaptation and improving the capacities of the most vulnerable social groups. This is fundamental to the success of adaptation programs. Similarly, national institutions are important as they provide the policy framework within which local institutions operate. The national institutions are instrumental in mobilizing capacity to intervene when extreme climate related events occur. Coordination between national and local level institutions is critical in this respect. Warner and Zakelideen (2012) argue that many studies show that strong collaboration between national and local institutions is crucial in disaster management, especially with regard to communication and disaster preparedness.

In Kenya, the new constitutional dispensation has introduced a two-tier government--national and county level governments. This will influence the institutional environment with regard to climate change impacts. The county governments will play a crucial role in dealing with challenges to development, poverty, resource mobilization, policy formulation, and implementation (GoK, 2013). They will be responsible for responding to the challenges of climate change and to its impacts on local level development and local community livelihoods.

Local public institutions include local government and higher level government offices operating at local levels. Local civil society institutions include rural producer organizations, cooperatives, and savings and loan groups, among others. Private institutions include service organizations such as NGOs and charities, and private businesses that provide insurance or loans (Argawal, *et. al.,* 2008). These local institutions shape the effects of climate hazards in three important ways: they influence how households are affected by climate change impacts; they shape the ability of the households to respond to climate impacts and pursue different adaptation practices; and they mediate the flow of external interventions in the context of adaptation (Argawal, *et. al.,* 2008).

However, institutional interventions need to be cognizant of local circumstances. Socio-economic and cultural perspectives are best captured when local communities and households are fully engaged in decision making. Inadequate and incoherent external support and inappropriate government policies limit the livelihoods outcomes and resilience of vulnerable households (Argawal, *et. al.,* 2008).

The experience in Bunyala appears to indicate weak institutional coordination that has failed to inspire appropriate adaptation responses to the perennial problem of flooding. Onywere, *et. al.,* (2011) noted that dysfunctional investments by the government in agriculture in the area—for example, the Bunyala Rice Irrigation Scheme (initiated in 1972)—is a clear manifestation of how inadequate institutional arrangements results in maladaptation, or inappropriate responses, to the impacts of climate change. The scheme was intended to provide employment opportunities, provide parcels of land where households could grow crops, and enable them to access markets for their produce. While Onywere, *et. al.* (2011) cites this as an illustration of weak institutional coordination, myriad factors may indeed be responsible for the failure of the scheme. In addition, no studies have been conducted on how local institutions access knowledge and information, capital and markets, and how these factors have influenced responses to the perennial floods in the study area.

3.0 RESEARCH METHODOLOGY

The research methodology consisted of a mixed method approach which entailed a combination of a quantitative method (household survey) and qualitative methods (focus group discussions and key informant interviews). The qualitative methods yielded narratives (in quotes and story boxes) about peoples' perceptions of flood impacts, while the quantitative method attempted to measure use and perception of coping and adaptation practices, ITK, gender dimensions and institutional dynamics in the study area.

3.1 HOUSEHOLD SURVEY METHODOLOGY

The study area of Bunyala sub-County has about 15,245 households in six locations that are further divided into eighteen sub-locations, as indicated in Table 1. Stratified random sampling was used to select the required number of respondents. The stratification was based on the populations of 18 sub-locations (KNBS, 2010). A total of 418 households were randomly selected and sampled from the selected sub-locations. There was provision of 18 households that were specifically set aside in case some of the households refused to participate in the household survey; however all households agreed to participate. The sample size of 418 provides a 5% margin of error at 96% confidence level. Within the sub locations, households were randomly selected using spatial randomization tools in a geographic information system. The required sample was calculated using a formula by Watson (2010).

ADMINISTRATIVE ZONES IN STUDY AREA:

SUB-COUNTY: BUNYALA

Locations (each headed by chief): Bunyala West, Bunyala North, Bunyala East, Bunyala Central, Khajula, and Bunyala South

Sub-locations (each headed by assistant chiefs): Bukani, Siginga, Bukoma, Bulemia, Mundere, Sisenye, Budalangi, Mudembi, Rwabwa, Magombe W, Magombe E, Mabinju, Mabusi, Lugare, Rugunga, Magombe C, Rukala, Ebulwani, and Obaro.

In Kenya, the smallest administrative zones are named "locations," followed by smaller "sub-locations." The location is headed by a chief, and the sub-locations are headed by assistant chiefs. In Kenya, what are known as "locations" are held within Sub-counties.

Bunyala is the Sub-county of this study and the six locations for the study are: Bunyala West, Bunyala North, Bunyala East, Bunyala Central, Khajula, and Bunyala South. Each of the above locations consists of three sub-locations. Each sub-location was surveyed. Please refer to Table 1 below for details of sample size within each location and sub-location. Households in these sub-locations are under the jurisdiction of an assistant chief who works with several village elders (locally called *Liguru*). A standard technique of random sampling was used to select the households, having the *Liguru* generate lists of households in their specific area. The lists were entered into an Excel program and random numbers applied to select the predetermined numbers of households. Questionnaires were administered to the households identified through this process.

TABLE 1: THE SELECTED LOCATION, SUB-LOCATIONS, AND SAMPLE SIZE WITHIN BUNYALA SUB-COUNTY

Selected Sampling in Bunyala Sub-County		
Locations	**Sub-Locations**	**Sample size**
Bunyala West		**103**
	Bukani	50
	Siginga	22
	Bukoma	31
Bunyala North		52
	Bulemia	43
	Mundere	9
	Sisenye	0
Bunyala East		**97**
	Budalangi	37
	Mudembi	27
	Rwabwa	33
Bunyala Central		**72**
	Magombe W	31
	Magombe E	18
	Magombe C	23
Khajula		**51**
	Mabinju Mabusi	22
	Lugare	15
	Rugunga	14
Bunyala South	Rukala	**43**
	Ebulwani	20
	Obaro	8
		15
	Total	**418**

3.2 HOUSEHOLD QUESTIONNAIRE

The household questionnaire consisted of four sections that had both closed and open-ended questions. The closed-ended questions aimed to prompt responses within a given range of choices to enhance standardization, while the open-ended questions were used to capture people's views and perceptions. The first part included the preliminary section, which dealt with consent and record information. The second section dealt with household livelihood activities, assets, and food security. The third section focused on flood impacts, and coping and adaptation practices. The fourth section explored the three main study themes: indigenous traditional knowledge, gender and floods, and institutions and floods.

3.3 PRE-TEST AND TRAINING

Prior to initiating the field work, both enumerators and supervisors were trained on their duties and roles. A two day training workshop was conducted for the enumerators and field supervisors. The training schedule had sessions on gender dimensions, questionnaire administration, and practical use of handheld global positioning system (GPS) receivers.

The process of quality control began with piloting (pre-testing) of the research instruments. The pilot study was carried out on August 21, 2013, at Lugare A and Lugare B villages in Lugare sub-location. The objective was to assess the adequacy of the household questionnaire tool, and sampling and data collection procedures. The pilot study (or pre-test) was used to identify errors and omissions, and to familiarize the enumerators and supervisors with the process and tools. Prior to the piloting exercise, the Principal Investigator (PI), Co- Principal Investigator (Co-PI) and one consultant (trainer on household survey administration and GPS receivers) recapped the training sessions and emphasized the importance of accurately recording responses.

3.3 FIELD WORK AND QUALITY CONTROL

The research team spent 19 days in the field between September 11, 2013, and October 4, 2013. During parts of October and November, the PI and two consultants, Denis Masika and Cyrilla Luvega, were involved in data collection using Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs).

During field data collection, the data collection team was divided into two groups. Each group was headed by a supervisor. The PI and Co-PI visited the study sites to observe how the enumerators administered questionnaires and the supervisors performed their tasks. The data collection team reported their observations and experiences during end-of-day feedback sessions. This information included discussion of any errors made during questionnaire administration and the time required for the administration of each questionnaire. The pilot data was entered into an SPSS pre-coded screen. Preliminary data analysis was carried out and the results indicated that the quality of data collected was good. The issues highlighted above and the results of the pilot study were used to modify the household survey tool, which was then submitted to ARCC for approval before commencement of full-scale data collection.

The process described above was used during full-scale data collection. During this exercise, measures to ensure quality control included the following: all the questionnaires had serial numbers and the supervisors kept daily records of the questionnaires issued to the enumerators each day, including records of the completed and incomplete tools. This allowed room for follow-up visits to households in case mistakes were noted. The supervisors then went through all the questionnaires before handing them to the technical team, who went to the field to collect them every week until the work was completed.

Anonymity was ensured in data collection, data entry, and analysis. Information on the identity of individuals was not included in the household survey data set. The household survey questionnaire included an introduction that clarified consent and confidentiality. The enumerators were under instruction to inform respondents that participation in the study was optional, and only those willing to participate were engaged. Any respondent not keen to participate was allowed to opt out. In such cases, the enumerators immediately terminated the interview, thanked the individual, and proceeded to the next household. Similarly, FGD and KII respondents were assured that only anonymous data would be used in the research report.

The enumerators did not encounter any refusals by households to participate in the household survey. However, in a few cases, the enumerators had to make call-backs to households. When they found no one at home, the enumerators marked the particular questionnaire and notified the supervisors. The supervisors then ensured that the households concerned were visited at a later date and time so that the required number of questionnaires was attained.

3.3 FOCUS GROUP DISCUSSIONS

The FGD method of data collection was used to pose questions to a group of individuals selected for this specific purpose. A total of seven FGDs with 65 participants were conducted. Some of the participants were identified based on the observations of the enumerators and supervisors, while others were identified in consultation with village elders, chiefs, and their assistants. As indicated in Figure 2 (study area), River Nzoia split the study area into two zones—the North and South. Three FGDs were conducted on the Southern side; two with women and men and the third with a mixed group of male and female youth. Three similar types of FGDs were also conducted on the Northern side. The exception was the fourth FGD conducted with a mixed group of male and female ITK experts on the Northern side. However, the participants were drawn from both sides of River Nzoia and were identified from the membership of an informal association of community elders in the study area. On the whole, the various categories of participants in FGDs were purposively selected based on their different roles and experiences with floods and weather-related events.

The research team took no direct role in the discussion, but presented topics and moderated the discussion, helping prompt participants to state their views and draw out the views of all group members. Each FGD had between seven and twelve participants.

3.4 KEY INFORMANT INTERVIEWS

The key informant interview (KII) method was used for more in-depth data collection from community members, and in particular, institutional representatives, who had diverse experiences with floods. The aim was to obtain information that would not easily be obtained from the other data collection methods. The KIIs were conducted with selected community members based on their experience in the subject matter and experts from selected organizations. The community respondents were identified based on the recommendations of the fieldwork research supervisors. The government and NGO officials were identified based on the work of their respective institutions in relation to floods in the study area. This method was used to obtain information from respondents who, by virtue of their positions, were deemed to have specific information on community coping and adaptation strategies, flood impacts and operations of the local county government.

A total of 11 key informant interviews were conducted with the following individuals: two KIIs with community elders (one male and one female); two KIIs with youth (one male and one female); six KIIs with government officials from the Ministries of Agriculture, Livestock, Public Health; National Irrigation Board, Water Resources Management Authority and Bulala FM (community radio), WKCDD-FM; and one KII with an NGO official from Busia Community Development Organization (BUCODEV).

3.5 RESEARCH CHALLENGES

The pre-test revealed errors and omissions in the instrument, uncertainty on the definitions of some terminologies, and time-related challenges inherent in both conducing the interviews and using the GPS units. Fortunately, discovering these issues during the pre-test allowed them to be resolved satisfactorily prior to initiating the field collection.

One enumerator resigned to go to college after the pilot study. Fortunately, another enumerator from the pool of those already interviewed for the position was still available to take her place. This individual was quickly trained and assisted by a supervisor during the initial days of data collection.

With 82 questions on 10 pages, the household survey tool was long. In some cases, this resulted in impatience from respondents. The enumerators sometimes sped up the administration of the survey. On the South side of River Nzoia in Magombe East, Magombe West, and Magombe Central (Bunyala

Central) the enumerators found that respondents could only be reached after 11 AM. Most respondents were farmers and their farms were located far away from the homesteads, where the survey was being administered. In these cases, enumerators made several call-backs to administer the questionnaire. The challenges described in this paragraph contributed to delays in completion of the field work.

Several enumerators observed issues with cooperation—respondents claimed that much other research work had taken place with little or no feedback provided to the locals. This concern was noted and they were assured that some selected households and other relevant stakeholders would be invited to a community dissemination workshop before the end of the project. A two-day dissemination took place in February 2014. Participants were also informed that both the county and national governments were aware of the study.

Some households were located in inaccessible and swampy areas, particularly those in Bukhuma, Maduwa, and Iyanga in Obaro, and in the Ebulwani sub-locations of Bunyala South. To reach the households in these places, the supervisors and enumerators had to wade in water and take boat rides. The research team was provided with gumboots and other necessary equipment for safety.

Finally, a few respondents especially, the aged, could not identify the specific organizations (public or private) or distinguish between NGOs/CBOs and government agencies involved in flood-related activities. To deal with this, enumerators were trained on how to ask questions in order to get the most accurate responses.

3.6 DATA ANALYSIS

Data Entry and Validity Checking

For the household survey, data entry was done using the Statistical Package for Social Science (SPSS) software and pre-coded screens. Data cleaning was carried out simultaneously as the data collection progressed. Data entry clerks entered the initial data and the co-investigator and two consultants ran quick statistical checks for consistency. This quick checking of the validity of the data collected enabled the data collection teams to rapidly conduct repeat surveys and promote accuracy of data.

Qualitative data was collected through FGDs and KIIs. Thus the data was in the form of notes only for KIIs, but data from FGDs included both notes and voice recordings. The voice recordings of all the group discussions were transcribed for consistency and validity of information.

Data Cleaning and Analysis

Data cleaning and analysis of the household survey data was conducted by a team of data experts under the guidance of the PI and Co-PI. Data were first coded for ease of pattern recognition, then analyzed to generate the information required for the key research objectives. Information on closed-ended questions was analyzed while open-ended questions were coded and then analyzed. Continuous data were grouped for ease of analysis. Frequency analysis and cross tabulations were carried out in SPSS. The statistics generated were frequencies and percentages of respondents and responses (cases) in regard to multiple options. The result of the analysis was presented in the form of graphs and tables.

The FGD method was used to obtain qualitative data. The perceptions of participants on various questions were recorded by note takers during group discussions. Digital voice recording was used to provide back-up data. The FGD notes were read by the PI and Co-PI to glean relevant information. In addition, two consultants were hired to transcribe the voice recordings of all the seven FGDs. The

transcriptions provided back up for field notes and were then used to provide information for the research report.

4.0 RESEARCH FINDINGS PART 1

This chapter describes the survey results on household and community experiences and perceptions on climate change impacts due to floods, and expectations on policy in Bunyala, Western Kenya. It is organized into five sections: the first section describes the general characteristics of the respondents; the second section details the household livelihood activities and demonstrates household vulnerability to floods--particularly in terms of food insecurity. The third section presents findings on crop production and food shortages. the use of indigenous traditional knowledge practices as a means to cope with floods; the fourth section describes findings on the perceptions of flooding in Bunyala; the fifth section details coping and adaptation measures used. The following chapter, "5.0 Research Findings Part 2" discusses the uses of ITK with regards to floods, the impacts of floods on men and women; and the findings on the current institutional response to floods in Bunyala.

4.1 CHARACTERISTICS OF RESPONDENTS

Age, Gender and Religion

The ages of respondents were divided into seven categories, with the youngest category being 18 to 30 years and the oldest category being individuals above 80 years old. The majority of respondents were in the 51 to 60 years of age category, followed by 18% of respondents who were in the youngest category. Only 4% (15) of the respondents were above 80 years old. Most respondents were female (62%, 261), partially because, in many cases, men were engaged in work away from home, while in some cases some households were women-headed households. Christianity was reported as the main religion by 99% (417) of respondents, with several Christian denominations in the study area.

Marital Status

About half of the respondents 51% (214) reported that they were in monogamous unions. A sizeable number were widowed (26%, 110), while a smaller number reported to be in polygamous marriages (15%,61). (See Table 2). The remaining respondents were either single or separated/divorced.

TABLE 2: MARITAL STATUS

Marital status	Number of Respondents	Percent
Single	21	5
Monogamous	214	51
Polygamous	61	15
Widowed	110	26
Separated/divorced	11	3
Total	**418**	**100**

Education

Most respondents generally had low levels of educational attainment; only about half reported having had some form of formal education. Of those receiving formal education, the majority reported having only received a primary education. Although those receiving no formal education were significant, they were for the most part still literate.

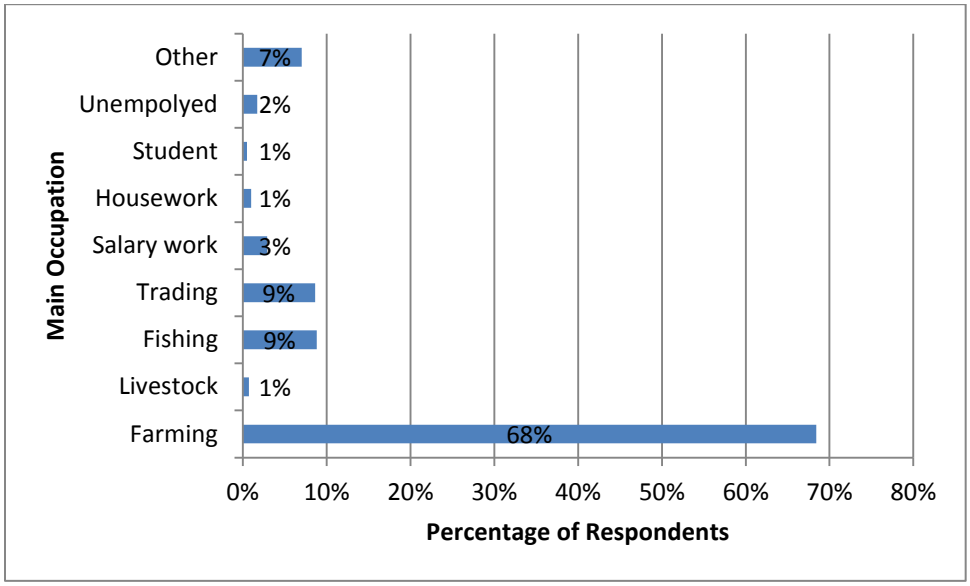
Land Use and Housing

In Bunyala, most households (94%, 394) own the land on which they live. The land use activities reported by respondents included construction of homesteads, crop production, grazing for livestock, renting it out to other users, and fallowing.

Similarly, almost all of the respondents 97% (405) reported owning the houses in which they live. The vast majority of houses in Bunyala are built with iron sheet roofs and earth/cement walls and floors. These materials make these households highly susceptible to flooding, as they are damaged and destroyed easily. A very small number of houses had walls made of stone blocks, or sun-dried and baked bricks, which build more permanent structures that can endure flooding more easily. The type of dwelling units is a good indicator of the socio-economic status of respondents, indicating that the majority of respondents were resource poor. Most respondents (90%, 375) reported that their houses do not have electricity; only a small number of households (9%, 37) reported having electricity. The common sanitary facilities in the area are pit latrines. Households without pit latrines use the bushes.

4. 2 LIVELIHOODS

FIGURE 3: MAIN OCCUPATIONS



Farming/Crop Production

Seven out of ten respondents engage in farming. Of all female respondents, 75% engage in farming. Of all male respondents, 53% engage in farming. Farming was the dominant primary occupation of respondents, with 68% reporting it as such. All other occupations were practiced by much smaller numbers of respondents, as can be seen in Figure 2.

In an open-ended question, respondents were asked to list the main crops cultivated. (Respondents were allowed to list more than one crop, which is why the percentages exceed 100 percent.) During data analysis, the crops mentioned were organized into the following categories: cereals, legumes, root crops, vegetables, and sugarcane. Multiple responses show that cereals, particularly maize, dominate (94%, 359), followed by beans (79%, 302), sorghum (35% 133), millet (24%, 91); root crops, (15%, 54) and vegetables (6%, 24). The root crops consisted of sweet potatoes (8%, 28) and cassava (7%, 26). The main vegetables planted were kale (4%, 16), tomatoes (1.3%, 5), and cabbage (0.8%, 3).

Livestock

Livestock keeping is a livelihood activity practiced alongside crop production. Most respondents (80%, 336) reported owning livestock. The main livestock breeds include cattle, goats, sheep, pigs, and poultry. Almost half of the respondents who own livestock indicated the main purpose as home consumption. Around one third of respondents indicated sale as the main reason for livestock keeping. This would explain why, despite 80% of households keeping livestock, only 1% of respondents reported it as their main occupation.

Fishing

Fishing was identified as another source of income. Some 40% (169) respondents reported that they, or members of their households, engage in fishing and related activities. Fishing is concentrated among the younger age groups with over 60% of fisher folk falling between the ages of 18 to 50 years.

Off-farm Activities

More than half of respondents (63%, 264) reported that they, or members of their households, derive some income from non-farm activities, while about one third (36%, 152) did not obtain income from non-farm activities. White and blue collar jobs were the main non-farm (off-farm) activities reported by respondents. Some respondents (3%, 12) reported participation in salaried work, for example, as teachers, laboratory technicians, and assistant chiefs. A small number of respondents (1%, 5) reported engagement in blue collar jobs including carpentry, driving public service vehicles, sand harvesting, and cobbling.

4.3 CROP PRODUCTION AND FOOD SHORTAGES

Most households (89%, 365) indicated that there were months during which they experienced food shortages. The survey results further showed that majority of respondents (90%,244) whose main occupation is farming are affected by food shortages. The most affected age groups are 51-60 (19%, 52); 41-50 (16%, 44); 61-70 (15%, (40) which are also the most active in farming as an occupation. A majority (89%) of the fisher folk also reported that they have experienced months of food shortages.

The respondents (65%, 220) attributed the main cause of food shortage to floods. The respondents also identified drought, lack of money to buy food, poor harvests, sickness or ill health, infertile soils, small agricultural land sizes, change in rainfall patterns, and wild animals/pests as other factors that contribute to food shortages.

Generally, farming is the major socio-economic activity for the residents of Bunyala. However, the main purpose of crop production was found to be household consumption. About 84% of crop yields were reported as being for household consumption. Very little, approximately 11%, was reported to be sold. The staple food eaten during most meals was a maize meal (locally called *ugali*) – which is eaten with a variety of sauces and vegetables. Traditional vegetables are usually grown by women in their private gardens and are used for household consumption.

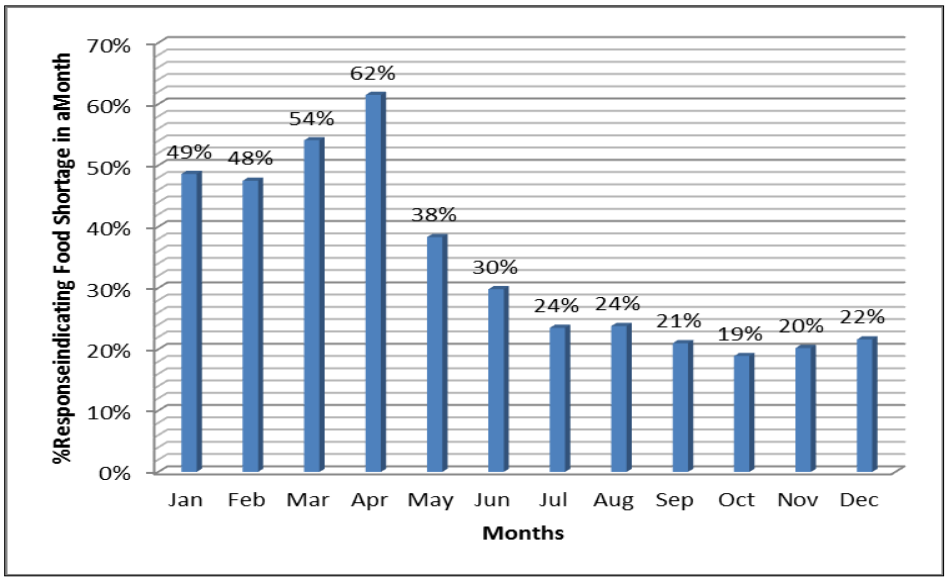
Additionally, during one KII with the Ministry of Agriculture the informant attributed food shortages to annual floods since 2008 in which farmers lose up to 60% of their crops and produce. More so, waterlogging after floods leads to further loss of crops and consequently, "the diminished resource base by recurrent loss of crops and land lead to loss of morale-people give up because why farm when one cannot harvest anything" (KII from Ministry of Agriculture).

With regard to crop production, respondents were asked about their perceptions of the decrease or increase in productivity over the last five years. A majority of respondents (62%, 259) involved in farming stated that crop productivity has decreased "a lot" mainly due to floods associated with too much rainfall and drought from low and unreliable rainfall (resulting from aridity caused by proximity to Lake Victoria); while for 28% (117) respondents, crop productivity decreased "a little." In comparison a small number (3%,12) respondents indicated that there was a small increase in crop productivity.

The link between crop production and food shortage was made by one key informant who stated that, at the beginning of the year, planting begins in the middle of February to March, weeding is in April, and harvesting of beans starts in early May when flooding does not occur. It takes about three months from

planting to harvesting. Ideally, the crop is harvested before the ideal time to avoid flood damage and supplement the diminishing food stock. As such, farmers were harvesting some crops earlier that they would have liked, in order to at least guarantee some harvest. However, food shortages may be experienced between the months of January to April due to the floods that happen regularly in the months of November or December (Figure 4).

FIGURE 4: PERCEPTIONS OF MONTHLY FOOD SHORTAGE



4.4 FLOODING IN BUNYALA

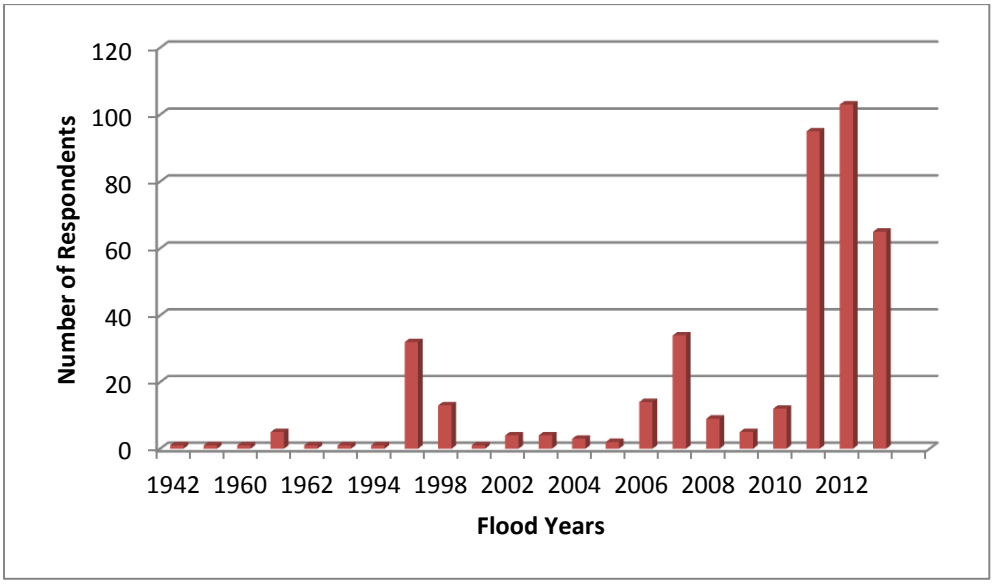
Household Perceptions of Flooding in Bunyala

Generally, when floods occur in Bunyala, the first alarm is usually raised by the people living near the river and dykes as they observe the rapid increase in the volume of water in the river channel or within the expanse between the northern and southern dykes. The alarm consists of ululations (shouts/screams called "*chinduru*" to convey danger from floods) by women and by men from the point of danger to other homesteads and villages in the area. Usually, there are no false alarms as floods are a matter of life and death not to be joked with. Available information shows no false alarm. Forewarned households move to gather children, livestock and household property in preparation for relocation to higher areas. The zone between the northern and southern dykes in Bunyala may be flooded without water overtopping into the adjacent floodplains. However, the dykes themselves are still considered as a viable option for temporary relocation because their height provides room for construction of temporary shelter and also allows movement of people and animals to move outside flooded areas. As events unfold, local government systems made up of the sub-ounty commissioner, chiefs and village elders liaise with other government officials to identify areas in which camps should be set up to accommodate households displaced by floods.

Since 2006, the patterns of floods have reflected the annual occurrence of severe floods. When asked about their perceptions of the most recent and severe flood, many respondents 25% (103) identified the

flood of December 2012 as the most destructive, followed by 23% (95) and 16% (65) who mentioned the floods of 2011 and 2013, respectively (Figure: 5).

FIGURE 5: YEARS OF REPORTED RECENT AND SEVERE FLOODS



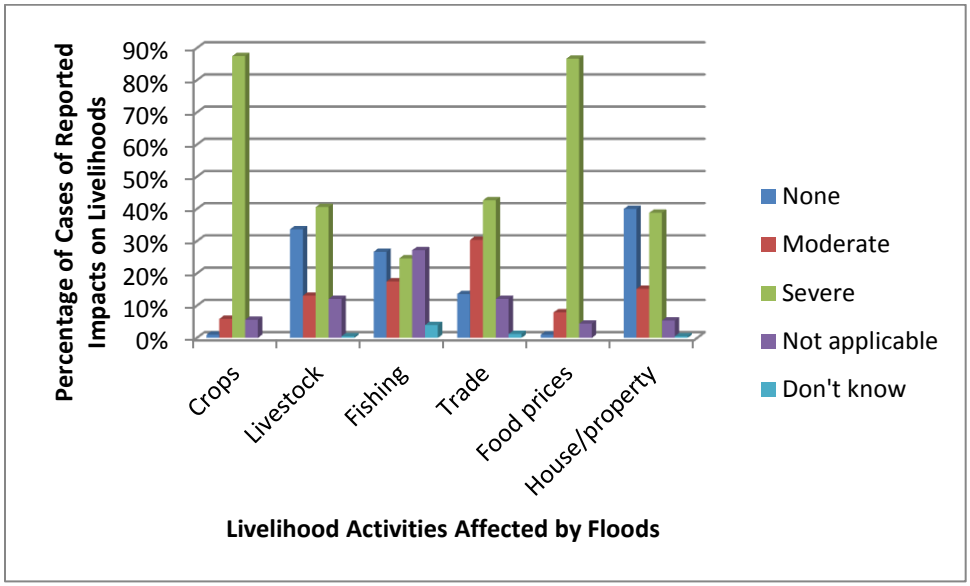
With regard to flood impacts, most respondents 92% (385) reported adverse flood impacts on their households. The response on the degree of flood impacts varied from severe 51% (213) to very severe 30% (126) to not severe 7% (29). A small number of households 7% (30) reported being unaffected by floods. Comments from the FGD with youth on the Southern side of River Nzoia shed light on the unaffected or less affected households.

Participants were unanimous that unaffected households were:

- Economically well-off;
- Their children went to school wearing shoes;
- Live in permanent houses (made of brick, stone or sand blocks with iron sheet or tiled roofs);
- Those whose homesteads are located on raised grounds (untouched by flood waters); and
- Those who own boats/ canoes (it costs about Ksh 50,000: USD 588 to build one)

The extent of flood impacts on livelihoods is presented in Figure 6.

FIGURE 6: FLOOD IMPACTS ON LIVELIHOOD ACTIVITIES



Flooding Frequency

In order to identify coping and adaption measures used to deal with flood impacts, respondents were first asked whether they had experienced changes in the frequency and intensity of floods. Most respondents 94% (39) recognized such changes. For example, one ITK expert stated that historically, floods occurred every five years but today, flood events are more frequent. In the period between 1938 and 1952, floods occurred but people were never displaced from their homesteads. The most severe floods in Bunyala occurred in 1961/1962 and led to the construction of the existing dykes. From that time until now, floods have become more frequent, occurring twice a year during the long and short rains (long rains season is between April and June while short rains are expected between September and November).

Vulnerability to Floods

The respondents were also asked about their perceptions on their current vulnerability to floods compared to previous years. A majority 63% (263) observed that they were now better able to cope, some 17% (71) reported about the same ability to cope, while others 17% (71), reported being less able and only 2% (8) reported having no difference in their capabilities to deal with floods. As mentioned above, participants in the FGDs were also emphatic about some of the reasons as to why some households were better able to cope versus others.

IMAGE 2: SUBMERGED HOMESTEAD IN IGIGO VILLAGE, BUDALANGI SUB-LOCATION, DECEMBER, 2008.

Credit: BUCODEV

Some of the reported characteristic of households that were able to cope were:

- Those with farms in flood prone areas where crops will be destroyed
- Those whose homesteads are located in flood prone areas
- Those who move temporarily to camps during floods
- Those who are illiterate and uninformed (for example households which use mosquito nets to fence off kitchen gardens against chicken reared under free range method rather than for use at night as protection against mosquitoes).

Flood Assistance

The respondents were asked about the assistance they received to deal with flood impacts. Most 74% (310) reported that they did not receive assistance from other people. However, some 26% (107) relied on assistance from other people. Of the latter group, assistance took the form of money 34% (33), shelter 30% (33), and materials 20% (22), and food items (one, 1%). In addition, many respondents 65% (271) received assistance from organizations. A significant number 30% (125) reported that they did not benefit from organizations. The main organizations that provide assistance during flood events were identified as NGO/CBOs 41% (236), government agencies and departments 38% (219), and religious organizations 20% (115).

The findings on floods in Bunyala in relation to household perceptions on increased intensity and frequency of floods, the reasons for vulnerability, and assistance provided to residents by other people and institutions indicated are indicative of the coping and adaptation practices to deal with flood impacts.

4.5 COPING AND ADAPTATION MEASURES

Generally, in dealing with vulnerability issues, reference is often made to coping and adaptation. The two terms appear similar but mean different things. Warner, *et. al.,* (2007) defines coping as short-term actions to respond to immediate risk, rather than adjustment to permanent threats. While the UNFCCC (2007) defines adaptation as processes by which communities or societies make themselves better able to deal with uncertain features on more long-term basis. In general, coping strategies, while addressing short-term situations, are less likely to be sustainable than adaptation strategies, which are longer term strategies.

Coping vs. Adaptation:

Coping: Short-term actions to respond to immediate risk, rather than adjustment to permanent threats. Coping strategies more often than not have long-term negative effects.

Adaptation: processes by which communities or societies make themselves better able to deal with uncertain features on more long-term Adaptation strategies have long-term positive effects.

Coping and Adaptation Practices

As discussed above, some respondents reported receiving assistance from public and private organizations in order to cope with flood impacts. Besides this coping mechanism, respondents also identified other coping and adaptation measures. Coping versus adaptation strategies that were adopted are listed below. They reflect a combination of information obtained from the household surveys, FGDs and KIIS.

Women reported adopted the following coping strategies to deal with the impacts of floods:

- Engaging in manual labor such as at construction sites and weeding other peoples' farms;
- Engaging in petty trade (retail buying and selling of food and non-food items such as cereals, tea leaves, sugar, salt, cooking fat and second hand clothes);
- Engaging in activities to earn extra income, such as manual labor and petty trade, were reported by 59 percent (211) of household survey respondents;
- Migration, defined as temporary relocation, to camps and to the homes of relatives and neighbors (29%, 104) living in safer areas;
- Spending less money on household requirements 22% (78) such as spending less money on food due to relief rations received from public and private organizations;
- Rationing of food by reducing the quantity and number of meals for both children and adults;
- Sale of household assets (5%, 17) such as mobile phones;
- Withdrawing children from school to help with domestic chores (in any case during flood events schools remain closed) and income-earning activities such as fishing in flood waters; and
- As previously discussed, the reliance on assistance from public and private organizations was also part of the short-term coping strategies of households.

The adaptation strategies highlighted in the FGDs and KIIs included:

- Planting trees around homesteads which helped with keep out water to protect houses;

- Construction of houses with raised foundations, preventing damage to household and household goods and decreasing chances of relocation;
- Purchase of land on higher grounds or, if do not own land, migration to land on higher grounds but this option was viable only for economically well-off households;
- Changing income sources by entry into small-scale trade and fishing;
- Planting early maturing crops such as vegetables for food and income immediately after floods;
- Strengthening food storage by use of traditional pots and gourds;
- In the FGD with the youth on the North, participants expressed a different position and identified the formation of groups (youth groups and community groups) that promote sharing of resources as critical.
- Other important adaptation measure involved leasing of farm land in the Migingo area for growing maize and sorghum.

As mentioned above, the *Migingo* area in Bunyala has high potential for agricultural production as it is not perennially affected by floods compared to other parts of the study area. According to the KII informant from the Ministry of Agriculture, it is the only area where large-scale agricultural production is possible with the potential for surplus food production to reduce food shortages and generate incomes for households. However, exploiting the land which borders Siaya County is complicated by lack of adjudication.

Although already highlighted above, the FGDs showed that households understood that there were clear reasons for adopting certain long-term adaptation strategies that helped household adapt to the effects of floods, and could identify some of the strategies very clearly. For example:

- In the FGD with women on the Southern side, participants thought that community members thought it was more effective to respond to floods with long term measures such as planting trees around homesteads and construction of houses with raised foundations;
- In the FGD with women on the North, participants emphasized the construction of houses on raised ground within homesteads, purchase of land and migration to higher grounds
- In the FGD with men on the Northern side, participants considered changing income sources and food storage important.
- In the FGD with the youth on the North, participants expressed a different position and identified the formation of groups (youth groups and community groups) that promote sharing of resources as critical.

Similarly, in a KII, the informant from the Ministry of Agriculture observed that people may report or talk about their ability (including individuals and communities) to cope and/or adapt based on information in the public domain, including: Radio bulletins, stories in newspapers, chief's barazas, community meetings, and public and NGO initiatives. This can happen by information trickling down to households through projects being implemented in the area. For example, at the time of this writing there was a project on tree planting in the upper catchment of River Nzoia and in the Bunyala Hills to deal with soil erosion being implemented by WKCD&FMP. There is information in the public domain on dyke management and construction of a new set of dykes (in a World Bank/Government of Kenya funded project). The presence of these projects has created awareness among households that these are measures that could help them deal with the impacts of floods, or help prevent the severity of floods.

In addition, the key informant from WKCDD&FMP also argued that the implementation of the two measures would effectively reduce the severity of floods--particularly the construction of dykes which is beyond the capacity of households and communities in the study area. However, if dykes are not constructed, the pattern of negative impacts of floods would continue or worsen. Thus the implementation of the structural flood management measures (particularly dams/ water reservoirs and dykes) by either public or private institutions would help strengthen existing adaptation practices by households in Bunyala and enhance their resilience to flood impacts.

Perception of Effectiveness of Coping and Adaptation Measures to Deal with Flood Impacts

The respondents were also asked about whether the coping and adaptation practices they used were effective in helping them deal with the effects of floods. A significant proportion (84%, 347) reported that the coping (engagement in extra income earning activities, sale of household property, spent less money on household expenses, and modified food consumption) and adaptation measures particularly permanent migration were inadequate (non-effective) while 15% (63) acknowledged some level of adequacy (effectiveness). However, even for the respondents to whom the coping and adaptation measures were effective, 98% (298) noted that the measures were still not enough to deal with the impacts of floods. In addition, 1% (3) reported that the measures had cost implications.

Some of the strategies perceived as most effective included:

- engagement in extra income earning activities beside farming;
- location of homesteads and farms in raised areas 18% (66);
- shifting/ diversifying from farming to small-scale farming to fishing and small-scale businesses; and
- early planting of certain crops such as vegetables, beans and sweet potatoes.

These useful strategies are indicative of viable adaptation practices used by some households. While some of the strategies perceived as least effective included:

- sale of household property such as mobile phones and bicycles
- spending less money on household expenses,
- modified food consumption by reducing quantities and number of meals per day for both children and adults.
- permanent migration) which requires huge sums of money for purchasing land and constructing houses;

In regard to the coping and adaptation practices of households, participants in the men only FGD on the Northern side reported that some households are better equipped and well prepared to deal with the impacts of floods. The characteristics of such households include:

- Households living in raised areas far from the river and dykes
- Households who own boats for fishing and transport
- Those who live near roads
- Households that are economically well off and can afford to migrate or buy land and settle elsewhere

- Small size households with up to four members
- Households with able bodied members

They also identified households that are ill-equipped and poorly prepared to deal with floods including:

- families with elderly members;
- families with disabled members;
- poor families and those with many disabled members;
- orphan-headed households;
- female-headed households;
- Households living near the river banks and low-lying areas such as *Siginga;*
- Families with large numbers of people, many houses and livestock – they will experience more destruction and recovering is expensive;
- The poor whose houses are mud-walled and roofs made of reeds or grass thatched; and
- Households in which elders live alone.

5.0 RESEARCH FINDINGS PART 2

5.1 INDIGENOUS TRADITIONAL KNOWLEDGE (ITK) AND FLOODS

The study focused on ITK in the context of communities with high poverty levels. As was pointed out in previous sections, many coping strategies are currently being used – and are often erosive (long-term negative effects) further increasing household vulnerability. Local knowledge on rainfall and flood patterns can provide insights into traditional coping and adaptation strategies and opportunities for integration into interventions by public and private institutions for long-term livelihood sustainability. Therefore, it was necessary to identify the ITK – which resides in people's memories and is transmitted orally to deal with natural disasters, such as floods. ITK can also provide and promote understanding of potential channels for communicating climate related information and adaptation options.

Custodians of ITK

The custodians of the ITK on rainfall and floods were reported as being mainly elderly men 64% (348) and elderly women 31% (166). In addition, it was noted in all the FGDs that elders, both male and female, possess ITK. The more youthful community members who engage in fishing were recognized to possess ITK on fishing and wind (wind patterns/direction and its influence on the availability of fish).

ITK Techniques

The ITK techniques noted are divided into two categories: those used prior to flood onset, and those used after floods to cope with flood impacts. People in Bunyala appeared to be highly knowledgeable or at least aware of ITK techniques used to predict rainfall. Participants in all FGDs identified examples of how ITK was used to predict rainfall and floods. Regarding use of ITK after floods, the household surveys results showed that, of those who used ITK, it was primarily used for food storage.

Some of the ITK techniques identified during the FGDs are listed below:

- ITK Techniques Used Prior to Flood Onset

- The sighting of certain migratory birds (*magungu)* indicate onset of the rainy season
- The sighting of a type of eagle (*Ikhwasi)* indicates onset of rainfall
- Wind direction was indicative of various predictions, including:
  - *Agundu* blows from North to South and indicates a dry spell
  - *Ikhoma* blows from East to West and indicates a dry spell
  - *Imbalaha, Nyauganda, Lugingo* blows from South to West and indicates rainfall onset
  - *Imbuga* blows from East to West in December signaling a dry spell
- Change in the color of water in the river, including foam and floating debris, indicates flood onset
- The behavior of animals such as frogs (croaking at night in November) indicates flood onset

- Dark clouds in the direction of Mt. Elgon indicates rainfall and flood onset
- Appearance of safari ants in homesteads and riverbanks/dyke indicates flood onset
- Shedding of leaves by the *Omudodo* tree heralds rains onset

ITK Techniques Used After Flood Onset:

Some of the ITK used after floods include:

- Fishing in flood waters- fish is plentiful in flood waters and fishing was done by men, women and the youth in flood waters using traditional traps made of reeds and sticks. The fish was used for both household consumption and sale.
- Traditional herbs and cow-dung was burnt in open fireplaces to deal with mosquito menace that affected both humans and livestock. Herbs are used to purify drinking water and cure water borne diseases.
- Food Storage/ Preservation:
  - Maize and meat is dried and then staked on sticks above the fireplace for preservation through smoking.
  - Food preparation includes processing and treatment using traditional methods such as mixing cereals (maize, beans and groundnuts) with ash in gourds and pots sealed with cow dung to make them air tight.
- Household Movement during Floods/ Temporary Migration:
- ITK on flow of flood waters enables community members to know the locations of danger and safety zones and the routes to travel for the safety of those affected.
- Alternative Shelter: relates to skill in construction of shelter using natural materials such as grass, sticks/branches of trees and reeds, and residing in homes of friends and neighbors.
- Safety & Security: relates to informal arrangements by men and boys to patrol homesteads using boats and canoes. In many cases men remained behind in homesteads to guard household assets stored on the roof tops and in the eaves of houses.

Awareness and Use of ITK

A majority of respondents reported a high level of awareness of the use of ITK techniques for predicting the onset of rainfall (81%,340) and floods (72%,299). However, only about a third of respondents (29%, 123) reported using ITK to cope with floods. Despite the seemingly high awareness and knowledge of ITK, most respondents (86%, 361) reported that they no longer use ITK to cope during and after floods; and only a very small number of respondents reported being able to cope with floods better by using ITK. Despite the lack of trust or use, there is still awareness of ITK uses; only 8% of respondents were unaware of ITK.

The households who use ITK to deal with the impacts of floods primarily do so as a means of food preparation and storage (79%, 72). ITK was used to a lesser extent to determine where to move households during flood events (43%, 39) and migration (34%, 31). Migration is defined as temporary

relocation, which takes place after flood onset. ITK is used in these latter two scenarios by following traditional migratory corridors taking into account topography of the area.

There were several reasons individuals reported for not using ITK, including lack of access to ITK (48%, 131), reliance on modern forecasts (35%, 97), and lack of trust in ITK (24%, 65). Upon further investigation it became clear that ITK techniques were generally not thought of as useful, with about half of participants reporting no usefulness of ITK whatsoever (49%, 200) and only a very small number reporting being able to cope with floods better by using ITK (7%, 27).

However, information from FGDs and KIIS demonstrated that some individuals were aware of ITK uses. One example discussed was how ITK was used to open up drainage channels to speed up the flow of flood waters toward Lake Victoria by community members, a practice organized by work parties called *silabalaba,* and coordinated by village elders. But this is no longer practiced. As a result blocked drainage channels in the study area have not been opened up, thereby exacerbating flood water retention.

POTENTIAL USES OF ITK

Alternative shelter: relief camps or the homesteads of relatives and friends in non-flood prone areas

Migration: following traditional migratory corridors taking into account topography of the area in order to temporarily relocate household. Make sure to distinguish difference between alternative shelter, migration and safety and security

Safety and security: ensuring that all household and community members are safe and that household property is protected

Storage of food: using traditional pots, gourds and plastic containers to preserve staple maize, sorghum, millet and fish

Healthcare: use of herbs to manage and treat human and livestock diseases

Flood prediction: (for example, what you could place here is a statement like: monitoring changes to weather patterns and the environment to predict when rains and floods will occur and to determine when crops should be planted)

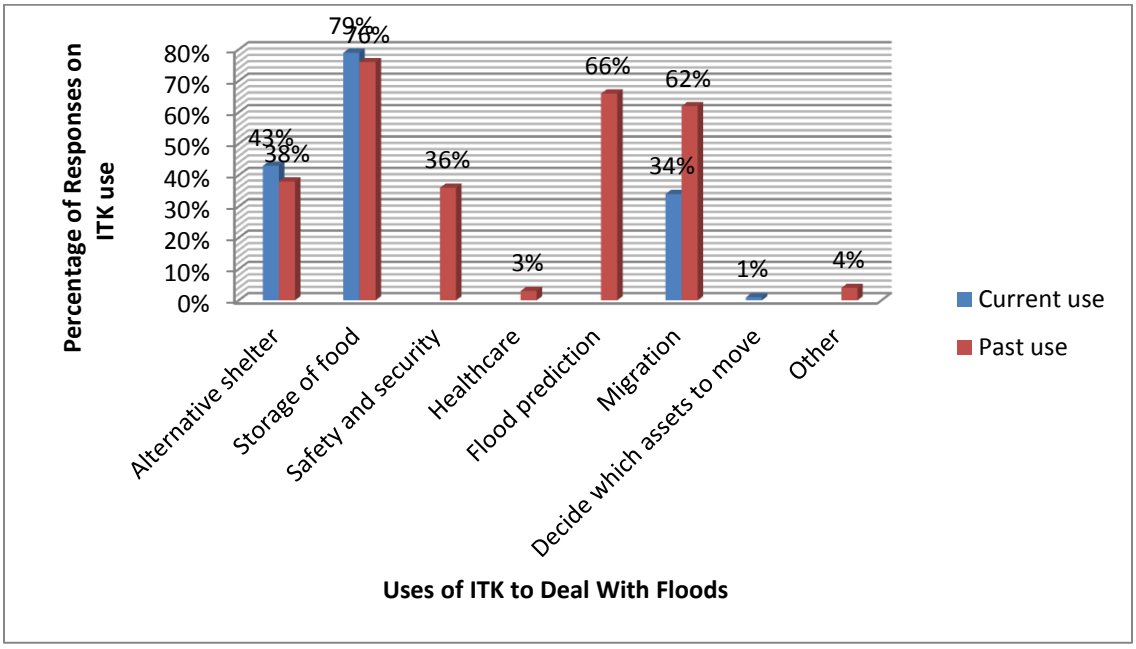
Decisions on assets: prioritizing assets for immediate use and items to be left behind in homesteads or discarded

Changes in Use of ITK Measures

The findings show that despite the perception that there have not been significant changes in the use of ITK in Bunyala, when asked about past and present use of ITK as a means to deal with floods; some differences were found (Figure 7). In addition, 25% (104) of the respondents claimed that ITK is no longer used at all as a technique to cope with floods.

The study also found that, historically, ITK was mainly used in storage of food (76%, 296), flood prediction (66%, 258), migration (62%, 240), alternative shelter (38%, 149), safety and security (36%, 140) (safety of people and security of belongings in the homesteads/villages), and healthcare (traditional medicine for management and treatment of illnesses/diseases that affect human and livestock) (3%, 11). It is interesting to note that although ITK was seen to be used significantly in the past for preserving safety and security, whereas it is hardly used for this purpose today. ITK was previously used and is still used about the same amount for alternative shelter and storage of food. Current and past use of ITK was seen to be minimal for flood prediction and healthcare (Figure: 7).

FIGURE 7: CURRENT AND PAST USE OF ITK



The respondents in the household survey identified some reasons for the changes in use of ITK including the following:

- Impact of modern education: 65% (258)
- Lack of transfer of ITK from the older to younger generations: 60% (241);
- Low level of accuracy of ITK: 52% (208);
- Negative attitudes by the younger generations: 41% (163);
- Contradictory and sometimes competing information from government agencies and other external organizations 28% (111);
- Climate change: 30% (119);
- Low level of accuracy: 29% (116);
- Use of modern forecasting methods: 17% (67);
- Lack of trust in ITK experts: 4.3% (17); and
- Association with witchcraft: 3% (10).

The views expressed above were corroborated by information provided by FGD participants, who observed that:

- ITK has been ignored by the present generation.
- There is a generational gap between the youth and elders who possess ITK on rainfall and floods

- The population of the elderly who possess ITK has declined and they have also isolated themselves and are selfish in sharing knowledge – for example, during hardship the elders would rather exchange their knowledge for money.
- Technology has denied the old men and women the chance to exercise their ITK;
- The meteorological department has discouraged ITK;
- There is lack of respect for the elderly by younger community members which limits intergenerational transfer of ITK.

Despite the seemingly negative perceptions of trust in and use of ITK that came from the household surveys, the FGDs and KIIs indicated that a reasonable number of people actually did still trust and use ITK for dealing with floods events.

One KII informant who is an ITK expert observed that he provides flood prediction information to the area chief/assistant chief and to the community members at public gatherings. He reported that some people listen but those who do not, regret later and recognize his earlier warnings. He also observed that his elder son who has gone to school has integrated modern education and ITK and is now more knowledgeable than the father. The informant wished he could get similar education to improve his practice. According to this particular informant, the continued trust in ITK in the community is supported by invitations received from primary school teachers at Busagwa and Buhoba primary schools where he volunteers teaches pupils about rainfall, floods and wind patterns in Magombe sub-Location to pupils in classes four, five, six, seven and eight. He also volunteers to mentor children to learn about ITK.

Another KII informant from the Ministry of agriculture mentioned that some aspects of ITK informs one critical adaptation practice for food security: the planting of fast crops (mainly beans, cow peas and sweet potatoes) immediately after flood waters recede. This is done for both household consumption and sale.

Institutions and ITK

The respondents were asked about their perceptions on use of ITK by institutions to deal with floods. Many respondents (63%, 265) observed that public and private institutions do not use ITK in their interventions, while 15% (61) reported that institutions used aspects of ITK. For example, one KII interviewee observed that officers in the Ministry of Agriculture in Bunyala use ITK only in crop production during extension.

In order to address the challenges to use and integrate ITK into institutional interventions, participants in all the FGDs observed the need for:

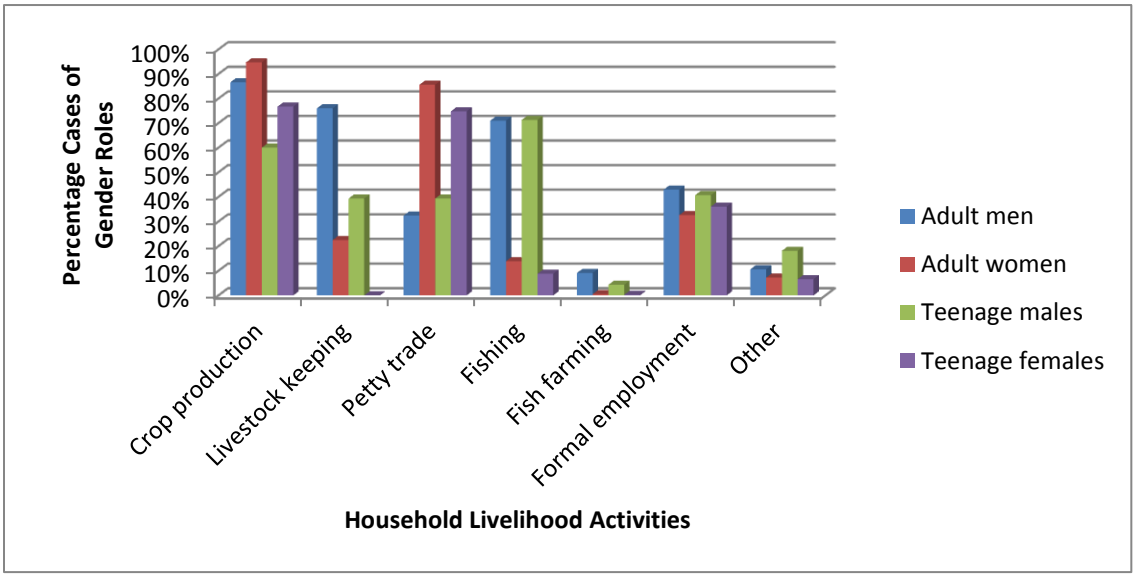
- Scientists to work with and consult ITK experts and to involve the community in research to enhance acceptability and success in implementation.
- The government to put in place policies where the elderly with ITK are acknowledged and even compensated monetarily.
- Modern climate forecasting should consult local ITK experts to improve presentation of climate information for public dissemination.

5.2 GENDER AND FLOODS

Gender and Livelihoods

While women and men both engage in crop production as a primary livelihood activity, among men, this activity is supplemented most commonly with livestock keeping and fishing, whereas for women it is supplemented mostly with petty trade. Among youth, fishing and petty trade dominate for males and females, respectively. All four groups participate about equally in formal employment (Figure 8).

FIGURE 8: GENDER ROLES IN LIVELIHOOD ACTIVITIES



Household Decision-Making

The household surveys, key informant interviews and focus group discussions repeatedly revealed that men were the primary household decision makers, with few cases citing women as playing a part in contributing to household decisions. Women were reported to contribute to less than a third of the decisions on livelihoods activities, land ownership (generally in Kenya land title deeds are in the names of men who own and decide on the use to which land is put) and how to respond to floods (Figure 9).

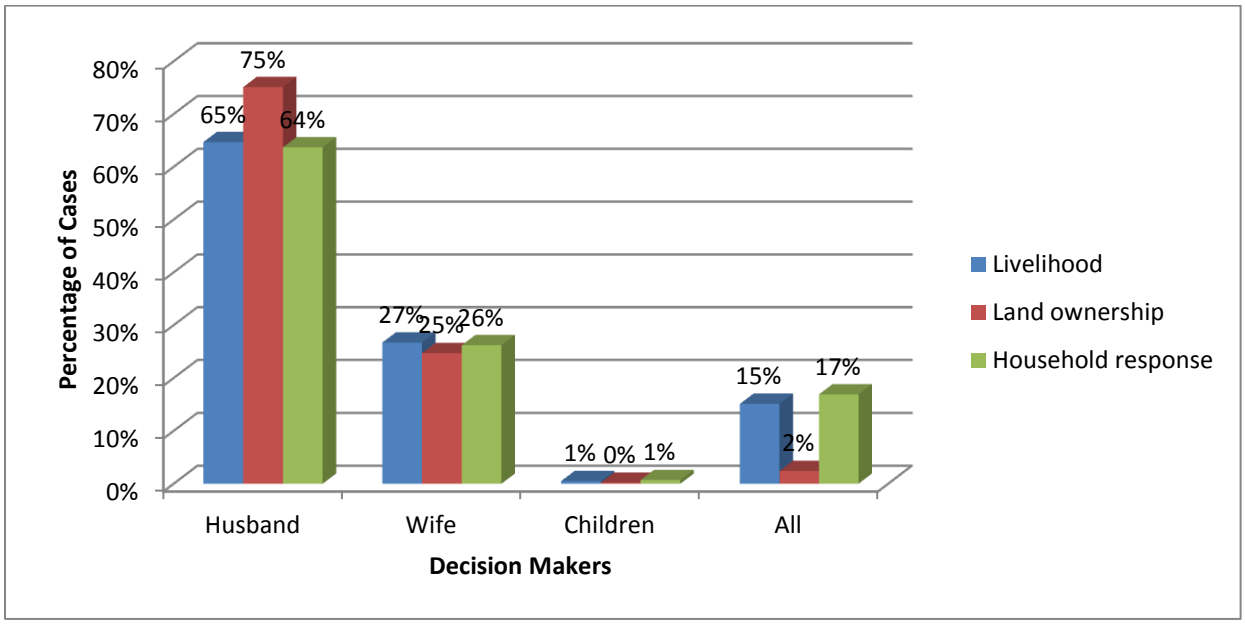
"Culturally, men are the sole decision makers"--KII participant from Western Kenya Community Driven Development & Flood Mitigation Project (WKCDD & FMP)

As discussed above, although women do have some freedom to own livestock and often engage in small-scale farming activities slightly more than men (other than the staple crops maize, sorghum, and beans; women also have their own vegetable kitchen gardens) they do not have control of the decisions and income associated with these activities. For example, women can own livestock but they have to consult men, usually their husbands, for permission to sell. Furthermore, as noted by one informant "women can farm but may not keep the money, so men are more resource-equipped" (KII from WKCDD&FMP). Since farming is the main livelihood activity, this demonstrates the low level of decision-making power women have. Since it was found that women typically do not own land they have little say in decisions

on how to use that land. This situation echoes what occurs in Kenya, where nationally, women account for 5% of registered land holders but contribute over 80% of the agricultural labor force, 64% of subsistence farmers, and produce approximately 60% of farm-derived income. There are huge disparities in land ownership and transfer of land between men and women. In addition, women and the youth are excluded in land decision-making processes. Furthermore, traditional inheritance rights and customary laws and practices exclude women and widows from inheritance of land (Benschop, 2002; Syagga, 2006).

However, the exception to this was when women were the primary bread winners. As one individual said, "decisions are always made by the bread winner--usually men but to a small extent, by women". Although the household surveys did not ask who the primary bread winner was, they did ask whether the household was headed by a male or female. About 20% of households were female-headed.

FIGURE 9: HOUSEHOLD DECISION-MAKING

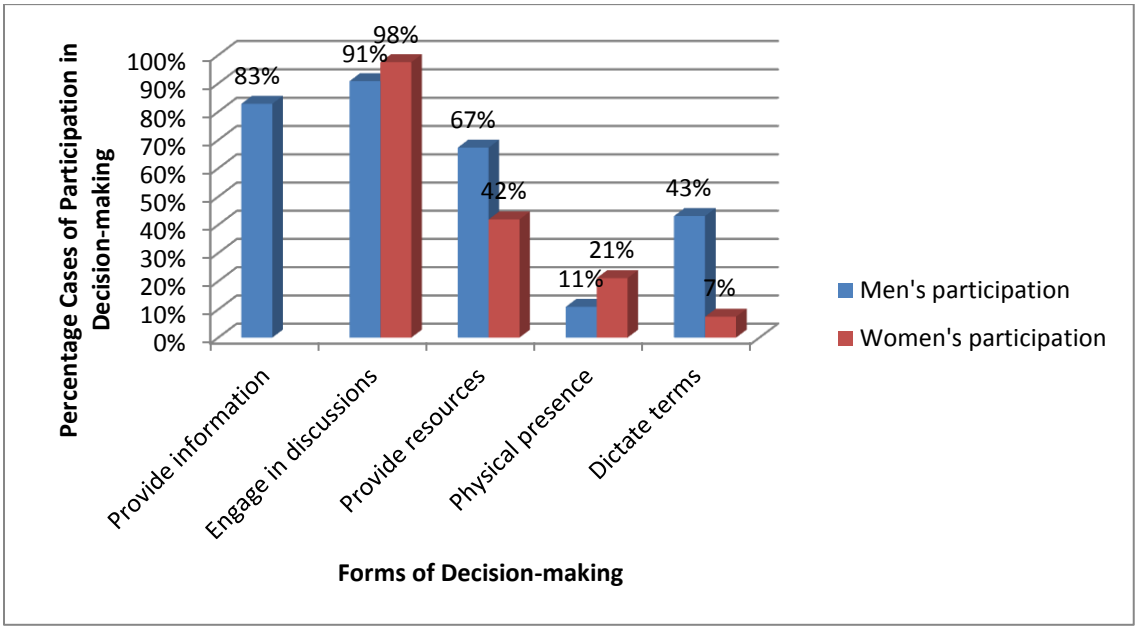


The household survey shows that the common decision-making processes used by men and women are: discussions in which men and women talk about household matters that concern them; provision of resources (since men are more endowed they provide more resources compared to women; while physical presence (means being personally present at the time of discussion and decision-making) is more important for women than men at the time of decision-making; the provision of information was found to be entirely the preserve of men, with no women stating that they were providers of information whether on knowledge of floods or livelihood activities. This indicates that men are seen to occupy the space of knowledge-providers, hence have greater authority when it comes to household decision-making.

Comparatively, men provide more material and financial resources than women as they are more resource-endowed. Men own land and livestock and also participate in wage employment more than women, who are restricted to domestic tasks in or around the home and small-scale/ petty trade. This tilts the balance of authority in household decision-making in favor of men. The implications of all these issues mean that men are able to get their way or "dictate terms" in as far as decision-making in household is concerned. For women, being personally present at the time decisions are made is

important since they are able to explain their position while men have to be consulted by women even when they are not present (away from home at work or due to any other reason) (Figure 10).

FIGURE 10: LEVELS OF GENDER PARTICIPATION IN DECISION-MAKING



Gender and Flood Impacts

In assessing perceptions of respondents on the effects of floods on women and men, approximately half of the respondents reported that women and men were affected differently. Although the households survey seemed to be split on the perception that men and women are affected differently, the FGDs gave very different results. During all seven FGDs it was echoed time and again by the vast majority of participants that, despite most households and community members being negatively affected by floods, the negative impact was greater on women. This was seen particularly due to the typical gender role of women – i.e. their domestic responsibilities, and responsibility for caring and nurturing children and family – which are exacerbated during times of floods. Women in Bunyala have to deal with the impacts of floods but also have to:

- Remain at home (or camp) while men go out to work within or outside the study area;
- Take care of children and other family members;
- Perform domestic chores such as looking for food, water and fuel wood and cooking;

Similarly, the KII informant from WKCDD & FMP observed that, "the impact of floods is felt more on women and children than men. During floods men can do fishing or casual labor to get some income, but women and children have nowhere to go." Much of the burden women face is because they are displaced from their place of work (their home). During the FGDs women and men discussed many of the burdens women face, including:

- Loss food and stored farm produce, household utensils/goods but still have to care for their children;

- Loss of income due to destruction of crops and displacement;
- Lack privacy in camps where they have to stay with children and teenagers in tents/temporary shelter in camps;
- Increased sexual harassment, exploitation and promiscuity at camps which increase the risk of HIV/AIDs and STI/STDs;
- Increased spread of water-borne illness, health issues such as cholera, typhoid and malaria;
- Pregnant mothers are unable to visit maternal clinics
- Conflicts and family break ups;
- Petty businesses run by women are either disrupted or destroyed by floods for example retail kiosks/shops, sale of food stuff and second hand clothes.

The KII informant from Ministry of Livestock identified some additional problems experienced by women including loss of food and income from kitchen gardens and petty trade, which in turn leads to increased reliance on men for food and income. Worse still, increased sexual harassment and promiscuity at camps was discussed as resulting in increased risk of HIV/AIDS and sexually transmitted infections (STI/STDs) particularly for women. Although this was not asked in the household survey, during many of the KIIs and FGDs individuals spoke up about the lack of privacy in the temporary camps, which lead to increased sexual activity and sexual exploitation and STI/STDs. During the household survey it was reported that women are particularly affected by rape, prostitution and drug abuse (11%, 39) and early marriage (5%, 18), respectively. Other problems experienced by women are conflicts and family break ups, poor diet for lactating mothers, and inability of expectant mothers to access antenatal clinics.

Accordingly, another KII interviewee from the Department of Livestock stated that women, children and youth are the most vulnerable to floods. In the case of women, floods destroy kitchen gardens, and water for domestic use becomes contaminated. Flood damage to crops therefore affects women most as they have to feed the children.

Gender Roles in Their Immediate Response to the Onset of Flooding

The participants in FGDs were able to distinguish the roles played by men and women in response to the onset of flooding.

Specifically, women

- Pack and care for household goods – utensils, food and bedding;
- Take care of children;
- Search for food and firewood;
- Cook food and wash; and
- Use gunny bags to strengthen dykes to stop over topping.

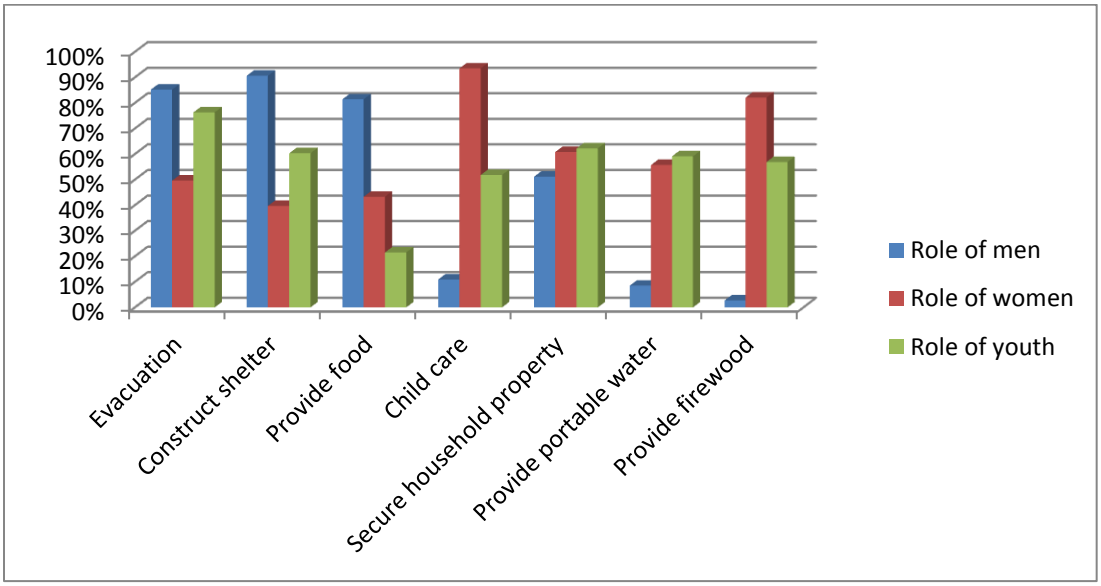
While men

- Source for boats for evacuation;

- Coordinate relief food distribution;
- Construct shelter--tents, tarpaulins and natural materials; and
- Search for food.
- Remain in homesteads to provide security, and
- Use gunny bags to strengthen dykes to stop water over-topping.

The household survey revealed that the roles of men in dealing with flood are mainly evacuation, construction of shelter, provision of food and securing household property (more masculine roles in Bunyala context) but have low contribution in childcare, provision of water and firewood (more feminine roles in Bunyala context). The contribution of women is more important in childcare and provision of water and firewood but they also contribute towards securing household property, evacuation, provision of food and shelter construction (more masculine roles in Bunyala context). The roles of youth were not segregated based on gender. In the more masculine roles of evacuation, construction of shelter, youth contribution was greater than that of women except provision of food. Similarly, youth contribution was higher than that of men in the more feminine roles such as child care, provision of water and firewood. The contribution of youth and women in securing household property is about the same (Figure 11).

FIGURE 11: GENDER ROLES IN DEALING WITH FLOOD EVENTS



Despite the fact that women, men and youth play specific roles when floods occur as discussed above, the roles played by women tend to be more stressful as compared to those of men.

For men:

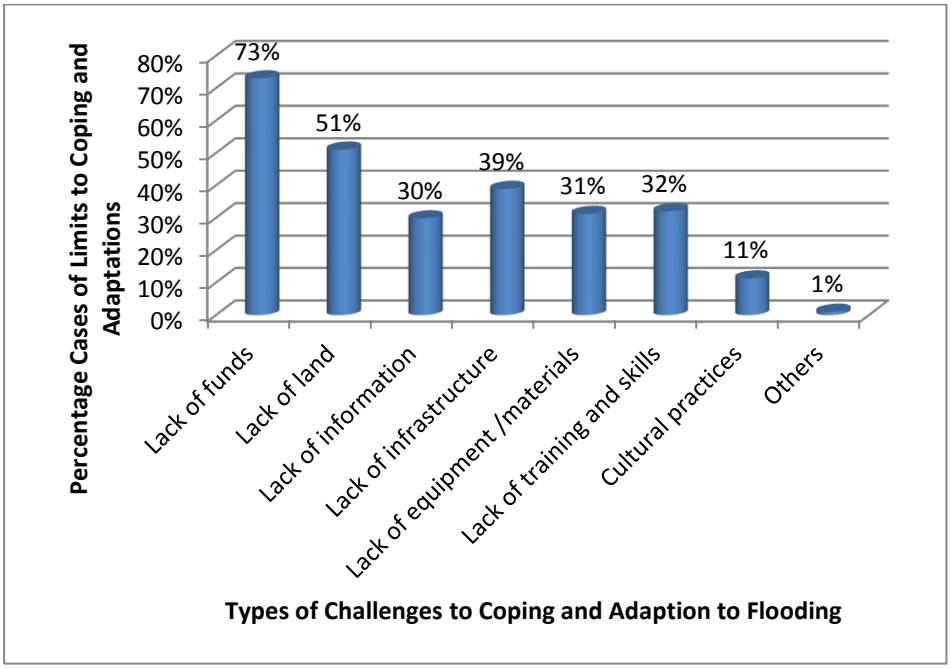
- the need to search for food to supplement household food stores take them away from other jobs but only temporarily ;

- the need to organize evacuation of household property reduces time available for other tasks like tending livestock, fishing or participation in manual labour which affect income;
- the need to replace lost household goods or items and to reconstruct houses and latrines after floods is not immediate and can be undertaken over long period of time subject to availability of resources after floods; and
- the need to cater for medical care of household due to water borne diseases such as cholera is not very difficult as they only supplement the free relief medical services and drugs provided by public, private and faith based organizations.

Challenges of Dealing with Floods

The challenges that limit the capacity of men and women to deal with floods in Bunyala include lack of money, lack of land, lack of infrastructure, lack of information, lack of equipment and lack of skills (Figure 12).

FIGURE 12: LIMITATION TO COPING AND ADAPTATION TO FLOODS



Youth and Floods

Just like everyone else, youth also experience flood impacts. According to one KII interviewee, the youth are displaced and, due to lack of food and incomes in home ventures, may move into activities that can jeopardize their lives including crime, substance abuse, teenage sex and prostitution. Promiscuity among teens/ youth at camps results in teenage pregnancies, early marriages among teenage girls and exposure/ risk of HIV/AIDS and STIs (for both young women and men). In addition, due to

impassable roads and inaccessible public facilities such as schools and village polytechnics, some youth temporarily discontinue schooling or drop out altogether.

In the household survey, more than half (52%, 217) of respondents reported that the youth are affected differently from other community members. The reasons for this range from school dropout (18%, 73); forced migration/relocation (13%, 48); rape, prostitution and drug abuse (11%, 39); and early marriage (5%, 8), respectively.

Gender and Institutions

Generally, women have low education and therefore occupy fewer positions of leadership in public and private institutions. Apparently, there are very few women (experts/professionals) who work in the institutions that operate in Bunyala Sub-county. For example, the Ministry of Agriculture has a staff of nine with only one woman. Similarly, in the Western Kenya Community Driven Development and Flood Mitigation Project (WKCDD/FM), women work as support staff. There are no female staff members in the Department of Livestock.

However, the perception of respondents in the household survey on leadership in institutions reveals that some women are in leadership positions in institutions. (It should be noted that, in the context of Bunyala, people make no distinction between experts and support staff in public or private institutions. For them, it does not matter that an individual is a secretary, cleaner or accountant- all these are leadership positions and the holders of the positions are usually consulted on various matters).

A minority of respondents said that women did not play any role in leadership. The findings also show that women moderately influenced decision-making. About a quarter of the respondents felt that women had limited influence in decision-making (Table 3).

TABLE 3: PERCEPTION ON WOMEN'S INFLUENCE IN DECISION-MAKING

Influence	Frequency	Valid Percentage
To a moderate extent	178	48
To a less extent	99	27
To a great extent	89	24
Don't Know	6	2
Total	**372**	**100**

5.3 INSTITUTIONS AND FLOODS

A variety of public and private institutions implement flood-related activities in the study area. Although, most of the institutions are not directly active in the area of climate change adaptation, they have activities and interventions to support communities during floods.

Institutional Activities Related to Floods

The main public institutions in Bunyala working in areas related to climate change and flooding include the Ministry of Agriculture which provides seeds for planting after floods and extension services; the Ministry of Health which provides drugs/medicine, mobile toilets, mosquito nets, clean water, mobile clinics, water purification tablets, and soap; and the Ministry of Special Programs which provides relief food and tents. Private institutions in Bunyala working in flood-related activities include NGOs/CBOs, FBOs and international organizations.

Institutional Provision of Assistance

Generally, institutions provide assistance targeted at people affected or displaced by floods. Participants in all the FGDs were in agreement that the private institutions provide the following services/ assistance:

- United Nations International Children's Emergency Fund (UNICEF) provides – tents, buckets, jerricans and soap
- World Food Program (WFP) – food items such as soyabeans, maize, beans, rice, cooking oil and unimix
- Kenya Red Cross provides – tarpaulins/tents, blankets, mosquito nets, cooking utensils, jerricans for water, food items – maize, soap, shoes.
- BUCODEV – information, gunny bags, boats for evacuation
- Population Services International (PSI) provides – treated mosquito nets
- Catholic Diocese of Bungoma provides – food items and blankets
- Anglican Church provides – food items and bedding

IMAGE 3: DISPLACED PERSONS CAMP ON TOP OF SOUTHERN CAMP AT MAKUNDA, DECEMBER 4, 2011.

Credit: BUCODEV

Despite the material assistance provided by both public and private institutions, it was found that most forms of assistance were not only inadequate but unsustainable. During a KII interview, one female community leader observed that "food rations are too little – a 2kg tin of maize cannot feed a family for one week, and the interventions are not sustainable because institutions only provide assistance during the period that people are in camps. But when they return home, no more assistance is forthcoming to help those affected to rebuild their livelihoods and move on."

From the household survey, it is clear that many respondents felt that most of the flood-related assistance is required: 70% (278), 18% (71) and 17% (69) of respondents said that assistance was required during, before and after floods, respectively. Only11% (45) said that assistance is needed during drought.

TABLE 4: PERIODS IN WHICH ASSISTANCE IS REQUIRED

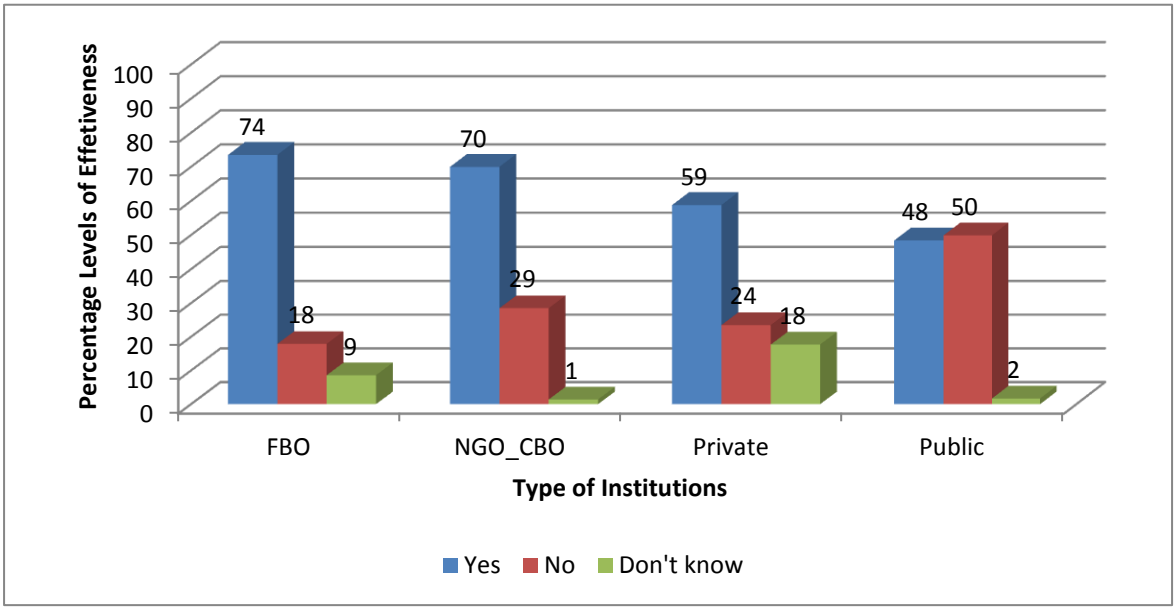
Period	N	Percent of Cases*
During floods	278	70
After floods	71	18
Before floods	69	17
During drought	45	11
When floods occur	32	8
Always (all the time)	8	2
During planting	5	1
During food shortage	2	1

Note: Respondents were allowed to provide more than one response to this open-ended question, thus the total adds up to more than 100%

Effectiveness of Public and Private Institutions

There appears to be significant involvement of public and private institutions in helping households and communities deal with flood impacts. Most respondents 74% (300) reported FBOs as the most effective, with approximately 70% (290) of respondents indicating a positive perception towards the effectiveness of NGOs. Public institutions were seen as less effective compared to FBOs and NGOs. However, approximately half of the respondents were still pleased with their involvement.

FIGURE 13: PERCEPTIONS ON COMPARATIVE EFFECTIVENESS OF PUBLIC AND PRIVATE INSTITUTIONS



Three quarters of the respondents observed that interventions by the institutions meet some of their expectations while less than one quarter reported that interventions by these institutions did not meet their expectations

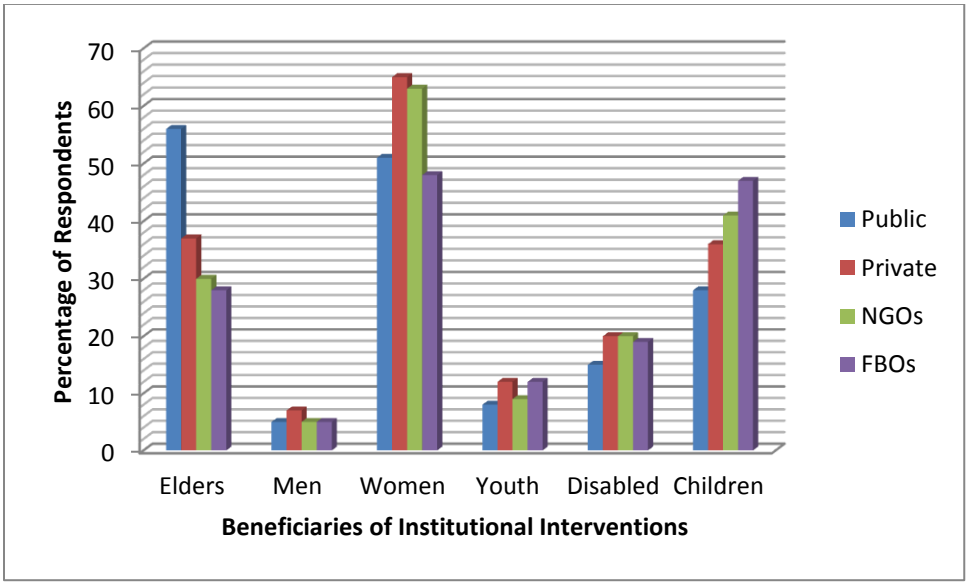
The respondents who perceived that the activities of institutions met their expectations to a moderate extent were (49%, 154), to a great extent (33%, 100) and to a less extent (18%, 58). This information is presented in Table 5.

TABLE 5: PERCEPTIONS ON EXPECTATIONS OF INSTITUTIONAL INTERVENTIONS

	Frequency	Valid Percent
Great extent	105	33
Moderate extent	150	48
Less extent	60	19
Total	**315**	**100**

Beneficiaries of Assistance

Respondents perceived that mainly women, elders, and children benefit from activities of institutions, as to some extent do the disabled. Men and youth benefit less. The perceptions (Figure 7) are that elders benefit more from public institutions; women from all types of institutions; and children mainly from the private sector, NGOs and FBOs FIGURE 14: BENEFICIARIES OF INSTITUTIONAL INTERVENTIONS



Platforms for Information-Sharing

An open-ended question was used to assess the perceptions of respondents to the sharing of information on floods. The findings indicate that the main channels for information sharing are the chiefs' barazas (local administration meetings), local radio programs and FBO meetings (religious functions) which are open and accessible to the general public. Other communication channels used are meetings organized by the District Disaster Management Committees, Self Help Group meetings, NGO/CBO meetings, workshops and seminars, Constituency Development Fund (CDF) meetings. These channels are accessible to a small number of individuals expected to disseminate information to others (Table 6).

TABLE 6 : PLATFORMS FOR SHARING INFORMATION ON FLOODING

Information platforms	Number	Percent of cases*
Chief's baraza	381	94
Local radio talk shows	327	81
District disaster management committee	178	44
FBO meetings	112	28
Self-help group meetings	109	27
NGO/ CBO workshop	92	23
CDF meetings	90	22
Other	4	1

**Note: Respondents were allowed to provide more than one response to this open-ended question, thus the total adds up to more than 100%*

How to Improve Effectiveness of Institutional Assistance

Community members who participated in the household survey and FGDs suggested some measures which they believed could be used to improve the assistance provided by both public and private institutions. It was perceived that public institutions could provide assistance better by:

- Providing sufficient assistance to flood victims, that was effective/adequate;
- Constructing dams and dykes; and
- Eradicating corruption in relief distribution.

Specific recommendations for where private institutions (charities, NGOs/CBOs, and FBOs) could improve the effectiveness of assistance included:

- Provide sustainable support rather than handouts;
- Increase the amount of food aid;
- Work together with government agencies;
- Eradicate corruption during relief distribution;
- Involve community members at the planning stages of interventions;
- Since it was perceived that some religious or faith-based CBOs only provided assistance to those of the same religious denomination, and in essence did not provide or distribute assistance to the community members fairly, one recommendation was for such organizations to distribute food and provide spiritual support to people from all religious denominations; and
- Partner with other institutions to avoid conflicts.

A majority (65%, 265) of respondents identified construction of a new set of dykes as the most effective way of reducing negative impacts of floods. The respondents also proposed other interventions including opening up of canals and the silted mouth of River Nzoia, construction of dams in the upper catchment of the river and repair and maintenance of dykes in Bunyala. Only 5% (20) proposed creation of awareness and capacity building of the community affected. Most FGD participants supported the view that, interventions to deal with floods should be planned in consultation with community members and local community organizations for ownership and sustainability

As highlighted above, some coping and adaptation practices in Bunyala are facilitated by public and private institutions. Assistance during flood events in the form of relief food, bedding and shelter are short-term and unsustainable. These short term interventions for coping disregard local practices and may contribute negatively to dependency on external support. Therefore institutional interventions should, in addition to short-term assistance, focus on long term measures that enhance adaptation by providing opportunities for households livelihood sustainability.

6.0 DISCUSSION AND CONCLUSION

The study findings have been summarized into five categories: respondent characteristics, household vulnerability and food security; gender and flood impacts; indigenous traditional knowledge; and institutions. This section summarizes key findings.

Respondent Characteristics

Most respondents (62%) are women compared to men (38%), and mainly from the Luhya ethnic community. Most marriages are monogamous (51%) but there is a high level of widowhood (26%). Most of the respondents had low levels of educational attainment, with only about a quarter of respondents being literate. Housing is a good proxy for poverty and typical dwelling units are made of iron sheet roof with walls and floors made of earth. Many houses have earth (mud) floors and walls; a few are made of bricks and blocks. Most respondents (90%) do not have electricity in houses, but 9% do. Most households have pit latrines while a few use bushes.

Household Vulnerability and Food Security

The main purpose of crop production was identified as household consumption. A very small portion (10%) is sold. Dependence on crops for household consumption and income makes farmers extremely vulnerable during extreme climatic events, such as floods and droughts. Approximately 90% of respondents reported months of food shortages (between January and May). The impact of floods on livelihoods leads to negative coping mechanisms, and increased vulnerability such as sale of assets, decreased household consumption/nutrition, and children withdrawn from school.

Gender and Flood Impacts

Since 2006, floods have occurred annually: The most recent and severe flood was in December 2012 followed in severity by those of 2011 and 2013, respectively. Floods have negative effects on crops, food prices, housing and property, trade and livestock.

The general impacts of floods on women and men include temporary displacement and relocation, loss of income due to destruction of crops and displacement, and water borne diseases. The unique impacts on women include pregnant mothers who are unable to access maternal health clinics, poor diet for pregnant and lactating mothers, as well as babies and young children, and loss of income-generating activities that women are typically in charge of (small-scale businesses and petty trade); conflicts and family break ups; sexual exploitation and increased exposure to sexually transmitted infections (STIs) and HIV/AIDS. In addition to typical roles (child care, domestic work), during flooding events, women experience increased pressure to contribute to household income/nutrition – especially if they are without husbands; and women lose food, household utensils and other goods but still have to care for their children.

The specific impacts of floods on men include the need to search for food and engage in other livelihoods (limited) such as fishing and casual day labor; organizing evacuation (routes to be taken) of family, livestock and household assets; and pressure to provide for family (food, shelter, school feed, medical expenses) with limited resources.

The specific effects on the youth include venturing into petty crime and substance abuse; promiscuity among teens/youth at camps which results in teenage pregnancies and early marriage of young girls, as well as increased risk of HIV/AIDS and STIs for both young women and men; and increased school drop-outs as girls marry early and boys go into fishing/ *boda-boda activities* (informal public transport business using motorcycles). These findings also highlight some of the challenges to empowerment of men, women and youth including lack of money, lack of land, lack of information, and lack of equipment/tools and lack of skills.

Indigenous Traditional Knowledge

A majority of respondents were aware or used ITK for prediction of rainfall and flood onset. Examples of ITK are observation of wind direction, behavior and sighting of animals, change in water consistency, and weather patterns.

ITK influenced decisions on how and where to move household members in order to avoid floods. ITK also influenced livelihood decisions during times of flooding: farming choices (crops, planting), and alternative sources of income. There is very little use of ITK after floods. Only about 30% of respondents use ITK techniques after floods for food storage and preservation. Non-use of ITK was attributed to lack of access to ITK, reliance on modern forecasts and lack of trust in ITK.

Institutions

Both public (government agencies and ministries) and private organizations (NGOs/CBOs, FBOs International organizations) work with communities to address the impacts of floods (but not necessarily directly with climate change adaptation).

Most assistance from these institutions is provided during and after flood events. The assistance is temporary and short-term. FBOs and NGOs were perceived as being the most effective in providing assistance. Public institutions were perceived as less effective compared to FBOs and NGOs. Women, children, elders, and to some extent disabled people, benefit more from institutions.

The respondents also suggested measures to improve assistance from public institutions during flood events. These included construction of upstream dams and permanent dykes; provision of adequate assistance to flood victims; and eradication of corruption in relief distribution. Respondents suggested that private institutions should move towards sustainable support rather than handouts; increase the amounts of food aid; partner/work with government agencies and other institutions; eradicate corruption in relief distribution; involve community members at the planning stages of interventions; distribute food to all people irrespective of religious affiliation; partner with other institutions and to avoid conflicts.

6.1 SIGNIFICANCE OF THE STUDY

This study has attempted to show that, despite the frequent incidence of flooding in the study area, there have been no long-term interventions to lessen the impacts of floods on local communities. Flood events result in short-term, *ad hoc* interventions by many government institutions and private organizations (including NGOs, public and private organizations, and government). Because

interventions tend to be limited to short-term ones, the capacity for long-term resilience by affected households and communities remains low. Until longer-term, sustainable adaptation strategies can be employed, the short-term coping measures taken will not only continue to be inadequate, but are also likely to be unsustainable, and perhaps even detrimental, in the long term.

Therefore, until longer-term, sustainable adaptation strategies can be employed, the short-term coping measures taken will not only continue to be inadequate, but are also likely to be unsustainable, and perhaps even detrimental, in the long term.

Indeed, poverty levels in the study area seem to be persistent, if not increasing. This supports the idea that at least some strategies adopted by households are erosive in nature and leave people worse off for the next flood event. This study has emphasized the necessity of long-term adaptation strategies that integrate community indigenous knowledge within effective institutional arrangements that also enable the ecosystems to continue providing livelihood support services. This has implications for any strategy for flood management in Bunyala Sub-county.

The study has examined the social aspects of flood impacts, particularly the gender aspects. It has shown that in Bunyala Sub-county, just like in other parts of Kenya, women, youth and children play an important role in small-scale subsistence agriculture--the mainstay of the livelihoods in rural areas. However, the contribution of women, in particular, is constrained by lack of, and access to, resources (land, information, and money) and involvement in decision-making processes at the household, community and institutional levels.

Currently, the new constitutional dispensation in Kenya has created new institutions--the most notable being the devolved government structure. In this case, devolution has provided new opportunities for engagement between households, communities and institutions in developing measures to enhance both coping and adaptation strategies and to build resilience to the impacts of flooding. However, the mechanisms put in place to promote community participation in planning and decision-making initiatives to address the problem of floods and other development challenges haven't been effectively felt on the ground. While well-appreciated by their beneficiaries, the interventions by public and private NGO/CBOs and FBOs still lack coordination, community participation, and sustainability.

6.2 RECOMMENDATIONS

This study aimed to examine the reasons for absence of long-term interventions in Bunyala despite perennial/frequent flooding in the context of existing ITK, gender and institutional dynamics. Therefore, the findings of this study have implications for policy makers and planners at both county and national government levels, and inform the following recommendations.

Indigenous Traditional Knowledge

There is potential for use of ITK in climate information and it is proposed that:

- Flood management can take advantage of the integration of modern scientific forecasting and climate modeling with ITK to strengthen the understanding, dissemination and use of climate information in Bunyala Sub-county;
- ITK be integrated into current approaches (i.e., integration of ITK on flood prediction into Early Warning Systems for preparedness);
- ITK experts can be tapped as a means to disseminate climate information; and
- ITK on climate should be documented for posterity.

Gender

The gender dynamics of flood impacts represent a complex situation. Dealing with the gender issues of flood impacts requires a multi-pronged approach which combines public interventions, cultural/attitude changes, and community action. It is proposed that:

- Local communities be empowered through trainings/skills (new technology for farming) to improve small-scale agricultural productivity (small-scale irrigation for food production and income generation can be promoted);
- Education (adult and regular education) vocational training to diversify livelihoods should be provided, along with other informal education and knowledge sharing; and groups should be formed for the empowerment of women and youth;
- Women are particularly affected negatively due to their domestic responsibilities and nurturing roles. As the primary producers of food, women have little or no control of resources such as land, livestock and money; and decision-making authority. Therefore, targeted measures to empower women with skills, knowledge and resources such trainings for women groups and credit schemes to promote their petty trade and small-scale businesses should be promoted for example by taking advantage of the governments Women Enterprise Fund.
- Promotion of community education and attitude change towards women's empowerment, violence against women and sexual exploitation in the era of HIV/AIDS.

Institutions

Households and communities in Bunyala Sub-county have limited capacity to deal with the negative impacts of floods. Improving the livelihoods requires interventions to address their coping and adaptation practices. The short term coping practices such as sale of land and household property, less expenditure on household requirements and temporary relocation worsen the vulnerability of affected households to future flood events in the context of illiteracy, lack of skills and resource constraints. This situation can be addressed by institutional investment in interventions to enhance household adaptation and resilience through long-term measures to improve the sustainability of livelihoods. In any case, coordinated interventions by public and private institutions can help address both structural and non-structural measures in flood management.

The interventions of public and private institutions that improve short-term household resilience to cope with immediate impacts of floods, should:

- Promote participation and decision-making by women in income generating activities such as small-scale agriculture and trade for income generation and livelihood diversification.
- Train farmer groups and women groups in modern farming techniques to not only improve agricultural productivity but also to enhance post-harvest conservation of food stocks.
- Institutions should collaborate to set up emergency relief facilities for accommodating households displaced by floods, taking into account, sleeping quarters/dormitories, sanitary and medical facilities. This will address the problem of privacy, lack of water, toilets/latrines and bathrooms and health concerns of pregnant mothers, children and the sick;
- Partner with communities to develop water storage facilities for domestic purposes to reduce incidence of waterborne diseases;

- Provision of learning facilities to ensure learning in primary, secondary and tertiary institutions is not disrupted to the disadvantage of learners;

The interventions of public and private institutions in Bunyala Sub-county may have the capacity to mobilize (which is beyond the capacity of individual households and community members) resources (whether in the form of public-private partnerships or otherwise) for investment in adaptation strategies for long-term household resilience to flood impacts. The interventions should aim to:

- Develop mechanisms for collaboration between ITK experts and climate scientists to promote dissemination viable ITK related to floods, and to develop local flood prediction and early warning instruments for application to emergency preparation that take into account local resources and community participation;
- Strengthen potential of agricultural production in Migingo are of Bunyala Sub-county through land adjudication and issuance of titles. This will provide incentive for modern commercial farming;
- Promote livelihood diversification initiatives to reduce reliance on subsistence agriculture and fishing which are vulnerable to climate change and climate variability in order to improve household food security and incomes;
- Promote flood proof housing technology using locally available resources to reduce flood damage in homesteads;
- Capacity build the relevant to national and county government institutions to mainstream gender and climate change policies into institutional policies. This will in turn help to institutionalize climate change issues in the activities and interventions by these institutions and also provide mechanism for coordinated community participation;
- Implementation of integrated catchment management initiatives of River Nzoia basin watershed to provide mechanisms for environmental conservation and management, as well as flood control to limit the exposure of households communities to in low lying areas and floodplains to adverse flood effects. This could be achieved through public/ private and community initiatives to address deforestation, soil erosion and ecosystem conservation.
- Invest in structural flood control measures such as dams and dykes. This could be achieved through public/private investment in multipurpose dams for water harvesting, storage and production of electricity. This can be exploited for fish farming and small-scale irrigation projects that target local communities in the study area.
- Conduct floodplain mapping, land use planning and enforcement of laws on land use, agriculture and settlement. For example, homesteads should not be constructed in the flood plains, near dykes or along river banks.

6.3 AREAS FOR FURTHER RESEARCH

This report has identified knowledge gaps that can provide opportunities for building long term resilience to floods in the Bunyala Sub-county. Thus, further research can be conducted to:

1. Examine how existing ITK and experiences of communities in dealing with floods can be mainstreamed into interventions by public and private organizations to deal with flood impacts in Bunyala sub-County.
2. Assess coping and adaptation best practices to improve agriculture based livelihoods in the context of Migingo.

3. Identify mechanisms that can be used to enhance the capacity of local county government institutions to promote community participation in planning and decision-making in adaptation interventions to address climate change impacts in Bunyala sub-County.

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FINAL RESEARCH REPORT

HOUSEHOLD AND COMMUNITY EXPERIENCES AND PERCEPTIONS ON CLIMATE CHANGE IMPACTS DUE TO DROUGHTS IN THE SAHEL REGION OF BURKINA FASO

MARCH 2014

This report is made possible by the support of the American people through the U.S. Agency for International Development (USAID). It was prepared by Association pour la Gestion de l'Environnement et le Développement (AGED). The contents are the sole responsibility of AGED and do not necessarily reflect the view of USAID or the U.S. Government.

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FROM THE AMERICAN PEOPLE

ASSOCIATION POUR LA GESTION DE L'ENVIRONNEMENT ET LE DEVELOPPEMENT
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ACKNOWLEDGEMENTS

Our thanks goes to United Nations Economic Commission for Africa-African Climate Policy Centre (UNECA-ACPC), for all of the support they have provided in the implementation of this study. We thank Dr. Tom Owiyo for his contribution to the revision of the document. Our thanks also go to the administrative and technical team, including *Association pour le Gestion de l'Environnement et le Développement's* (AGED) Boureima Z. Drabo, Rakieta Kiendrebeogo, Bouraimou Gnada, Frederick Kiema, and Ghislain Bambara. We would also like to extend our sincere thanks to the technical and scientific team including INERA's Dr. Nouhoun Zampaligré, Idriss Serme, and Ousmane Zono. Finally, we recognize and appreciate the participation of the local people in the 16 villages of the study, and their support in helping us acquire the data collection necessary for the realization of this report. This report was prepared by André Kiema (PhD), Principal Investigator. Thank you to Rivaldo AB Kpadonou, from the UNECA-ACPC, Addis-Ababa, Ethiopia, for his assistance in preparing this paper.

This report was prepared by André Kiema (PhD), Principal Investigator, AGED.

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ACRONYMS AND ABBREVIATIONS

ACPC	African Climate Policy Center
AGED	*Association pour le Gestion de l'Environnement et le Développement* (Association for Environment and Development Management)
ARCC	African and Latin American Resilience to Climate Change
CILSS	*Comité Permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel* (Permanent Interstate Committee for Drought Control in the Sahel)
CONASUR	*Conseil National de Sécour d'Urgence*
CREAF	Center for Environmental Research and Agricultural Training of Kamboinsé
CVD	*Conseil Villageois de Développement* (Village Development Council)
DRED-SHL	*Direction Régionale de l'Economie et du Développement - Sahel*
ECOWAS	Economic Community Of West African States
ENSA	*Enquête Nationale de Statistiques Agricoles* (National Survey for Agricultural Statistics)
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
IDR	Institute of Rural Development
INERA	Institute of Environment and Agricultural Research
IPCC	Intergovernmental Panel on Climate Change
MED	*Ministère de l'Economie et du Developpement*
MRAH	Ministry of Animal and Fishery Resources
NAR	Natural Assisted Regeneration
OECD	Organisation for Economic Co-operation and Development
ORSTOM	Office de la Recherche Scientifique et Technique d'Outres Mer
PANA	*Programme d'Action Nationale d'Adaptation*
PLACE	Prosperity, Livelihoods, and Conserving Ecosystems Indefinite Quantity Contract
SRAT	*Schéma Régional d'Aménagement du Territoire*
SWAC	Sahel and West Africa Club
UNECA	United Nations Economic Commission for Africa

UNEP	United Nations Environment Programme
USAID	United States Agency for International Development

GLOSSARY

Adaptation: Actions taken to reduce vulnerability to actual or expected changes in climate stimuli or their effects and consequences on communities' livelihoods, which lessens negative impact or exploits beneficial opportunities.

Adaptation Practices: Changes including adoption of technologies engaged by local communities to enhance their resilience and/or reduce their vulnerability to actual and expected changes in climate.

Adaptive Capacity: The ability of a system to adjust to climate change (including climate variability and extreme climate events) to moderate potential damages, take advantage of opportunities, or cope with the negative consequences.

Agriculture or Farming: Economic activity based on crop and/or animal productions. In Sahelian area, farming includes three major sub-systems: cropping, pastoralism, and agro-pastoralism.

Agro-Pastoralism: An integrated farming system aiming to capitalize on the complementarity between crop and livestock productions in order to diversify and increase farmers' livelihoods and resilience to climate stress, pests and diseases, and market risks. In this report, farmers practicing agro-pastoralism system are called agro-pastoralists.

Breeders: People involved in animal production, either through pastoralism or agro-pastoralism systems. Therefore, breeders include both pastoralists and agro-pastoralists.

Breeding or Animal Production: Animal raising for meat and/or milk production, either through pastoralism or agro-pastoralism systems.

Climate Change: A statistically significant variation in either the mean state of the climate or in its variability persisting for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces owing to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Community: A group of people living together in one place, e.g., in a village; also called "local community."

Composting: Improved process of producing organic fertilizers through decomposition of both vegetal and animal organic matters in a dugout ditch.

Crop Producers: People involving in crop production either through cropping or agro-pastoralism systems.

Cropping System: Farming system based on crop growing for household consumption and/or income earning.

Farmers: People relying on farming, including crop and/or animal productions, for their major livelihoods.

Half-Moons: Large holes in the shape of a semi-circle where the excavated material is deposited on the semi-circle. They allow runoff water to be captured and can also hold organic material (See photos in Annex).

Household: A group of people, generally but not necessarily relatives, who live under the same roof and rely on same or common resources and farming for their livelihoods. This also includes individuals who live outside of the village but have not established their own family yet.

Natural Assisted Regeneration (NAR): consists of promoting and protecting the shoots of woody species in the crop fields to promote regeneration of degraded soils and to create multiple-use agro-forestry systems.

Pastoralism: Farming system based essentially on animal breeding for milk and/or meat production and generally involving the practice of transhumance. "Pastoralism," therefore, has generally a mobile aspect characterized by the moving of the herds in search of fresh pasture and water. In this report, farmers practicing agro-pastoralism system are named pastoralists.

Sahel/Burkina: This is the part of Burkina Faso that falls within the Sahel; it is also the name of the one of 13 regions in Burkina Faso. This region is located in the northern part of the country, and borders Mali and Niger. It includes the provinces Seno, Soum, Oudalan, and Yagha. In this report, Sahel/Burkina is sometimes replaced by the term "study area."

Sahel: The agro-climatic and bio-geographic zone of transition localized from north to south between the Sahara desert and the Sudanese savannah. It stretches in Africa from the Atlantic Ocean to the Red Sea, covering countries such as Senegal, Gambia, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Cameroon, Chad, Sudan, and Eritrea. In this report, Sahel is sometimes replaced by "Sahelian region".

Slow-Onset: For the purpose of this study, "slow-onset" refers to the late starting of rains, its early cessation, or a "failure of rains" during the rainy season. Slow-onset events are very common in the Sahelian region and have significant implications on crop and animal productions.

Stone lines: Rocks deposited along contours to slow runoff water, increase infiltration, and capture sediments (See photos in Annex).

Technologies: Set or package of measures and knowledge used or which can be used (transferable) by farmers for better resilience to climate and other biophysical stresses and for better livelihoods.

Transhumance: Seasonal and cyclical migration of breeders over long distances across countries seeking of better grazing, water resources, and better market opportunities.

***Zaï* Technique:** Digging small holes in the field before the first rains to retain runoff water. Organic matter and fertilizer is placed inside to create favorable growing conditions (See photos in Annex).

EXECUTIVE SUMMARY

INTRODUCTION

This one-year small grant on "Household and Community Experiences and Perceptions on Climate Change Impacts due to Droughts in the Sahel Region of Burkina Faso" began in April 2013. The grant was awarded to Association pour le Gestion de l'Environnement et le Développement (AGED) by the African and Latin American Resilience to Climate Change (ARCC) project, a United States Agency for International Development (USAID) funded Task Order implemented by Tetra Tech ARD under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract. The grant was implemented by the *Association pour le Gestion de l'Environnement et le Développement* (Association for Environment and Development Management [AGED]), a non-governmental organization based in Burkina Faso, with guidance from the United Nations Economic Commission for Africa–African Climate Policy Center (UNECA-ACPC) situated in Addis Ababa, Ethiopia.

The aim of this study is to identify key practices used by smallholder farmers in response to the impact of recurrent droughts in the Sahelian region and to understand the factors determining famers' adaptive choices. The research questions that guided this study are:

1. *What are the main strategies and measures adopted by people living in the Sahel area of Burkina Faso in response to the frequent incidences of drought?*
2. *What do local people report as the reason why they adopt one practice over another?*

By addressing these questions, the results of this study provide information that can help to identify practices that could enhance current responses to the impacts of climate change and climate variability among households located in the study area.

The study was carried out in the northern part of Burkina Faso located in the Sahel zone. The Sahel region of Burkina Faso was chosen for this study because of the zone's limited rainfall and frequency of drought. The targeted study populations of this study were smallholder farmers, including crop producers and agro-pastoralists, and pastoralist communities of the selected villages whose livelihoods predominantly depended on rainfall.

RESEARCH METHODOLOGY

Methods used consist of a combination of qualitative methods (focus group discussions [FGDs], and key informant interviews) and more quantitative methods (questionnaire survey). Household questionnaires were administered to 500 respondents from 16 villages and three provinces. A total of 12 FGDs were conducted within four villages with men; women; youth; and key political, religious, and community leaders.

SUMMARY OF FINDINGS

The results of the study reveal that the socio-economic activities of people in Sahelian area of Burkina Faso are characterized by the predominance of crop production and livestock. Crop production (also referred to throughout the paper as farming) constitutes the main livelihood activity of around 41 percent of households, while roughly 53 percent reported agro-pastoralism as their main activity. Crop production is essentially based on the growing of millet, sorghum, and cowpeas, while livestock rearing

focused on breeding cattle, sheep, and goats for milk and meat production. Only 2 percent of households reported practiced pastoralism as their primary activity. Non-farming activities, such as trading and panning for gold, are minor and only 3 percent of households reported non-form activities as their main livelihood. On average, households engaged in two livelihood activities, but some had up to seven.

The results indicate that drought is the main climate constraint for both crop and animal productions in Sahel/Burkina. Drought is an aggravating factor for the other biophysical constraints identified in the study, namely decline in soil fertility, pest and diseases, water scarcity, disappearing of grazing, erosion, and desertification.

These climatic and biophysical constraints affect the livelihoods of populations through significant impacts on crop production, livestock, food prices, and labor availability. The recurrent and severe episodes of drought lead to a significant drop in crop yields, as well as important environmental disturbances with the upsurge of plant and animal pest and diseases, the disappearing of grazing, and the drying up of usual rivers and water sources used for livestock.

To deal with drought and other biophysical constraints, populations in the study area are using a set of coping and adaptation practices to minimize the effects of climate change. These measures include practices for reducing exposure to climate risk and shock (adaptation practices) and post-risk management mechanisms (coping practices). The coping practices are often used after the onset of drought despite adaptive efforts, and can often have negative implications for households.

Risk and shock reduction practices, also referred to as adaptive practices, include the modification in farming systems and the adoption of water and land management technologies. Modifications in cropping systems include the adoption of new crop varieties, planting of several varieties, adoption of new crops, and the removal of crops and/or varieties deemed more vulnerable. Regarding the adoption of water and land management technologies, crop producers mainly use organic matter, mulching, stones lines, natural assisted regeneration (NAR), *zai*, and half-moons to reduce their exposure to drought. Crop producers also reported that they use organic manure, mulching, chemical fertilizers, stone lines, and *zai* to address challenges of decline in soil fertility. Measures used to combat erosion include stone bunds, NAR, mulching, and windbreaks.

Changes to livestock practices include the adoption of new animal breeds and species and the removal of breeds and species deemed more vulnerable to drought. Breeders also use crop residues, woody forage, transhumance, and groundwater as alternatives for increased water and grazing scarcity.

However, adaptive practices used to reduce risk and exposure to drought and shock were not seen to be sufficient to build farmers' resilience fully to the severe and recurrent episodes of drought in the Sahel of Burkina Faso. Consequently, people have developed post-risk management strategies to reduce short-term risk and exposure. Post-risk management mechanisms, also referred to as coping practices, include asset liquidation, transfer and risk sharing, migration, changes in food habits, use of grain banks, participation in local and international solidarity networks, and the use of ecological services including forest and biodiversity resources. Women play an important role in this mechanism through selling some of their assets, harvesting non-woody forest products that are used for food consumption and income, and helping support household survival.

Farmers' adaptive choices are determined by many socio-cultural characteristics of the households, their access to technical services, awareness about climate change and adaptation, and the characteristics of their production systems. Ethnicity, gender, , and the type of land rights significantly affect farmers' decisions to adopt practices. For example, individuals who do not hold land property rights are less likely to adopt land and water management micro-technologies. Similarly, the sex of the head of the household and women's decision-making authority in on land uses affects the chances of adopting

certain water and land management techniques. Furthermore, cases where a household member attended an awareness or capacity building training on climate change and adaptation were more likely to use water and land management technologies. Also, the more households are connected to the market, the more access households have to using some technologies, such as drought-tolerant varieties of crops. The proportion of degraded land and number of cattle or ruminants owned are other factors which significantly influence farmers' adaptive choices.

Despite their current adaptive efforts, people in the Sahel of Burkina Faso continue to experience the adverse impacts of drought and are looking for more effective and more appropriate measures to deal with drought. Efforts must be made to provide additional measures to strengthen the capacity of people who, despite their current efforts to adapt, still suffer from impacts of increasingly severe and recurrent episodes of drought. In conclusion, the study reveals the need to strengthen the capacity of crop producers, agro-pastoralists, and pastoralists in the study area to respond to extreme climate events, such as drought, through the promotion and improvement of adaptive practice.

RECOMMENDATIONS

The findings of this study have implications for policy makers and planners at both the county and national government levels. Several recommendations for future interventions are presented below.

- Promote and scale up the use of water and land management technologies including organic manure, mulching, drought-resistant varieties, stone lines, NAR, agro-forestry, and *zai*.
- Improve farmers' access to information and markets to increase the ability to capitalize on market opportunities and to adopt alternative crops and economic activities.
- Improve farmers' access to credit in order to enhance their ability to adopt more advanced and input-demanding technologies, such drought-resistant varieties.
- Address gender gap and social differentiations in resources control.
- Strengthen the existing mechanisms for risk sharing and transfer such as grain banks and local and international networks for solidarity, among other mechanisms.
- Implement additional risk-sharing and transfer mechanisms such as micro-insurance programs and programs for social security in order to support risk reduction.
- Increase awareness on climate change adaptation and/or land and water management practices through training and capacity building programs.
- Encourage integration of cropping and breeding systems through promoting multipurpose crop varieties (food and forage), composting and manure production technique, and forage and crop residues storage techniques.
- Promote additional research efforts on agro-forestry, mixed crop-animal-tree systems, supplemental animal feeds, and land and water management technologies.

1.0 BACKGROUND

1.1 CONTEXT AND RESEARCH QUESTIONS

Since the mid-1970s, the Sahel zone in Northern Burkina Faso has experienced recurrent and severe episodes of drought, which have had adverse impacts on communities' livelihoods. Today, there is a great concern about how this region can cope with current changes in climate patterns and secure their already more climate-sensitive livelihoods. For decades, local communities in the Sahel have used adaptation strategies to sustain their livelihoods during droughts and extreme climatic events. However, with the increased frequency and intensity of droughts and climate variability, there is a need for local communities to develop more complex and effective adaptation strategies. *Available evidence leaves no doubt that extreme and slow-onset drought is undermining the livelihood resource-base on which Sahelian farmers, agro-pastoralists, and their families depend for survival.*

The Sahel of Burkina Faso (referred to in this report as Sahel/Burkina Faso or the study area) region's socio-economic and ecological systems are under high exposure to climatic threats. The results from various studies indicate that climate change has already had significant impacts on the farming systems in the Sahel (Joachim, 2011; Kiema et al., 2013). The effects of climate change and climate variability have severe repercussions on farmers and pastoralists. Preliminary results from a case study undertaken by the Institute of Environment and Agricultural Research (INERA) in collaboration with the African Climate Policy Center (ACPC) on climate-related loss and damage among rural communities in the Sahel[1] indicated that drought was the climate extreme event that affected households the most in the Sahel region of Burkina Faso, as indicated by 98 percent of survey respondents. The same survey revealed that 98 percent of respondents still suffered from the negative effects of drought, despite adaptive measures used.

Impacts of droughts have increased in recent years. More severe crop failures and death of large numbers of livestock have directly affected millions of people whose livelihoods depend on these systems. Of all the challenges currently facing rural communities in the Sahel, the most pressing is halting, or at least lessening, the adverse effects of climate change on livelihoods.

This study attempts to document the various measures that communities and households have adopted in response to climate change impacts. In particular, the study looks at the two main livelihood groups in the Sahel: farmers and agro-pastoralists. Several studies have shown that more than 90 percent of households in the Sahel engage in crop production and/or livestock breeding as their main activity and primary source of livelihood (Ministry of Animal and Fishery Resources [MRAH], 2012). This study provides a base on which to identify practices and technical interventions that could enhance current response measures among communities and households in the study area.

Data collection was done through individual household surveys, focus group discussions (FGDs), in-depth interviews at the household and community levels, and key informant interviews. Specific attention was given to gender dimensions and disadvantaged groups. Data were analyzed using standard statistical procedures.

[1] INERA (2012). Climate related loss and damage assessment among rural household in the Sahel region of Burkina Faso. Draft Case Study Report.

This study is a starting point for understanding the points of entry for future interventions. It provides farmers and pastoralists with information about how various options will potentially increase income and crop yield, protect household food security, and help to decrease the negative effects of climate change at the household level. This study, and the sharing of its findings, seek to strengthen farmer and agro-pastoralists' participation in decision-making at the local level in order to increase the sustainability of interventions and improve the effectiveness of measures adopted. Finally, this study hopes to encourage future studies that measure the effectiveness of the adaptive practices identified and presented here.

There are several key gaps in the literature review and current research that this study seeks to address. First, no clear evidence could be identified in the literature review of the coping and adaptation practices currently being used by households in the Sahel zone of northern Burkina Faso. Second, there is no clear, documented understanding of why certain practices are chosen over others, or how and who makes those decisions. Our research questions intend to address these gaps. Specifically, the principal research questions are:

1. *What are the main strategies and measures adopted by people living in the Sahel area of Burkina Faso in response to the frequent incidences of drought?*
2. *What do local people report as the reason why they adopt one practice over another?*

The results of this study provide information on practices that could enhance household responses to the impacts of climate change and climate variability in the study area.

The main objective of the study is to analyze community experiences, perceptions, and responses to climate change impacts in the Sahelian area of Burkina Faso. The specific objectives are:

- Analyze perceptions about the impacts of drought on cropping and breeding systems in the Sahel/Burkina;
- Identify the major adaptation practices used by farmers in response to the recurrent and severe episodes of drought in Sahel/Burkina; and
- Analyze the determining factors of adaptive choices of farmers.

1.2 STUDY AREA

The Sahelian region in West Africa is the transition zone between the Sahara desert and the Sudanese savannah of Africa and stretches from the Atlantic coast of West Africa up to Sudan (Ridder, Stroosnijder, and Cissé., 1982). The zone receives 150–900 mm of rainfall per year. In West Africa, the Sahelian region covers several member countries of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS): Burkina Faso, Cape Verde, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, and Chad.

In Burkina Faso, the Sahelian area spans an area of 36,166 square kilometers and is one of the 13 administrative regions of the country according to the spatial indentation of 2001. It is characterized by a very limited rainfall and experiences frequent droughts. Sahel/Burkina covers three agro-ecologic zones including the Northern zone, the Sahelian zone and the South-Sahelian zone (Figure 1.1). The region includes four provinces(Oudalan, Séno, Soum, and Yagha), with 650 villages and 969,881 people grouped in 182,769 households (*Direction Régionale de l'Economie et du Développement - Sahel* [DRED-SHL], 2007). The population is composed of 49.7 percent males and 50.3 percent females (DRED, 2003), with a large ethnic diversity including Fulani/Peulh, Rimaïbé, Foulcé, Mossi, Gourmantché.

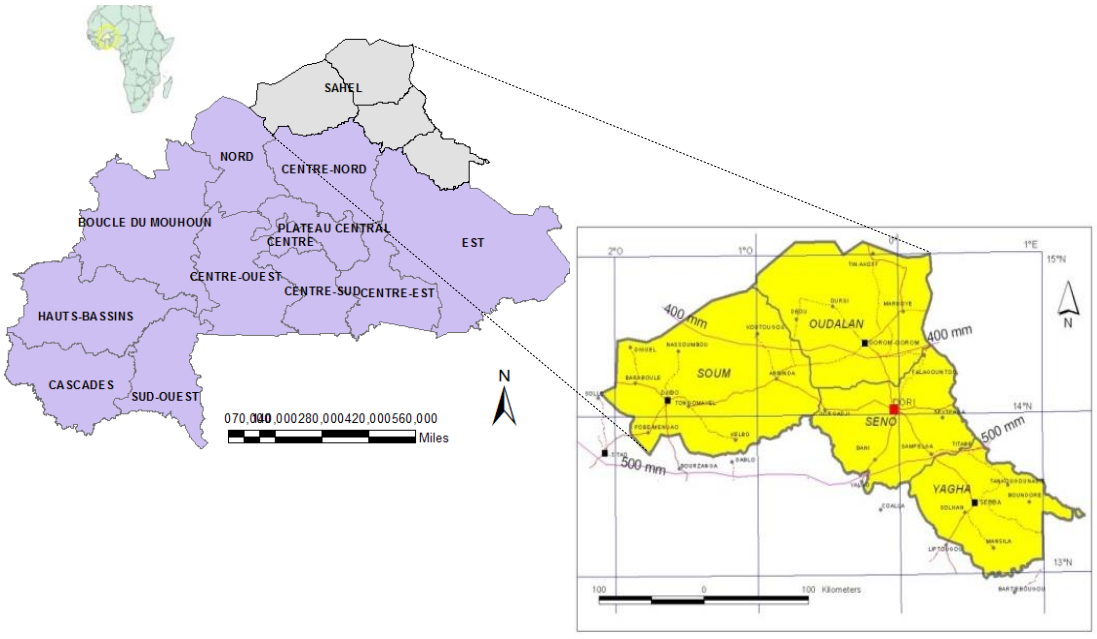

Figure 1.1: Provincial Boundaries of the Sahel in Burkina Faso
(Source: Kiema, 2008)

1.3 CLIMATIC CONDITIONS

1.3.1 Rainfall

The decrease in rainfall during the last decades is among the largest recognized effects of climate change in the Sahel (United Nations Environment Programme [UNEP], 2012). Actually, the Sahelian region has undergone important long term changes in the weather patterns with significant implications on rainfall which has decreased persistently during the last four decades (Somé, Toé, and Ouattara, 1998). It has been reported that the average rainfall in Sahel over the last four decades has remained below one of the period 1900–1970 average (Hulme et al., 2005). The decrease in rainfall continues (L'Hôte., Mahé, Some, and Triboulet, 2002; L'Hôte., Mahé, Some, 2003)although less dramatically after the mid-1990s compared to the 1980s. Recent evidences indicate a light increase of rainfall since 1990s, but the amount of precipitations is still low compared with a poor distribution to the periods before 1970 (Mahé and Paturel, 2009)

In Sahel/Burkina Faso, the annual rainfall has decreased drastically during the last five decades. The average annual rainfall over the 10 last years is 480±135 mm (Kiema, 2008). Studies have shown several decades of latitudinal shift of mean isohyets southward over the period of 1951–2000 (MECV, 2007). The shift of annual mean isohyets had significant consequences on the delineation of climatic zones in the region (Figure 1.2). Specifically, the Sudano-Sahelian zone has been narrowed with an extension of the Sahelian zone throughout 1951–1971. The decade 1981–1990 appears as the driest with the manifestation of the isohyets 300 mm at extreme north of the Sahel/Burkina (Figure 1.3). Some suggested that this drying trend in Sahelian area may be explained by either decadal modes of natural variability or by human-driven emissions. However Duncan et al. (2011) pointed to both aerosol and greenhouse gas emissions as triggers of the changes in weather patterns in Sahel.

Many episodes of severe droughts have been reported after 1970 in Sahel/Burkina Faso, including during the years 1970–1973, 1983–1984, 1991–1992, 1997–1998 and 2003–2004. Empirical evidences and knowledge about the impacts of these drought episodes in the region are sparse.

Figure 1.2: Rainfall by Agro-Climatic in Northern Burkina Faso

Figure 1.3: Zone Average of rainfall showing the dryness pattern of the Sahel region at the Northern Burkina Faso

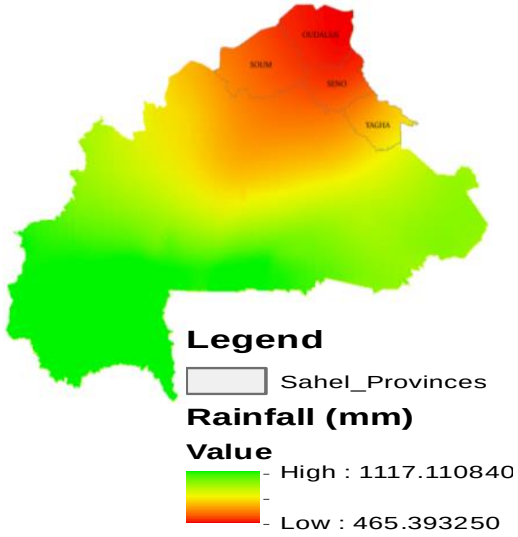

TABLE 1.1: CLIMATIC CHARACTERISTICS OF THE SAHEL REGION

Parameters	Values
Annual rainfall	< 600 mm
Length of the dry season rainfall	110 d
Number of rainy days	< 45 d
Average annual temperature	29° C
Seasonal amplitude	11° C
Humidity in the dry season	20
Humidity in the wet season	70
Annual evaporation	2,200–2,500 mm
Annual evaporation	3,200–3,500 mm

Somé, 2003

1.3.2 Temperature

Average annual temperature in the study area is 29°C. During the last decades, temperatures in the Sahelian areas have increased faster than the global trend, increasing from 0.2°C per decade before 1970 to 0.8°C since the late 1970s (ECOWAS-SWAC/OECD/CILSS, 2008). According to AGRHYMET (2008), it is predicted that global warming will cause the minimum temperatures increase up to +1°C,

and the maximum temperatures to increase up to +0.5°C in Sahel. Half of the models used in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007 have predicted an average increase of 0.5 degrees in Sahel (Christensen et al. 2007). Greater warnings of an increase of around 4° are expected in some parts, including in the western areas of the Sahel.

1.3.3 Extreme Weather Events

Extreme weather events, such as droughts, floods, temperature peaks, violent winds, and desertification, are expected to become more recurrent in Sahelian areas. In Sahel/Burkina Faso, people have experienced many unexpected flooding years during the last two decades.. Particularly, the provinces of Yagha and Soum are most prone to flooding. August, July, and September are recognized as the most-sensitive flooding months, with increased flood risk compared to the annual average (*Programme d'Action Nationale d'Adaptation* [PANA], 2006). Deficits in rainfall are also assumed to be greater and recurrent due to climate change. Over the last two decades, the Sahelian region of Burkina Faso has experienced eight years of severe droughts resulting from significant deficits in rainfall patterns. These extreme climate events, previously experienced only in the province of Gorom Gorom, are spreading with greater intensity over the entire region with great threats to cover the whole nation. These events are potential accelerated factors of the erosion and desertification which already represent other natural constraint affecting Sahelian people.

1.3.4 Natural Resources

In the Sahelian region of Burkina Faso, communities are largely dependent on natural resources for their livelihood. The adverse effects of climate change on these resources threaten rural communities' livelihoods. The adverse impacts of climate change on the natural resources include land and vegetation degradation, biodiversity and ecosystem disturbance, and water scarcity.

Soils, Land, and Vegetation

The Sahel is characterized by soils mostly inadequate for vegetation due to their low permeability that inhibit the infiltration of water. The larger share of the lands is arid and uncultivated because of desertification and erosion. As a result, the smaller share of lands, which is more adequate for crop production, is continuously being over-exploited without any real efforts at maintaining soil productivity through using fertilizers. Soils are therefore generally infertile and equally very sensitive to physical degradation under the increased climatic and human threats. Pastoral lands even suffer from overgrazing and poor management. In addition, the advent and expansion of gold panning sites throughout the region have contributed to land degradation and scarcity.

Land over-use and degradation led to increased pressure on the vegetation. Starting in the 1970s, vegetation in the Sahelian region began declining (De Wispelaere, 1990). However, a slight recovery in vegetation was observed in the mid-1980s, particularly on the fossil dunes of province of Oudalan in Sahel/Burkina Faso (Rasmussen et al., 2001; Herrmann et al., 2005). Pastures and grazing become very scare with important implications on people livelihood mostly based on agro-pastoralism.

Soils are also subject water and wind erosion, which make them susceptible to degradation in addition to the impacts of poor farming practices.

Biodiversity and Ecosystems

Land, defined as the aggregate of all surface areas, excluding bodies of water, represents 91 percent of the Sahelian territory and is primarily covered with herbaceous plants. The other major ecosystem resources include river streams, reservoirs and ponds, floodplains, wetlands, and irrigated ecosystems.

The real value of these different ecosystems for national economics and for livelihoods is still unknown. Also, a major knowledge gap remains on the impacts of erosion on social and economic conditions of people (Warren et al., 2001).

Moreover, the biological potential of the land experienced increasing pressure from climate change and human activities. These pressures result in such impacts as:

1. Decreased ability to meet the demands for goods and services;
2. Disruption of biological resources due to significant migration into the Sahel; and
3. The acceleration of land degradation due to overgrazing and trampling.

Water Resources

Water resources in the Sahel/Burkina include rivers, tributaries, natural pools, and shallows. The main streams watering the area are the River Béli, River Gorouol, and River Sirba (and their tributaries). There are several retaining reservoirs in the area; the greatest is the dam of Yakouta, the capacity of which is estimated to be about 26 million m^3. Stream flows vary greatly throughout the year. The dry season exhibits a drop of the flows with a number of perennial pools. The most important of these pools are those of Oursi, Tin-Akoff, Yomboli, Dori, Darkoye, and Soum. During the rainy season, water levels increase and the pools spill over significantly. Over the last 50 years water availability in Sahel/Burkina has declined drastically. Rainfall deficits were estimated to be 15–20 percent during the 1980s. The river streams progressively disappear and even are discontinued in many parts as a result of decline in rainfall, sandbanks and sedimentation.

1.4 POVERTY AND VULNERABILITY

Sahelian people are particularly vulnerable to climate risks since their livelihoods depend greatly on climate sensitive sectors such as rain-fed cropping, free-range breeding and natural resources. A recent study indicates 96 percent and 93 percent of Sahelian people are involved in crop and livestock productions, respectively, against only 20 percent and 3 percent who are involved in trade and fishing (op cit, INERA 2011). But, many empirical evidences indicate that climate change is significantly affecting farming systems in the Sahel (Joachim, 2011; Kiema et al., 2009). According to Oxfam (2012), grain production in many parts in Sahel was 36 percent lower in 2011 than the average for the previous five years (2006–2010). The most affected households are those which depend on subsistence farming. The incidence of poverty for subsistence farmers is 44 percent against 36 percent for those who essentially produce for the market (Ministère d L'Économie et du Développement [MED], 2005). Women and other marginalized and disadvantaged groups are more vulnerable to poverty (Table 1.2). Youth are relatively marginalized by a gerontocratic social structure – where elder members of the household are the decision makers. The tendency among youth is to leave their villages at seeking of economic opportunities in cities and neighboring countries.

The region is already food unsecured due to frequent and intense droughts that are caused loss of livestock and decreased crop production in the past. The production losses have led to severe hunger and malnutrition, loss of human lives, disease, and mass displacement of people from rural areas to nearby cities. Population mobility is exacerbated by recurrent drought episodes in the region, and is leading to significant conflicts around land, pasture and water control (Benjaminsen, Alinon, Buhaug, and Buseth, 2012). Actually, competition for natural resources is increasing and causing greater tension between transhumant breeders and other users of natural resources, such as crop producers and foresters (SWAC/OECD, 2010).

TABLE 1.2: VULNERABILITY OF SOCIO-ECONOMIC GROUPS

Socio-economic group	Incidence of poverty (Po)	Depth level (ft)
Subsistence farming	43.7	13.0
Progressive agriculture	36.4	10.5
Inactive	28.7	8.3
Unemployed	23.4	6.9
Other assets	14.4	3.5
Nonagricultural independent	8.9	2.0
Unprotected workers	7.8	1.5
Protected workers	1.3	3.0

Sources: MRA (2005) / PANA _ Burkina Faso (2006)

1.5 PRODUCTION SYSTEM

1.5.1 Cropping System

According to figures from the National Survey for Agricultural Statistics (*Enquête Nationale de Statistiques Agricoles* [ENSA], 1993), crop production is the main activity of people living in the Sahel area of Burkina Faso. Cropping represents the main activity of 81 percent of the active population and employs 93 percent of all men and 69 percent of all women. Crop production is staple crop-based, with millet, sorghum, and maize as the main crops. Crop production in the study area still remains very extensive and manual with a low input use. As a result, crop yields in this region are very low compared to Sudanian and humid regions. Estimates indicate that the average yields of millet and sorghum range from 150–400 kg/ha (Claude, Grouzis, and Milleville., 1991; Kiema, Ouedraogo, Nianogo, and Sanou, 2001). On average, households produce three staple crops and one cash crop. The average harvested acreage is of 5.75-8 hectares.

1.5.2 Pastoralism

Pastoralism in the Sahel is characterized animal breeding for milk and/or meat production, and generally involving the practice of transhumance. The breeding is dominated by ruminants including cattle, sheep, and goats, but with also some monogastric stock such as donkeys, camels, horses, and poultry. The most common cattle breeds reared in Sahel are *Puli Puli* bovine (or *Fula* zebu in the Sahel), *Bodrogui* bovine (or *Bororo* zebu), *Goudali* zebu, and the Azawak zebu. Sheep breeds include *Bali* and the *Peul* sheep, while *Sahel* and *Maradi* represent the most common breeds of goat. Pig raising is minimal and is explained by the cultural characteristics predominated by Muslims.

On average, pastoralists own around 27-29 heads of cattle and around 23-16 and 14-11 heads of goat and sheep, respectively (DRED-SHL, 2007). Breeding techniques are various and more extensive. They include transhumance, which is one of the major practices used by pastoralists to gain access to natural grazing and water and to cope with the adverse effects of recurrent droughts on pasture resources. Animal feeding types include natural grazing (herbaceous and ligneous plants), crop residue (cereal straw, legume haulm, wheat bran, seed pod, and sorrel and sesame branches), and feed from picking (water lily bulbs). Crop residues and feed from picking are usually used as supplemental feed for more vulnerable animals, mainly young calves and dairy cows that are weakened by pasture scarcity in dry season. Increasingly, breeders' use natural grazing is becoming more and more scarce-. Mineral salts also represent an important component of animal feeding in the study area. Some salts are kitchen salt, made

in Niger, but common salt and salt licks are also used (Claude et al., 1991). However, animal breeders still encounter significant challenges to feed and water their livestock.

1.5.3 Agro-Pastoralism

One of the fundamental economic characteristics of the study area is the coexistence of crop and livestock production in the farming system. Agro-pastoralism is an integrated farming system aiming to capitalize on the complementarity between crop and livestock productions in order to diversify and increase farmers' livelihoods and resilience to climate stress, pests and diseases, and market risks. While agro-pastoralists depend mainly on extensive breeding for their livelihoods, they also are greatly engaged in crop production for food security. About 94 percent of the Sahelian people practice crop production, while more than 80 percent are involved in various types of breeding (*Schéma Régional d'Aménagement du Territoire* [SRAT], 2006). In most cases, agro-pastoralism results in a reconversion of highly affected pastoralists who have experienced an irreversible loss of their livestock during the severe episodes of drought of 1973–1974 and 1983–1984. When livestock losses reach a certain threshold—often 50 percent of a cattle herd—it is difficult for the pastoralist to remain wholly on pastoralism for their livelihoods. Consequently, many pastoralist become agro-pastoralists by practicing unsecured crop farming. This explains the surge of agro-pastoralists during the last decades in the Sahelian area of Burkina Faso.

2.0 METHODOLOGY

The research approach includes qualitative methods through focus group discussions and key informant interviews, and quantitative methods based on household surveys.

2.1 FOCUS GROUP DISCUSSIONS

Focus group discussions were held in four villages distributed in the four provinces of the study area. Three FGDs were held in each village. The focus groups' participants included the leaders of the Village Council Development (CVD), the village heads, and members of other key groups such as women and youth. A total of 12 FGDs were conducted.

Villages were notified two-to-three days prior to the date of the discussions. This helped to spread the news and make the required arrangements to succeed the FGDs. For each group, the discussions were carried out with a discussion guide designed for this purpose (Appendix 1). Each discussion group was composed of 20–50 individuals including crop producers, agro-pastoralists, and pastoralists, with men, women, and youth well represented. The average duration of the discussion was about one hour. Table 2.1 presents the different villages involved in the focus group discussions. No major problems were reported during the FGDs.

TABLE 2.1: NUMBER OF FGDS PER VILLAGE

Province	Village	Number of FGDs
Séno	Sambonaye	3
Soum	Tongomayel	3
Oudalan	Bagawa	3
Yagha	Solhan	3
	TOTAL	**12**

2.2 KEY INFORMANT INTERVIEWS

Ten key informant interviews were conducted with resource persons. The people interviewed were adults of over 50. Interviews with resource people were carried out with a semi-structured survey guide. The resource people were selected in light of their experience in the region in diverse areas of development, particularly crop production, breeding, governance, politics, and leadership, and also took into account their understanding of the problems associated with climate change in the Sahel. Interviews focused on natives or long-term residents who have lived through or been repeatedly afflicted by the effects of climate changes in the region.

2.3 HOUSEHOLD SURVEYS

A total of 500 households distributed across 16 villages within four provinces of the Sahel region were surveyed as shown in the Table 2.2 (next page). Stratified sampling was used for these surveys. At the regional level, villages were selected in a manner to cover the four provinces. Villages were also selected in a way that could capture regional differences. Within each village, the persons to be interviewed were

chosen by neighborhood. Households were selected based on age and ethnic representation. Those interviewed were household heads or their representatives.

Data were collected using a questionnaire developed for this purpose. Data collection was carried out by enumerators under the control of supervisors. Both enumerators and supervisors are experienced in data collection, having at least secondary school and master's degrees, respectively, and the ability to speak the native languages of the study area. Data collected was recorded using SPSS software.

Data collected from vulnerable persons was also done using a survey questionnaire. This questionnaire was administered to people with a specific history of exposure to the effects of climate change; that is, people who were identified as those particularly vulnerable to the effects of climate change.

Before administering the survey, a training session for enumerators and supervisors was held to explain the research goals and data collection method. At the end of the training, the questionnaires were pre-tested in the village of Diouga with five households. Actual investigations lasted 45 days, from September 20–November 5, 2013.

For each village surveyed, a supervisor for two enumerators was assigned to provide advice to the enumerators and control the quality of the data collection. Investigation permits that briefly stated their mission objectives were issued to the supervisors by the Association for Environment and Development Management (AGED) in order to facilitate and formalize their interventions in the study area.

On average, each enumerator administered three household survey questionnaires per day. It took up to one day for supervisors to complete the survey forms on the vulnerable persons.

One constraint was that the questionnaire was very lengthy. Considerable time was required to fill out the questionnaire, which became a burden to household heads being surveyed.

The surveys were conducted at the interviewee's home. All the selected sites were accessible and the interviews went smoothly due the fact that AGED and INERA are institutions well-known by the farmers.

TABLE 2.2: SUMMARY OF VILLAGES AND NUMBER OF VILLAGES SURVEYED

Province	Village	Number of households
Séno	Sambonaye	25
	Lelly	40
	Diouga	20
	Niagassi	40
Soum	Tongomayel	40
	Belhou	30
	Koutougou	20
	PobéMengao	40
Oudalan	Tin Akoff	36
	Bagawa	18
	Darkoye	26
	Oursi	24
Yagha	Mansila	40
	Boundoré	34
	Solhan	22
	Titabé	45
TOTAL HOUSEHOLD SURVEYS		**500**

2.4 DATA ANALYIS

Data entry was done in SPSS using a template adapted to the survey form. After the entry, the data were cleaned before proceeding to the analyses. Descriptive statistics and logistic regression (Logit) were used for the analyses. Analyses were done by a statistical analyst at United Nations Economic Commission for Africa–African Climate Policy Center (UNECA-ACPC).

2.5 MAJOR CONSTRAINTS

The team observed that a significant amount of time was spent preparing for the interviews, especially the notification period for people to convene. Scheduling meetings with the resource persons was also difficult because of time conflicts, resulting in delays in conducting these interviews. The survey form was quite long. Administration time was relatively lengthy, which at times contributed to tiring the heads of households being interviewed. In spite of these challenges, no major problems were encountered related to data collection and analysis.

3.0 FINDINGS: GENERAL CHARACTERISTICS AND PERCEPTIONS

3.1 SOCIO-ECONOMIC CHARACTERISTICS OF HOUSEHOLDS

The heads of household surveyed were predominantly male (96 percent). The results indicate a large ethnic diversity in the study area. The ethnic majorities in the Sahel region are Peulh, Rimaïbé, Foulcé, Bella and Mossi. Islam is the principal religion and is practiced by approximately 97 percent of households surveyed. The other religions, namely Christianity and animism, have minimal presence and are only practiced by around 3 percent of households surveyed.

Agriculture remains the principal activity of people in the study area. Approximately 98 percent of households surveyed indicated agriculture as their principal economic activity. The other 2 percent depend mainly on non-agricultural activities, such as trade, gold panning, and crafts for their livelihood.

Of the approximately 98 percent who indicated agriculture as their principal activity, 41 percent of household are engaged in crop production as their principal activity, 55 percent indicated agro-pastoralism as their principal activity, and only 2 percent of households practiced pastoralism as their principal activity.

Other activities—including trade, crafts, gold panning, and wage earning—are practiced by around 3 percent of households as their principal activity. Households practice an average two activities, but practice up to seven activities in certain situations practice (Table 3.1). The average age of the head of household is 49 years old. The average household size is 12 persons, and the average duration of living in the region is 45 years.

TABLE 3.1: SAMPLE DISTRIBUTION BY PRINCIPAL ACTIVITIES FOR THOSE THAT INDICATED AGRICULTURE AS THEIR PRINCIPAL LIVELIHOOD

Province	Principal Activity		
	Crop production	Agro-pastoralism	Pastoralism
Seno	43% (n=52)	56% (n=67)	01% (n=1)
Oudalan	18% (n=19)	75% (n=78)	04% (n=7)
Soum	67% (n=83)	32% (n=39)	01% (n=1)
Yagha	38% (n=52)	61% (n=83)	01% (1)
TOTAL BY PRINCIPAL ACTIVITY	**43% (n=206)**	**55% (n=267)**	**02% (n=10)**

3.2 ROLE OF WOMEN IN AGRICULTURAL PRODUCTION

Table 3.2 indicates the role of women in the principal economic activities practiced in the study area. In crop production, women are often in charge of planting, collecting and transporting manure, weeding, and harvesting activities. For animal production, they are responsible for milking and processing and selling milk. Women also raise small ruminants and poultry. Women are specialized in small-scale trading and selling poultry products, especially eggs.

TABLE 3.2: GENDER DISTRIBUTION OF RESPONSIBILITIES IN ECONOMIC ACTIVITIES

Main Activities	Men	Women
Livestock	• Conducting grazing animals • Maintaining health and watering herds • Practicing transhumance • Processing milk and feeding/fattening	• Practice of fattening • Watering and feeding of calves and animals not taken to pasture • Processing and selling milk
Agriculture	• Seeding, plowing, weeding, fertilization (manure) harvesting, and collecting crop residues • Protecting damaged fields	• Seeding, thinning, manure collecting, weeding, and harvesting • Aiding in field protection
Artisanal craft making	• Masonry, jewelry, blacksmithing, and brick making	• Making straw mats and leather goods (manufacturing bags and other leather items)
Business trade	• Livestock commerce, grain and boutique items	• Small businesses (cakes, peanuts, and cola) • Selling poultry products • Selling farm-fed animals (sheep and cattle)
Gold panning	• Digging holes, grinding, washing, and extracting ores	• Blowing sand, washing and extracting ores
Exploitation of natural resources	• Collecting firewood	• Selling firewood, collecting and selling non-wood related products
Fishing	• Fishing	• Frying, smoking, and selling fish

Source: Focus group results

3.3 FARMERS' PERCEPTIONS ON RECENT DROUGHTS

According to focus group participants, the most recent severe episodes of droughts in the Sahelian region of Burkina Faso are those of the years 2004 and 2011. Those that occurred in 2004–2005 were characterized by a drastic reduction in rainfall with at most 30 rainy days. The drought of 2011 was characterized by a late onset and an early cessation of rains. Focus group participants noted a reduction in rainfall and an uneven distribution in time and location during the last 20 years, with some years having exceptional heavy rainfall.

The consequences of the extreme climatic events of 2004 and 2011 on crop and livestock production have resulted in decrease in crop yields and the upswing of destructive crop pests and diseases, such as locusts. For breeding, the lack of pasturage and the drying up of water sources for watering cattle were notable. This led to considerable herd loss and early and long departures for transhumance. Many pastoralists and agro-pastoralists are not fully recovered, as they have not yet restored their herds after the major losses experienced during these extreme episodes of drought.

At the social level, there was a strong migratory movement of youth and certain heads of household who left the study area for other villages or other regions. Some have even left their villages permanently. Many people sold personal equipment and assets (such as carts, bicycles, telephones, and women's jewelry) in order survive and to cope with adverse of the drought. One anecdote reported

was that some had even sold their beds. The drought affected the social fabric by weakening the sense of solidarity and social assistance that is part of the culture in the region. Some farmers noted that their dignity was violated because they were forced to resort to begging in order to assure their survival.

3.4 CONSTRAINTS ON CROP AND ANIMAL PRODUCTION

Tables 3.3 and 3.4 present the ranking of major constraints confronting the farmers of the study area. The results indicate that the principal constraint for crop production is drought, which affects almost all activities. Around 98 percent of households surveyed reported being severely affected by drought at least once in the course of the last 10 years. The other major constraints noted are decline in soil fertility and plant diseases (Table 3.3). Erosion and desertification seem less important in the view of crop producers compared to the challenges of decline in soil fertility and plant pests and diseases. These results support those of the FGDs, which had also indicated an upsurge of insects, other crop pests, and animal diseases during the 2004 and 2011 episodes of drought.

TABLE 3.3: CONSTRAINTS RANKING FOR CROP PRODUCTION

Constraints	Average Rank	Priority
Drought	1.616	1
Soil fertility	3.78	2
Plant diseases	4.33	3
Desertification	5.03	4
Erosion	5.59	5
Flooding	5.89	6

For animal production, the major constraints indicated by the farmers are, in order of importance, drought, lack of pasturage, scarcity of water, and animal diseases (Table 3.4). These results also support those of FGDs. Market constraints linked to price reduction in animal protein products (such as meat, milk and eggs) are less important for breeding, given that considerable price drops of these products are less frequent. Numerous studies have indicated increased price and demand for such protein products, as meat, milk, and eggs during the recent last years in the Sahelian area.

Drought represents an aggravating factor of other constraints, including reduction in fertility, diseases, water scarcity, lack of pasturage, erosion, and desertification. During the FGD, farmers mentioned upsurge of pest and diseases as one of the implications of drought in 2004 and 2011. Implementing effective adaptation strategies of for drought control is therefore necessary to improve the livelihood of Sahelian populations, and could contribute to alleviating numerous other constraints that the farmers face.

TABLE 3.4: CONSTRAINTS RANKING FOR ANIMAL PRODUCTION

Constraints	Average Rank	Priority
Drought	1.86	1
Pasture scarcity	2.17	2
Water scarcity	2.38	3
Animal diseases	3.27	4
Desertification	3.35	5
Price drop	4.24	6

3.5 SENSITIVITY OF LIVELIHOODS TO DROUGHT

Figure 3.1 indicates farmer perceptions of the impacts of drought on their major livelihood. The results indicate a large sensitivity of the principal livelihoods of people in the Sahelian area of Burkina Faso to the effects of drought. According to the surveyed individuals, drought most severely affects crop and animal production, the prices of local foods (milk, staple crops, eggs, etc.), and the availability of natural resources. Around 90 percent of the surveyed individuals declared that crop production, breeding, natural resources, and food prices are highly affected by drought. Of individuals surveyed, 65 percent said that the availability of agricultural labor is also affected.

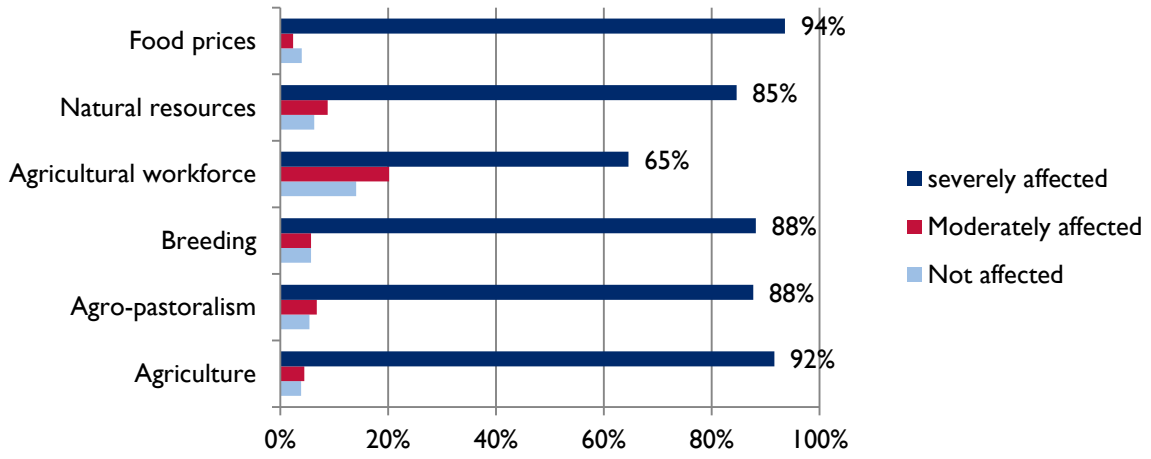

Figure 3.1: Severity of Effects of Climate Change on Farmers' Livelihoods

Nearly half the surveyed individuals stated that they lose all their cropping income in severe drought years, the rest of the surveyed individuals indicated that they experience loss of 25–75 percent when they are affected by drought. Around 12 percent of surveyed individuals indicated that they lose all their breeding income in drought years, while 38 percent stated that they lose 75 percent of breeding income (Figure 3.3). Half of the surveyed individuals indicate a decrease of 25–50 percent of breeding income during drought years. These results indicate diverse vulnerability levels of activities due to drought.

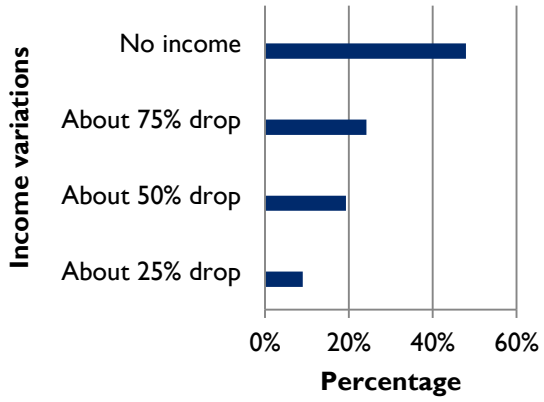

Figure 3.2: Impact of Drought on Agricultural Income

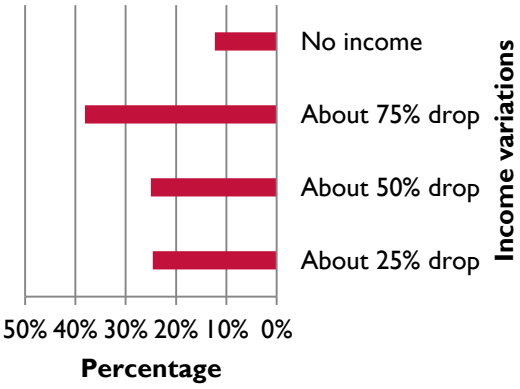

Figure 3.3: Impact of Drought on Livestock Income

Peoples' perceptions about the changes in their livelihoods align with the changes in their crop (Figure 3.2) and breeding (Figure 3.3) productions. Figure 3.4 (next page) presents the perceptions of crop producers about the impacts of drought and other bio-physic constraints on their livelihoods during the last 10 years. The majority of respondents indicated that their levels of crop production have declined over the past decade in terms of either yield or area planted. More than half of crop producers (56 percent) reported a decrease in food crop yields over the past 10 years, and about 30 percent believe that the yields of cash crops have also decreased. The decline in crop yields reported by the majority of crop producers is partially explained by the occurrence of increased soil degradation and the rapid population growth during the recent decades. Both factors have pushed people to cultivate drier and poorer lands located in the north parts, where crops are more exposed to the risk of severe episodes of drought (Diakite, 2013).

In terms of income, 30 percent of crop producers indicated an increase in their cropping income during the past 10 years, while around 14 percent think having experienced a decrease. The majority of crop producers, around 70 percent, reported having observed an increase in their income generated from livestock over the last 10 years, as opposed to 23 percent who do not notice a change in their livestock income. On the other hand, 59 percent of crop producers reported a decrease in the amount of milk produced during the last 10 years. The increase in livestock income among the crop producers can be explained by the intensification or integration of livestock activities in the production system for the purpose of diversifying their livelihoods.

For agro-pastoralists, the results indicate that most have experienced a reduction in their animal production during the last 10 years. Approximately 75 percent of agro-pastoralists reported a decline in the size of their herds over the past decade, while about 80 percent indicated that their milk production has also decreased over the same period. Income from livestock declined for only 35 percent of agro-pastoralists while about 55 percent reported that they noticed an increase in their income from livestock. Regarding to crop production, only 17 percent of agro-pastoralists reported a decrease in their harvested areas of staple food crops in the last 10 years, while 56 percent think having not noticed any change in their harvested areas. However, about 67 percent reported that crop yields have declined over the last decade. These features support the evidence that there are more households moving into agro-pastoralism as a result of herders who have experienced an irreversible loss of cattle following extreme episodes of drought.

4.0 FINDINGS: ADAPTIVE PRATICES

4.1 MODIFYING CROPPING PATTERNS

Modifying crop systems is a strategy used by crop producers to confront dry climatic conditions and extreme events. This strategy involves modification of the production system through the adoption of new varieties or crops, diversification, or the abandonment of crops deemed most vulnerable. As demonstrated in Figure 4.1, the top practices adopted by the crop producers to reduce the effects of drought on crop production in the study area are resowing, adopting new varieties, integrating new crops, and planting/sowing several varieties.

Figure 4.1 shows all of the practices farmers reported using. These practices add up to more than 100 percent, as a single farmer uses a variety of strategies.

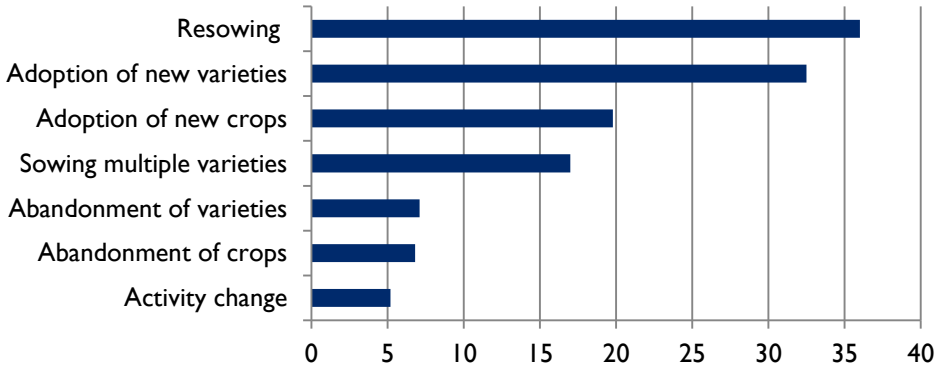

Figure 4.1: Modifications in Crop System

4.1.1 Resowing

Resowing is major practice by farmers to face to the impacts of droughts and is practiced by around 35 percent of the respondents. In resowing, a farmer will sow a field again if the first or successive sowings did not sprout due to erratic rainfall or temporary rain-break at the beginning of rainy season. It allows farmers to reduce the impacts of erratic rainfall on crop sprouting out and to reduce the impacts of drought at the beginning of the season.

4.1.2 Adoption of New Varieties

Around 33 percent of the farmers adopted new crop varieties during the last 10 years. Of the new varieties adopted, 62 percent were millet, 21 percent were sorghum, and 15 percent cowpeas. The main reasons for adopting the new crop varieties are the shortness of the duration of the cycle and the resistance to drought. Around 70 percent of the adopters have indicated shorter cycles as the main

reason for adopting the new varieties. Even for farmers are interested in adopting drought-tolerant varieties, the duration of varieties' growing cycle influences their decisions to adopt.

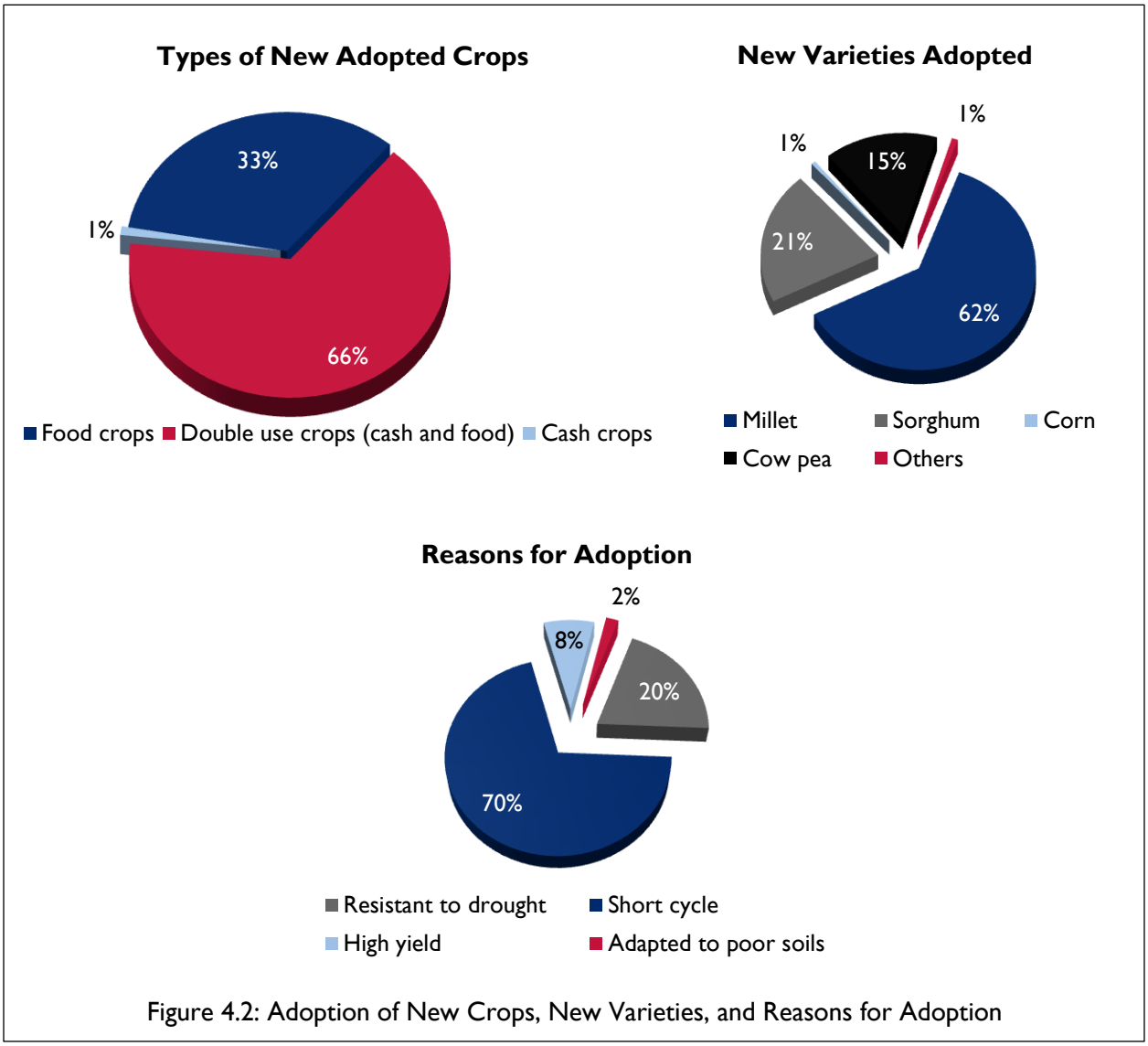

Figure 4.2: Adoption of New Crops, New Varieties, and Reasons for Adoption

4.1.3 Adoption of New Crops and Sowing Multiple Varieties

The adoption of new crops mainly involves dual-purpose crops (i.e., both subsistence and cash crops), allowing farmers to simultaneously increase monetary revenue and assure food security from their use. Around 66 percent of new crops adopted are dual-purpose crops, while 33 percent are staple food crops including millet, sorghum, and maize (Figure 4.2). According to Andres and Lebailly (2013), the adoption of dual-purpose crops becomes a practice more and more current in Sahelian area to confront numerous biophysical constraints, notably degradation and scarcity of natural resources, and also to reduce climatic risks while increasing profit from market opportunities.

Dual-Purpose Crops

The main dual-purpose crops adopted during the last 10 years are sesame, cowpeas, and legumes. Sesame and cowpeas are emerging crops in the Sahel and in West Africa, and there has been large scale

adoption of these (Andres and Lebailly, 2013). According to farmers' statements, the principal reasons for adopting dual-purpose crops in the last 10 years was primarily due to their market potential and the crops early cycle and yield. A recent study (Andres and Lebailly, 2013) in the Niger indicated the new market opportunities through an increased demand and price, the resistance to drought, the low input requirement, and the higher yields are the principal factors that enhance the rapid and massive adoption of sesame in farming systems in Sahelian region. The annual rainfall requirements for sesame vary from 250–600 mm/year (Santens, 1980) and make its very suitable to the Sahalien climate. In addition, the annual evolution of its price is characterized by an average growth of around 28 percent between 2008 and 2009 with a still-growing demand (Andres and Lebailly, 2013). At household level, sesame contributes to economic, social, and nutritional balance. It allows households to ensure their food security and to minimize the risk of a bad year for staple food crops such as millet and sorghum. For instance, sesame is used as a substitute for peanuts or "soumbala", to make sauce or to mix with sorrel leaves. It also provides the opportunity to be processed locally and provides, especially for women, a source of income through the sale of sesame-based cookies and/or oil.

Cowpeas are another dual-purpose crop adopted because of the earliness of its growing cycle and its market opportunities. Cowpeas are often harvested early when still green to meet a growing local demand for green beans. The leaves and pods of cowpeas play an important role in the food security of the population and are a source of diversification or a substitute for staple foods such as sorghum and millet during the bad years. This makes the cowpeas a dual-purpose crop as they contribute to peoples' food security, even in bad years, while helping them to earn income through the market opportunities it provides.

Staple Crops Diversification

Staple crop diversification is another practice used by farmers to reduce their vulnerability to drought. During the last 10 years, many farmers who did not grow certain staple crops before started to introduce those crops in cropping system. The new staple crops adopted during the last 10 years are millet, sorghum, and maize (Figure 4.2). They are not new in the study area, but are new for some farmers who did not grow them before. Historically, millet and sorghum are the main staple crops grown in Sahel/Burkina, as reflect of their food habits. Due to the recurrent impacts of drought on food production, people started to diversify their food production. So, millet producers have started growing sorghum, and sorghum producers started growing millet. Millet is represents 62 percent of cases where farmers decided to diversify their staple crop production, followed by 21 percent for sorghum and 15 percent corn. According to farmers, the main reasons for adopting new staple crops and sowing multiple varieties are the early maturity, the yield, and the ability to resist drought (Figure 4.3). These results indicate that the farmers have a preference for the short-cycle varieties to confront the variable climate conditions and the risks of drought.

4.1.4 Abandonment of Varieties and Crops

Abandoning crops or varieties and changing economic activities are less frequent and are in each case practiced by less than 8 percent of the respondents. This indicates that diversification of the cropping system through diversification of varieties and crops is the most common modification farmers make to the cropping system for reducing the impact of droughts on crop production.

4.1.5 Change in Livelihood Activities

Around 5 percent of farmers indicated that they have changed their principal activities during the past 10 years because of decreasing crop yields, drought, market opportunities, the scarcity of pasture, and the loss of livestock (Figure 4.3). Some producers changed from crop production or pastoralism alone to agro-pastoralism or outright to non-agricultural activities such as small trading and gold panning.

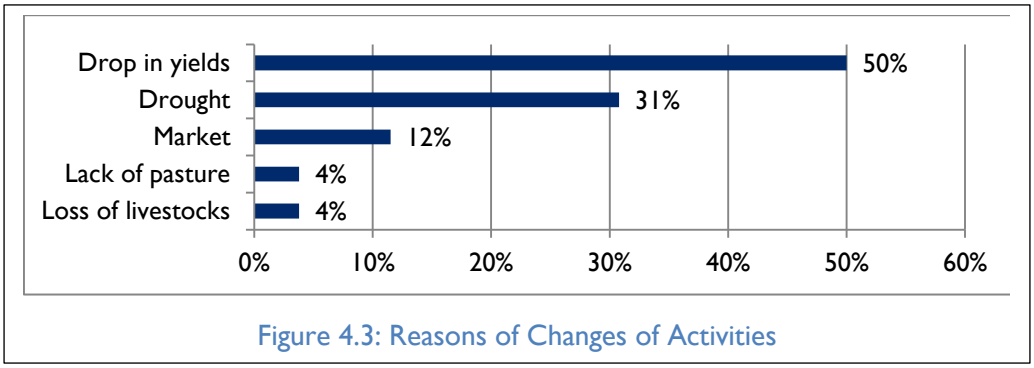

Figure 4.3: Reasons of Changes of Activities

4.2 MODIFYING LIVESTOCK (BREEDING) SYSTEM

The modifications to the livestock system involve the adoption of new breeds or species and/or the removal of other breeds or species more vulnerable to climatic constraints. Figure 4.4 indicates that in the last 10 years, around 12 percent of the respondents have adopted new breeds of animals, while 5 percent stated having integrated new species in their livestock system. The removal of animal breeds or species is relatively rare compared to adoption. The adoption of new breeds involves principally bovines (43 percent) and goats (52 percent). The new species adopted are goats (43 percent), bovines (39 percent), and others (18 percent) (Figure 4.5).

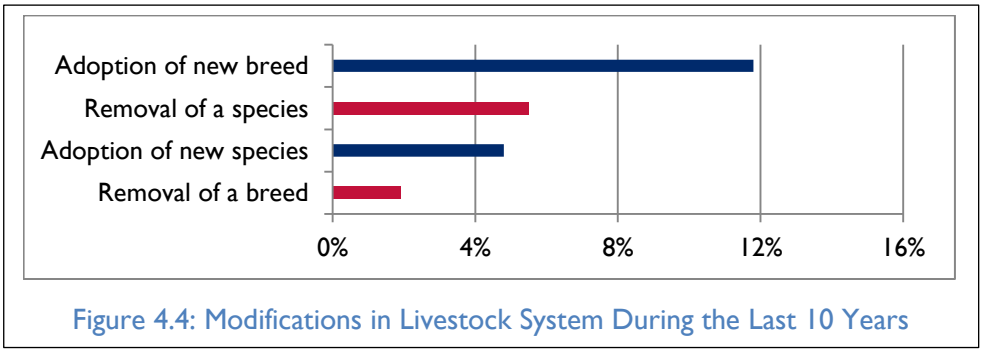

Figure 4.4: Modifications in Livestock System During the Last 10 Years

The principal reasons for which breeders adopt new animal breeds are linked to the animals' capacity to adapt to drought, lack of pasturage, and the animals' resistance to diseases. Goats are very frugal animals and capable of searching for forage, particularly woody forage, during the dry season or drought episodes. The adoption of certain races of bovines was favored by projects and governmental programs with the objective of milk production. This was done most notably via the introduction of the Azawak and Goudali breeds and to a lesser extent the Gir and Girolando breeds in the province. These breeds are characterized by their exceptional performance in producing milk. For instance, the average milk produced by Zebu Azawak is 8–12 liters/day compared to 2–4 liters/day for the local Zebu peulh breeds. With the breeds Gir and Girolando, farmers can produce over 20 liters/day. Yet those breeds

are more feed demanding, and therefore less tolerant to pasture and animal feeding shortage compared to Azawak and local breeds. Also, Azawak, Gir, and Girolando breeds are more vulnerable to animal diseases compared to local ones as they are imported breeds.

The adoption of new species is by contrast determined by market opportunities, the productive performance of the species, and their resistance to drought (Figure 4.5).

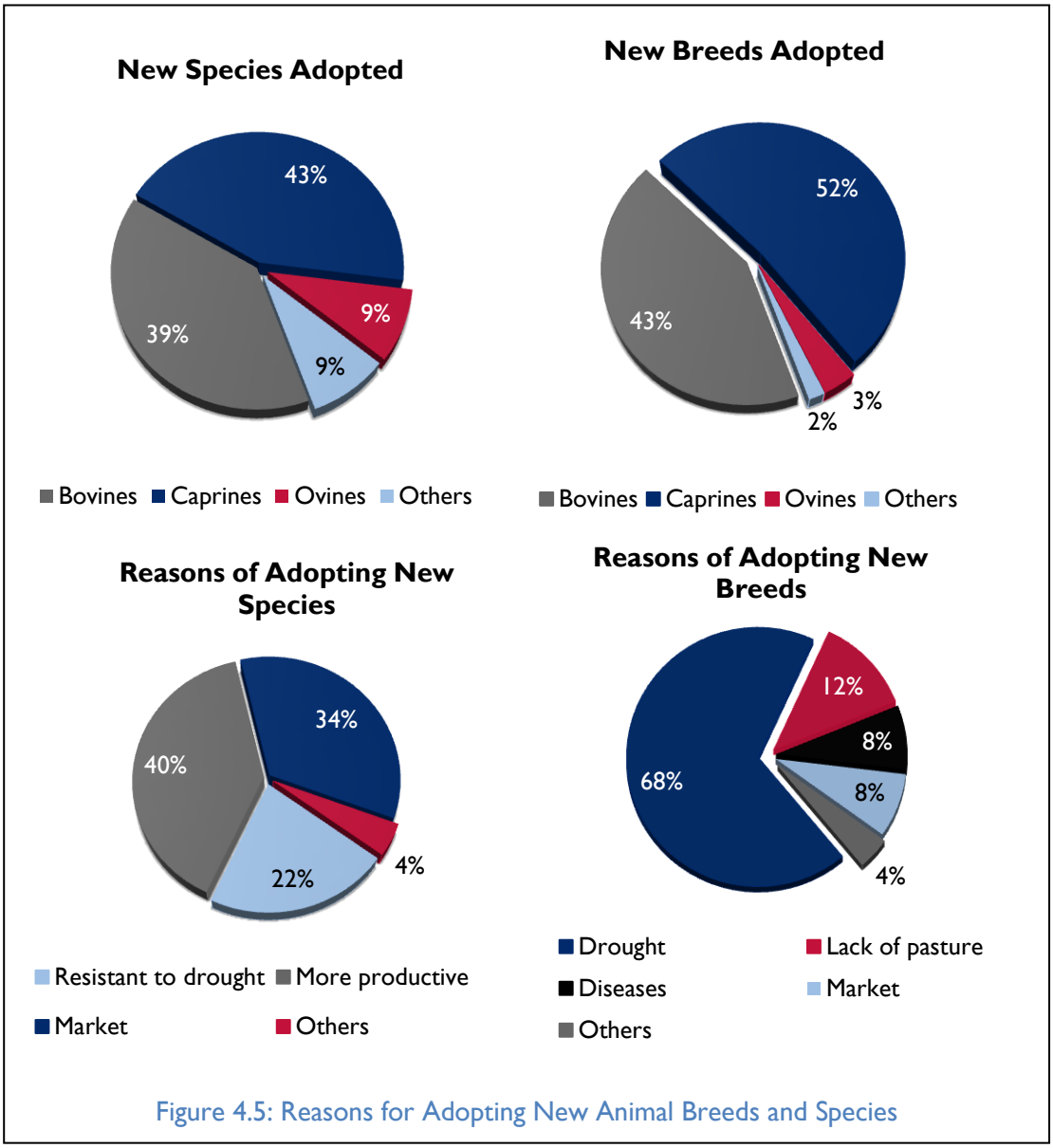

Figure 4.5: Reasons for Adopting New Animal Breeds and Species

4.3 SOIL AND WATER MANAGEMENT PRACTICES

Faced with recurring and severe episodes of drought in the Sahelian zone, farmers have been undertaking vast projects of land restoration, via local techniques of sustainable management of soil and water, especially related to water conservation, land protection, and agro-forestry. The techniques include a diverse range of integrated measures for improving water management, restoring fertility, and increasing soil humidity.

Figure 4.6 shows the principal practices identified in Burkina Faso in matters of soil and water management. Organic manure was mentioned as the most common practice. It is used by 88 percent of surveyed individuals for various functions. Other dominant practices are stone lines, natural assisted regeneration (NAR), and mulching, each used by 42 percent of those surveyed, followed by fallow land used in 23 percent of the respondents. Other less-dominant practices are *zai*, compost, half-moons, grass strips, and wind screens. However, farmers' perceptions about the effects and the roles of these various practices in regard to the different climatic and biophysical constraints they are facing are various. One practice can serve to combat many constraints.

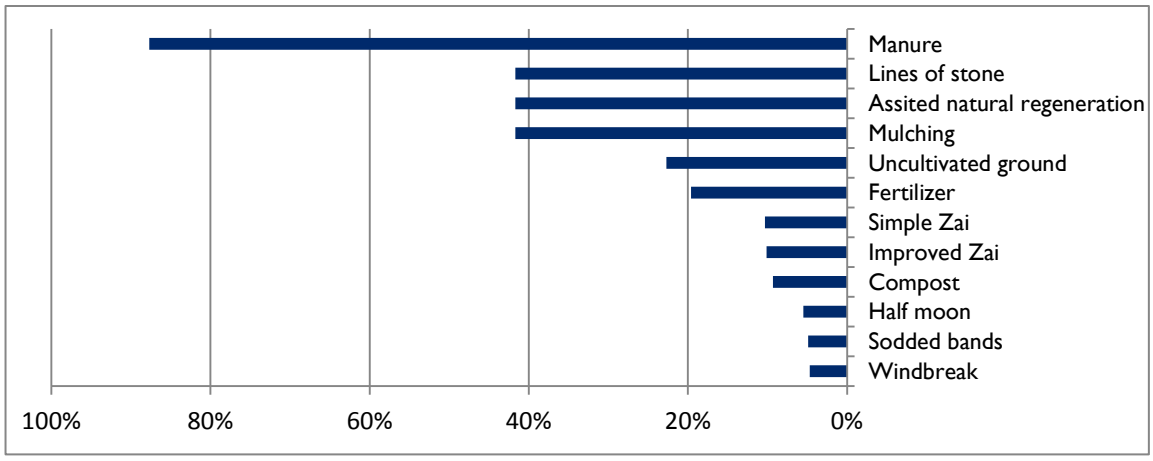

Figure 4.6: Water and Soil Management Practices

In the following sections, the paper further explores practices used to combat the specific constraints, including: drought (Section 4.4), soil fertility (Section 4.5), desertification (Section 4.6), and erosion (Section 4.7), and pasture and water management (Section 4.8). This was done intentionally, as it was clear that individuals make different choices based on the major constraints they are facing and their perceptions on the practice in combating a specific constraint. For instance, manure, mulching, and stones lines are the major water and soil management practices that the respondents use to combat drought, while stone lines are more used to combat erosion. The following sections help highlight why certain practices are chosen over others.

Some definitions

Zai: On-farm rainfall harvesting practice consisting of digging small holes in the field before the first rains to retain runoff water (***simple zai***). These holes are later used for sowing crops after the first rains. With ***enhanced zai***, organic matter or mulching and a little fertilizer are placed inside the holes to create favorable growing conditions (See photo in Appendix). Also, the way the holes are arranged with improved zai is different from simple zai, and takes into account the direction of runoff water on the plot with also some requirements about the spacing between the holes in order to enhance water catching in the holes.

Half-moons: Large holes with the shape of a semi-circle where the excavated material is deposited on the semi-circle. Millet, sorghum, and maize are sown in half-moons. The half-moons allow capture of the runoff water, and therefore to improve soil humidity and reduce water stress for the crops. Farmers may use manure as fertilizers in half-moons (See photo in Appendix).

Some definitions, continued.

Stone lines: Rocks deposited along contour lines in order to slow runoff, increase the infiltration, and capture the organic sediments that contribute to improve soil fertility (See photo in Annexes).

Natural assisted regeneration (NAR): Promoting and protecting the shoots of woody species in crop fields in order to enhance the regeneration of degraded soils and create a multiple-use agro-forestry system.

Composting: Improved process of producing organic fertilizers through decomposition of vegetal and animal organic matters in a dugout ditch.

4.4 DROUGHT CONTROL PRACTICES

Many studies have shown that water and land management practices have diverse and multiple effects, from improving fertility, restoring degraded land, and restoring vegetation canopy closure (e.g., Yameogo et al. 2013; Zougmoré and Zida, 2000; Doamba, Nacro, Sanon, and Sedogo, 2011). This study showed that techniques such as using organic manure, mulching, stone lines, NAR, agro-forestry, and *zai* are the most common practices employed by farmers for mitigating the adverse effects of drought on crops (Figure 4.7). Around 45 percent of those surveyed consider organic manure as a practice for combating drought. It is used in combination with other practices such as *zai* or placed directly at plant level to improve soil humidity and fertility and create favorable conditions to plant development. Stone lines, NAR, agro-forestry, and *zai* are other adaptation practices households reported using to combat the effects of drought on crop production. The different techniques employed by farmers indicate their usefulness for adapting to diverse needs and conditions.

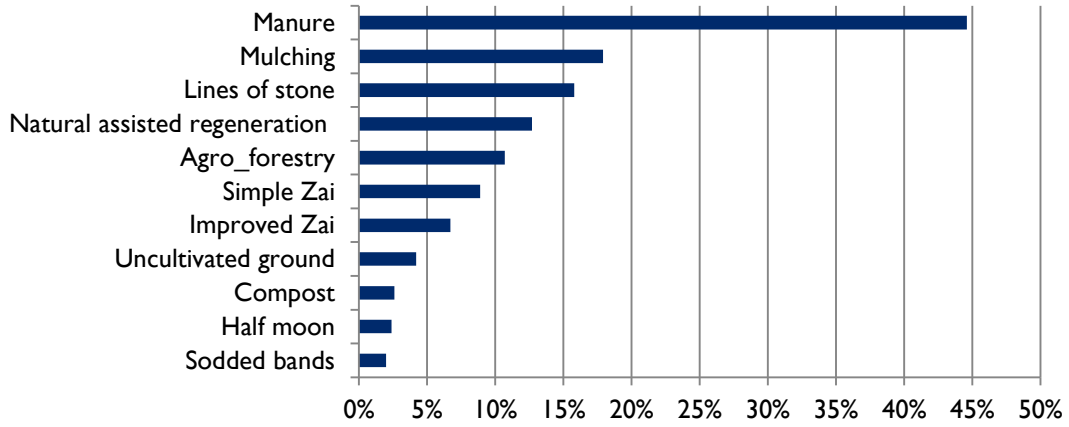

Figure 4.7: Drought Control Practices

The enumerators were trained on these different terms, which were explained to farmers in clear and simple words. For instance:

Drought: Unusual delay in the beginning the rainy season, unusual dry spells during the rainy season, and/or the shorting of the rainy season.

Desertification: Denudation of the vegetative cover on large extent of lands that were recovered before, making the lands unsuitable for cropping and grazing.

Water scarcity: The disappearing of natural and artificial water sources such as rivers, natural springs, lakes, artificial dams, and other water sources usually used to irrigate crops and/or water animals.

Erosion: Large ravishment of lands making them unsuitable for crop production.

Soil fertility: The drop of crop yields on the lands due to their over-use, at an extent where they require an intensive use of fertilizers (or to be left for fallow) before being suitable for crop production.

4.5 SOIL FERTILITY MANAGEMENT PRACTICES

According to farmers' statements, the decline in soil fertility is the second major constraint to crop production in Sahel/Burkina Faso. Farmers use mainly organic manure, mulching, stone lines, and chemical fertilizer to combat this (Figure 4.8). Results indicate a consensus relative to farmers' perceptions on the importance of these practices in managing soil fertility. The majority of users of these practices indicated they are the suitable measures for improving soil fertility. Other empirical studies confirm the farmers' perceptions of the importance of these for improving soil fertility (Yameogo et al. 2013; Doamba et al. 2011; Sawadogo et al. 2011).

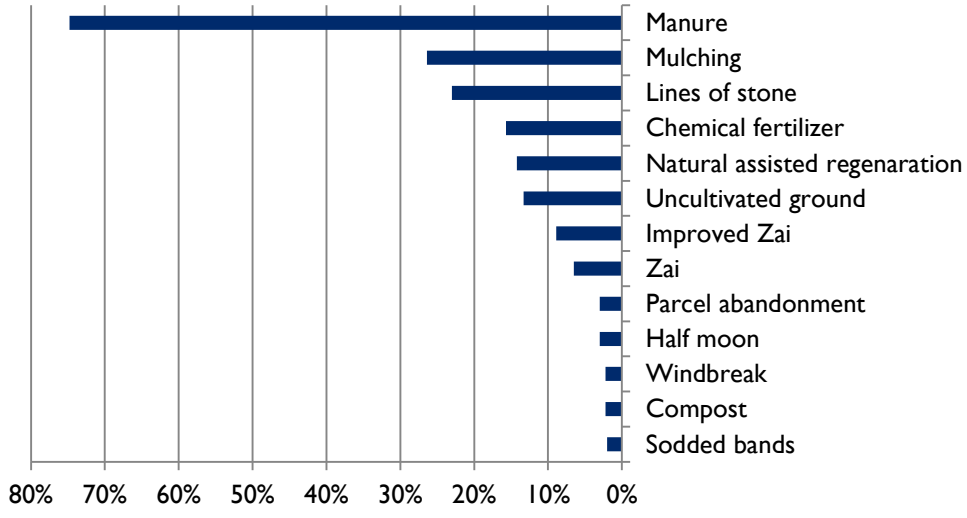

Figure 4.8: Soil Fertility Management Practices

4.6 PRACTICES FOR COMBATING DESERTIFICATION

For combating desertification, NAR, stone lines, and organic manure are the most used practices (Figure 4.9). Meanwhile, the proportion of farmers considering these practices as measures for controlling desertification is relatively small relative to the proportion of farmers using them. In the case of NAR, only one-third of adopters indicated that this practice combats desertification. It is the same for stone lines and organic manure, with only 13 percent of those surveyed having indicated each of these practices as measures to control desertification, while the rates of adopting these practices are 42 percent and 88 percent, respectively. This means that NAR is more suitable in combating desertification than other practices, which are more suitable in combating other constraints.

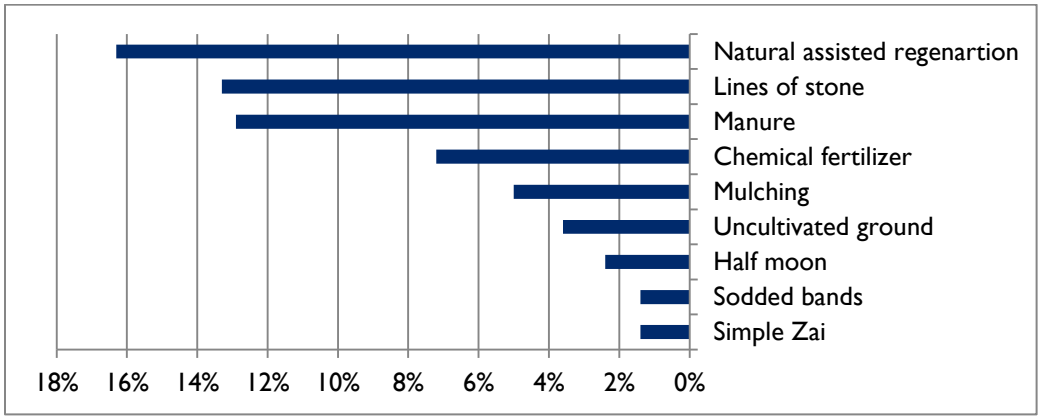

Figure 4.9: Practices for Combating Desertification

4.7 PRACTICES FOR COMBATING EROSION

For confronting erosion, farmers indicated that the stone lines are the principal practice used (Figure 4.10). The other practices indicated are NAR, grass strips, mulching, and windbreaks. Yet the proportion of those surveyed having indicated these practices as measures for combating against erosion is relatively small compared to share of respondents using these practices. This indicates that farmers prefer use stones lines to combat erosion rather than other existing water and land management practices. Those practices, as shown in previous paragraphs, are suitable to combat other constraints.

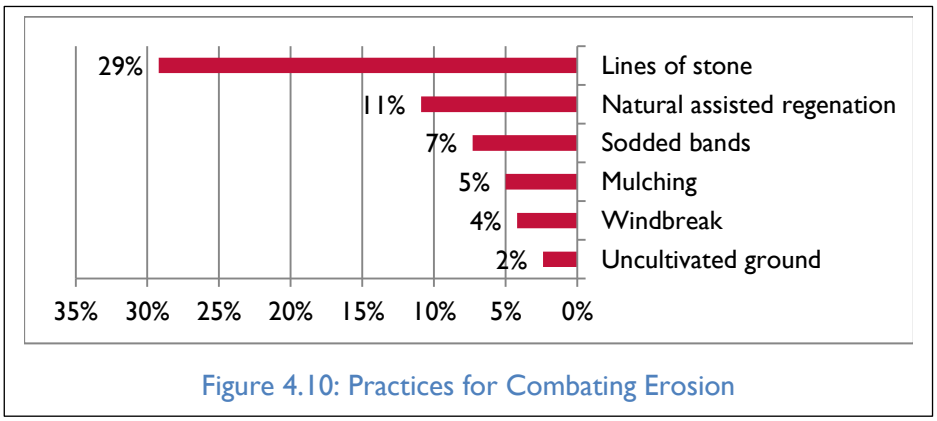

Figure 4.10: Practices for Combating Erosion

4.8 PASTURE AND WATER MANAGEMENT PRACTICES IN LIVESTOCK SYSTEM

The scarcity of pasture and water are the major effects of drought on the pastoral production in the Sahelian region. In light of these constraints, farmers resort to a range of practices, namely use of crop residue, woody forage, breeding/feeding, seasonal transhumance, and use of groundwater. According to the study, crop residue and woody forage were the most commonly cited techniques for addressing scarcity of pasturage in the Sahel (Figure 4.11). Around 25 percent of producers indicate that they practice more and more feeding, while others have resorted to seasonal transhumance in view of guaranteeing access to water and pasturage for their herd during periods of drought. Use of groundwater (i.e pastoral wells and boulis) are used by around 5 percent of those surveyed as alternatives to the disappearance and lack of surface water for watering the animals, especially in the dry season.

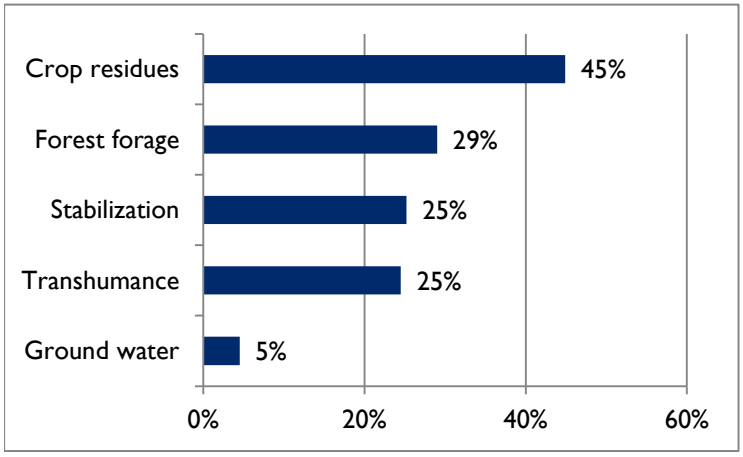

Figure 4.11: Water and Pasture Management Practices in Livestock

5.0 FINDINGS: COPING PRACTICES AND POST-RISK MANAGEMENT OF CLIMATIC SHOCKS

In our approach, we have split the adaptation practices in two major groups:

1. *Risk- and shock-reduction practices*, which include all strategies used by farmers to reduce their exposure to the shocks and its effects on their farming system. These practices are already described in previous sections and include changes in farming systems and water and soil management practices. They are implemented before the risk occurs, and are often thought of as adaptation practices.
2. *Post risk-management practices*, which include strategies used by people after the risk has occurred, despite the adoption of risk and *Risk- and shock-reduction practices*. These are often thought of has coping practices.

This section is devoted to post-risk management practices, which includes asset liquidation, transfer and risk sharing, migration, and changes in food habits, among others.

Despite efforts to reduce the negative impacts of climate change and variability, people in Sahel/Burkina Faso are not fully sheltered from the negative effects of drought on their livelihood. They are still vulnerable in various ways to drought that reduces their traditional sources of livelihood, namely crop and animal productions. The efforts to reduce vulnerability are therefore not sufficient to ensure the resilience of the Sahelian population to the effects of more severe and regular droughts. Being aware of this, the population implements post-risk management mechanisms as an additional resilience measure to risk reduction and exposure practices. Post-risk management mechanisms includes asset liquidation, transfer and risk sharing, migration, changes in eating habits, grain banks, local and international solidarity networks, and ecological services including forest and biodiversity resources.

5.1 ASSET LIQUIDATION

Liquidation of assets constitutes an important strategy for post-drought risk management in the study area. This strategy includes the sale of animals and other household assets such as such as carts, bicycles, telephones, beds and women's jewelry, All of these practices are common in the study area. Around 88 percent of households surveyed indicated that they sell animals as a drought coping strategy, while around 33 percent reported they sell other operating assets (Figure 5.1, next page).

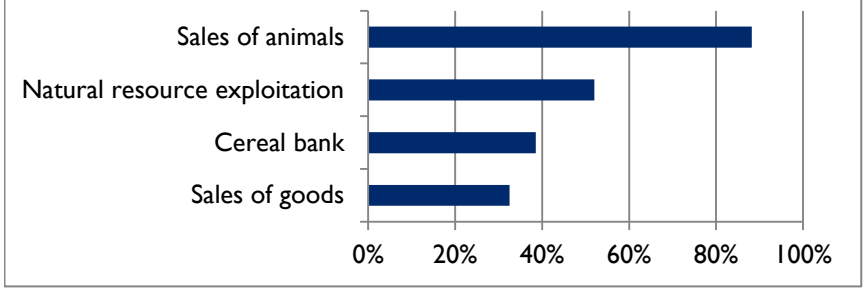

Figure 5.1: Asset Liquidation

5.2 USE OF ECOSYSTEM SERVICES AND NON-WOOD OR WOOD FOREST PRODUCTS

Natural resources, namely forests products, play a significant role in Sahelian communities' livelihoods and resilience to drought and others bio-physic constraints. Around 98 percent of surveyed people have reported that they depends on forest woody-species for various needs such food security, animal feeding, earning income, both animal and human health as well plan protection. Actually, 45 percent of the respondents indicated that they use many woody-products including fruits, leaves or seeds for their food needs. Also, around 40 percent of the respondents reported that they use usually forest products for animal feeding, while about 10 percent have indicated that they use these products for human health. However, more than half (52 percent) of those surveyed indicated that they rely on natural resources, namely non-wood forest products, including fruits, leaves, or seeds for their food needs during drought years. Around 50 percent of the respondents use these products at any time throughout the year, 16 percent use only during dry season, and 22 percent only during harvest period. The most woody-species used by people are *Tamarindus indica*, *Combretum glutinosum*, *Diospyros mespiliformis*, *Faidherbia albida*, *Acacia sp*, *Terminalia sp*, and *Parkia biglobosa*.

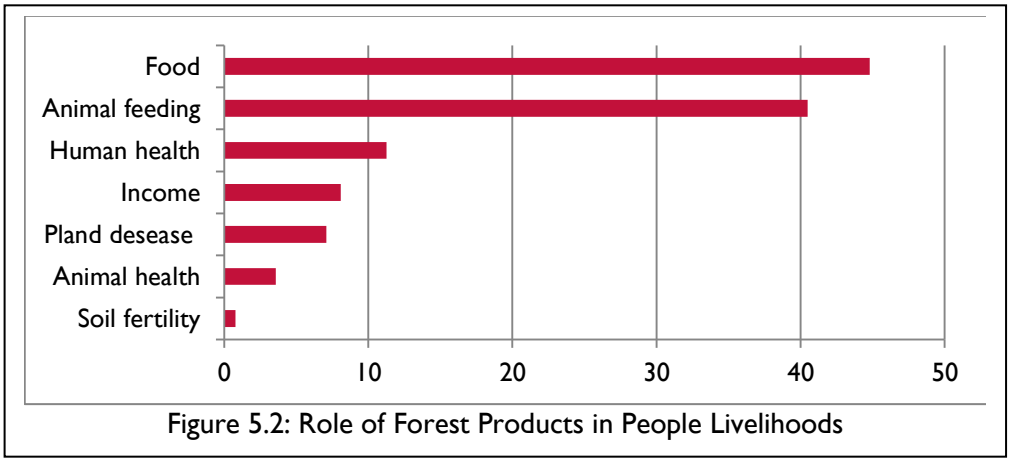

Figure 5.2: Role of Forest Products in People Livelihoods

5.3 GRAIN BANKS

Grain banks constitute another widespread practice. Grain banks are village-level food reserves implemented by local communities with or without the support of development agencies and/or the government to cope with recurrent food crises or food insecurity in the Sahel. Grain banks are used by

around 40 percent of the households surveyed as a post-risk management measure for the effects of drought on food security. Grain banks are becoming a popular strategy to fight against food insecurity and drought impacts in the study area, and they play a strong role during the years of extreme climate events. The grain banks are managed by a local committee who buys staple crop foods during harvesting period where food prices are lower, stocks them in granaries, and sells them later for its members during the driest season when food becomes scare and more expensive. The members contribute to the implementation of grain banks in kind with their crop harvest, labor force, or in cash. The stored grains include crops such as maize, millet, sorghum, and rice. The poorest and marginalized individuals or those experiencing food crisis are given priority and can be allowed to buy the food at credit.

5.4 MODIFYING EATING HABITS

Most people surveyed reported that they usually change their diets in terms of the number of meals and/or quantities of food to cope with the impacts of drought. Figure 5.3 shows that about 80 percent of surveyed households reduce their usual number of daily meals during drought periods, and 73 percent of them decrease the volume of meals. Diet diversification through the introduction of new crops/foods is also a strategy used by people to ensure their survival during periods of drought. Approximately 26 percent of surveyed households reported having introduced new crops/foods into their diets as a post-risk management strategy from the effects of drought. The main foods that have been introduced to their diets are rice and cowpeas. For some, dietary diversification is also a coping strategy. For example, some respondents reported that previously, millet was their staple food; now they have added sorghum, cowpeas, or rice to their diets, and vice versa for those who considered sorghum as their staple food.

Around 26 percent have reported that they have included new crops (millet, sorghum, rice, cowpeas, or others) in their eating habits in the last 10 years. Those who did not frequently eat millet before have started to consume this crop, and vice versa for sorghum. Sometimes, they make mixed flour of millet or sorghum; if the conditions are not favorable, they consume only millet or sorghum as usual. Yet almost all farmers did not give up their main staple crops, and prefer to consume this crop if they do not face constraints on their production system.

Historically, millet and sorghum are the principal foods of the population in the study area. They crops are not new to this area, but some farmers have newly adopted them. Some farmers who did not grow millet before have started to produce this crop, similar to the case with sorghum. The region's populations still remain dependent on these two crops for their essential food needs. Currently, millet is the staple food for 70 percent of surveyed households while 30 percent of households reported sorghum as their staple food. The results show that dietary habits have not changed over the past decade, as millet and sorghum continue to be the main staple foods in the same proportions today as in the past. However, significant changes were noted in diets during periods of drought.

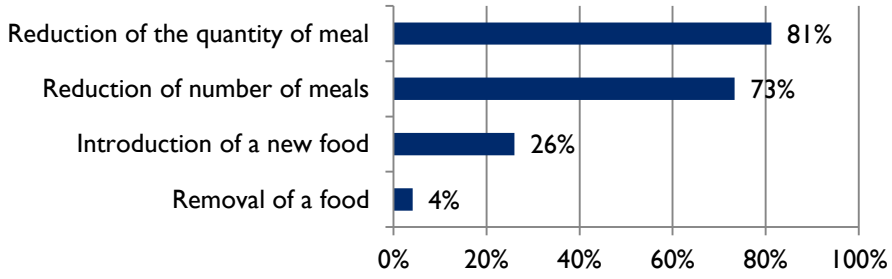

Figure 5.3: Changes in Food Diet

5.5 RISK SHARING AND TRANSFER: MIGRATION, TRANSFER, AND FOOD ASSISTANCE

The transfer and sharing of risks also play a part in the post-drought risk management strategies used by the farmers. Measures include migration, food or cash transfers, food aid, and the use of local and international solidarity networks such as borrowing of food from other households and food assistance.

Food aid and loans play an important role in post-risk management of drought; about 50 percent of surveyed households reported that they have used at least one of these two strategies during periods of drought. Temporary migration is also a common response as indicated by about 40 percent of the surveyed households. Migrations are generally toward urban centers such as Ouagadougou and Bobo Dioulasso, but more and more toward gold washing sites currently emerging. Other mechanisms and risk transfers observed are the transfers of food in terms from other households in living same the village or in neighboring villages. Some households depend on remittances or food transfers from household members living outside the village. In fact, 20 percent of surveyed households reported that they benefit from remittances from members living outside of the village; while about 20 percent of others receive food transfers instead (Figure 5.4). The remittances give farmers the ability to purchase food and diversify the eating habits.

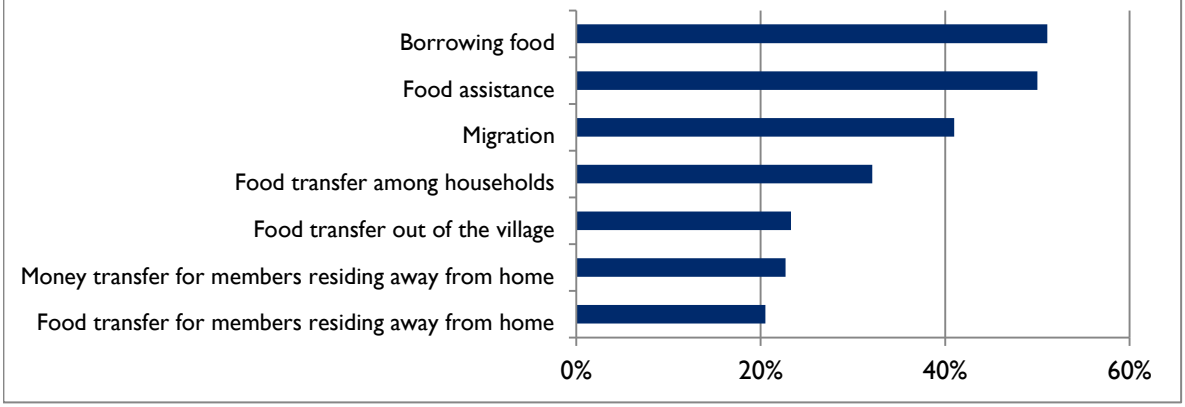

Figure 5.4: Drought-Risk Sharing and Transfer Strategies

5.6 CLIMATE INSURANCE

Climate insurance is a post-risk management strategy that does not actually exist in the study area according to the statements of persons surveyed. In fact, almost all households surveyed stated they have no knowledge of climate risk insurance or of its operating mechanism. Meanwhile, most of the farmers displayed a positive interest in subscribing to a service of drought insurance if there were access. This indicates that the adaptation mechanisms described in the preceding sections are not sufficient for facing the effects of drought, and the households continue to sacrifice their livelihoods following major drought events. Climate insurance against the risk of drought could therefore constitute a complementary alternative to mechanisms already in place in view of increasing resistance of populations to drought, given that this measure already receives a large acceptance of farmers. In general, between 79 and 91 percent of crop producers and agro-pastoralists are available to subscribe to an insurance service against drought (Table 5.1). Farmers' ability to pay is variable. The crop producers are more disposed to pay than the agro-pastoralists and pastoralists (Table 5.1).

Climate insurance is difficult to implement, but this mechanism is gaining a great deal now in developing countries and many trials are now going on. This indicates that local communities are still experiencing the adverse effects of climate change, despite the current adaptation efforts, and they are still seeking others or better strategies. This also indicates that climate insurance can work with Sahelian people if its meets their conditions and ability to pay.

TABLE 5.1: INDIVIDUALS WILLING TO PAY FOR A CLIMATE INSURANCE FOR DROUGHT CONTROL (PERCENT)

Province	Crop Producers	Agro-Pastoralists	Pastoralists
Séno	54.9	97.0	100
Oudalan	73.7	81.8	28.6
Soum	82.9	94.9	0
Yagha	98.1	94.0	100
Sahel	78.8	91.4	40

5.7 PERCEIVED EFFECTIVENESS OF THE PRACTICES

Most farmers have positive perceptions of the efficacy of the dominant adaptive practices they employ for combating the effects of drought. For most of the practices identified in the region, between 65 percent and 90 percent of the adopters indicated that these practices are effective at reducing the negative effects of drought on their principal livelihoods (Figure 5.5, next page).

Many of the techniques used by the farmers have been presented in the literature as effective adaptive practices by numerous empirical studies. In a recent study on the Burkina Faso plateau, Yameogo et al. (2013) showed that improved *zai*, stone lines, and organic manure have significantly contributed to improving the infiltration of water in the soil, and have restored fertility. The techniques increased the sorghum yield by four-to-six times compared to the control plots where these practices are not used. Techniques such as NAR, improved *zai*, stone lines, and half-moons have restored or improved the fertility of hundreds of thousands of previously degraded hectares, and consequently have contributed to improving the resilience of the Sahelian populations to the risks of more severe and recurring droughts (Zougmoré et al. 2013).

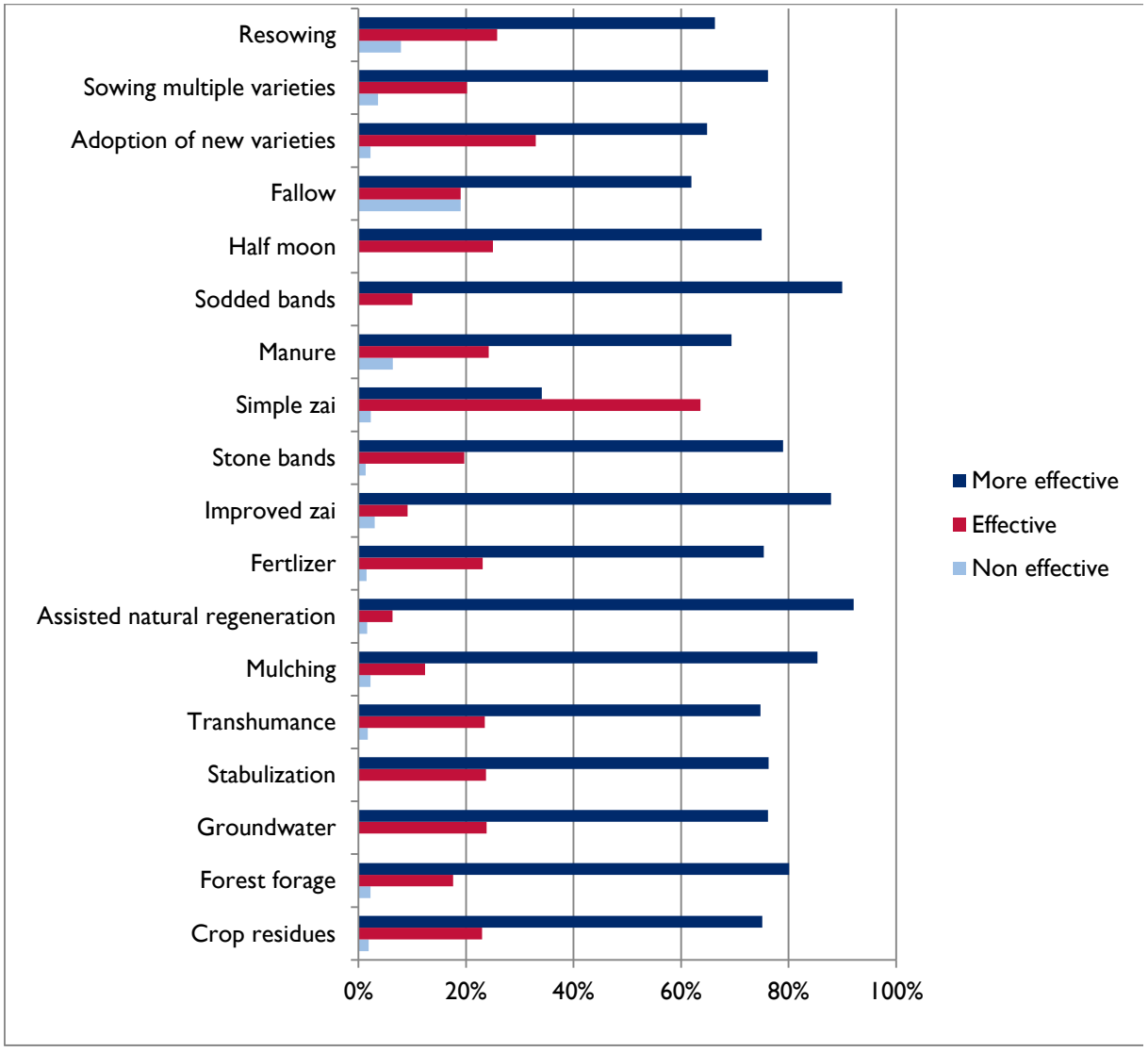

Figure 5.5: Farmers' Perception on the Effectiveness of Adaptive Practices in Response to Drought

6.0 ANALYSIS OF COPING AND ADAPTATION PRACTICES

The gender and sociocultural characteristics of farmers influence their decisions in terms of choice of adaptation to drought and other practices linked to climate change in the Sahel. In this section, the findings related to determining factors of adaptive choices of famers are examined.

6.1 SOCIOECONOMIC, SOCIOCULTURAL, AND GENDER FACTORS

Farmers' adaptive choices are determined by many sociocultural characteristics of the households, their access to technical services, awareness about climate change and adaptation, and characteristics of their production systems.

6.1.1 Type of Livelihood

The findings of the study indicated adaptive practices differ depending on the main livelihood identified by the respondent. For example, the results indicate that agro-pastoralists are more likely to use new crop varieties than are crop producers. Agro-pastoralists own less acreage than crop producers do, as they practice cropping as a supplemental activity greatly for their food security, rather than as a primary source of income. Consequently, they resort to intensives practices in order to increase their crop production. Also, while the use of organic manure is very common in the study area, agro-pastoralists are more likely to use this practice than crop producers. This might be explained by the fact that agro-pastoralists have more facilities for producing manure than crop producers. The number of herds of ruminants held by the farmers also affects their likelihood to organic manure: the more the ruminants the farmer holds, the more he could use organic manure. These results indicate that ruminant breeding is a determining factor in a farmer's ability to use organic manure. This is explained by the fact that manure is essentially produced from bovine herds and small ruminants.

Moreover, subsistence farmers are less likely to adopt drought-resistant varieties compared to those practicing agro-business or those whose production decisions are oriented toward the market. The more the farmer is connected to the market, (i.e., the more the farmer produces cash crops), the more he is able to use technologies such as drought-tolerant varieties. Adoption of new seed varieties implies numerous requirements and additional costs, such as the use of fertilizer and the purchase of seeds. The more the farmer produces cash crops, the more they will be able to get in cash, and consequently be able to purchase improved crop varieties and required inputs.

6.1.2 Age

The use of mulch is inversely and significantly influenced by the age of the head of the household. In other words, households consisting mostly of elderly persons and infants are less likely to use mulch as a measure for addressing the effects of drought. Mulching is a labor-intensive practice, requiring the collection and transport of leaves from one place to another.

6.1.3 Land Tenure

The results indicate that access to land plays an important role in the decision to use mulching. The individuals who do not hold land property rights are less likely to adopt land and water management micro-technologies such NAR. Numerous empirical studies have shown that property rights favor adoption of water and land management practices (Paris et al. 2002). Farmers having only the rights of use on the land are in a situation of land insecurity; and this limits their incentive to invest in enhanced land management practices.

6.1.4 Gender

The amount and quality of lands under control of female heads of household influence significantly and positively the likelihood to adopt certain water and land management technologies. Resource control and the type of land rights significantly affect farmers' decisions to adopt practices. Similarly, the sex of the head of the household and women's control on land resources influence significantly the chances to adopt certain water and land management techniques.

6.2 ACCESS TO ADVISORY SUPPORT SERVICES AND MARKETS

Capacity building and access to advisory services is decisive in the adoption of many practices. For example, attending training on water and soil management or climate change and adaptation increases the chances of adoption of many drought controls practices. Contact with extension services also plays an important role in the farmers' decisions to use NAR and enhanced *zai*. In contrast, contact with extension services significantly reduces the likelihood to use simple *zai* and mulching, as enhanced *zai* is an improved technology proposed by technical services in place of simple *zai*. It consists of combining simple *zai* with organic matter and a bit of manure to create favorable plant conditions. Also, the way the holes are arranged with improved *zai* is different from simple *zai*, and takes into account the direction of runoff water on the plot and has some requirements about the spacing between the holes in order to enhance water catching in the holes. Improved *zai* is therefore more effective than simple *zai* in terms of on-farm water fertility management, and consequently attracts more interest of technical services. Consequently, the more the farmers are in contact with technical extension services, the greater their chance to be exposed to enhanced technologies. Those without contact with these technical services remain using older practices.

6.3 PRODUCTION SYSTEM CHARACTERISTICS

The characteristics of the production system play a significant role in farmers' choices in terms of the drought adaptation practices and addressing other biophysical constraints. The use of *zai* and half-moons seem to be significantly correlated with the proportion of degraded land under control of the household. The larger the share of degraded land under the control of the household, the more the he will be interested in using these practices. In contrast, the use of NAR and stone lines is negatively and significantly affected by the proportion of degraded land under control of the household. This can be explained by the fact that both half-moons and *zai* are "quick results" practices for land restoration and water management compared to other practices such as stone lines and NAR. Therefore, stone lines and NAR are not appropriate for farmers with large shares of degraded lands and who are seeking for a rapid response to ensure their livelihood.

The use of new varieties is significantly correlated with the use of several other practices to combat the effects of drought and to address other biophysical constraints. This is the case with practices such as organic manure, half-moons, and enhanced *zai*. This can be explained by the measures taken by the

farmers to guarantee good yields when adopting improved varieties, as adoption of these varieties is generally accompanied by such costs as purchase of manure, seeds, or labor, which must be recovered.

Altitude is shown to be a determinant in the adoption of several practices. Farmers located at higher altitudes are less likely to use certain practices such as half-moons, enhanced *zai*, and stone lines, as well as utilizing improved varieties.

7.0 CONCLUSION

The principal objective of this study was to analyze the choices of farmers in matters of adaptation practices faced with climatic constraints, notably drought in the Sahelian zone of Burkina Faso. The research questions aimed to identify the principal strategies and measures adopted by farmers and/or herders that help them face the frequent incidences of drought and to know the principal reasons for their choices.

The results of the study show what the Sahelian populations really do when faced with numerous biophysical and climatic constraints that threaten their livelihood, which mainly depends on agricultural and pastoral production. The major biophysical constraints in agriculture are, in order of importance, drought, reduction in soil fertility, crop diseases and pests, desertification, and erosion. The major constraints for pastoral system are, in order of importance, drought, lack of pasturage, scarcity of water, and animal illnesses. Drought appears to be the principal climatic constraint to both vegetable as well as to pastoral production. It is also a factor for other constraints identified in the area, such as fertility, disease, scarcity of water, lack of pasturage, erosion, and desertification. Faced with these multiple constraints, farmers have implemented a range of practices and measures for reducing their vulnerability or for being able to survive after a climatic shock. The reduction of sensitivity measures consists of the crop and animal raising systems and the water, land, and pasturage management practices.

The principal modifications noted in crop system are adopting new varieties, planting several varieties, and abandoning crops and/or varieties judged most vulnerable. The major modifications in pastoral system are adopting new breeds of animals, adopting new species, and/or withdrawing the most vulnerable breeds or species. Concerning water and agricultural land management techniques, the principal measures adopted by the producers are using organic manure, stone lines, NAR, mulching, fallow, *zai*, compost, half-moons, grass strips, and wind screens. The farmers do not have the same appreciation of the effects of the various practices when faced with different climatic and biophysical constraints, and use them therefore for a wide variety of reasons. They principally use organic manure, mulching, stone lines, NAR, and *zai* to combat the adverse effects of drought. Faced with a decline in soil fertility, farmers principally use organic manure, mulching, stone lines, and chemical fertilizer. To combat desertification, NAR, stone lines, and organic manure are the most used practices. The measures used to address erosion consist of stone lines, NAR, grass strips, mulching, and wind screens. For animal raising, the producers used crop residue, woody forage, breeding/feeding, seasonal migration, and ground water to combat the adverse effects of drought on pastoral production. Efforts to reduce exposure to risks are not sufficient to assure entirely the Sahelian population's resilience to the effects of more and more severe and frequent droughts. They have also implemented a range of post-drought resilience strategies that complement pre-risk exposure reduction strategies. The post-drought strategies include savings and liquidation mechanisms, transferring and sharing risks, local and international assistance, and changing eating habits.

The analysis of reasons and factors determining the choices of producers in matters of adaptation indicates that the primary motivation of farmers is their perceived effectiveness. This effectiveness is evaluated based on numerous, often interlinked factors. These factors include the scale and characteristics of individual operations, their access to technical services and access to markets, and the characteristics of their production systems. At the sociocultural level, additional factors include ethnic origin, gender and age of the head of household, type of operation, female control of resources, land tenure status, and dependency ratio. For example, individuals who are land-insecure are less disposed to use the techniques to combat the effects of drought. In the same manner, the gender of the head of

operations or the level of control of women over land resources significantly influences the use of certain techniques. Ethnic origin, the objective of production, and the type of operation (agricultural, agro-pastoral, or animal raising) also influence the adoption of many practices. In addition, access to extension technical services or participation in training for water and soil management techniques and/or in climatic change and adaptation play a significantly important role in the adoption of most practices to combat the effects of drought. In general, the operations for which at least one member has participated in training in water and soil management techniques or in adaptation to climate change have a greater change of using the techniques. The degree of openness to the market (number of cash crops produced), the proportion of degraded lands in the operation, and the size of the cattle or ruminant herd are characteristics of the production system that significantly influence the adoption of techniques to combat the effects of drought. The operations having the most degraded land prefer to use rapid effect techniques such as *zai*, manure, mulching, or half-moons, and have a tendency to reject techniques which produce effects in the medium to long term such as stone lines and NAR.

8.0 RECOMMENDATIONS

The study revealed a wide range of often interlinked reasons and factors for adapting certain practices. Many of these reasons and factors are independent of climate change, and include a wide variety of sociocultural, economic, institutional, and physical factors. In light of the results of this study, the following recommendations could help farmers deal with the adverse effects of drought in the Sahel.

8.1 SCALING-UP ADOPTION OF WATER AND LAND MANAGEMENT PRACTICES

Water and land management technologies are the major strategies that people are using to cope with the adverse effects of drought in the Sahel region of Burkina Faso. The most effective practices mentioned by farmers are using organic manure, mulching, stone lines, NAR, agro-forestry, and *zai*. Yet the study showed that the rate of adoption of many of these practices is still low. An important effort could therefore be to expand the use of these technologies to enhance farmers' resilience to climate change.

8.2 IMPROVING ACCESS TO INFORMATION AND MARKETS.

The study indicates that livelihood modifications through the use of alternative crops and alternative economic activities are important adaptation mechanisms. On the one hand, these measures are greatly motivated by market opportunities; on the other hand, they are constrained by information access, including access to information about improved technologies such as drought-resistant varieties. Improving farmers' access both to the market and to information could provide farmers with a greater range of alternatives for modifying and diversifying farming systems.

8.3 IMPROVING CREDIT ACCESS

Improving farmers' access to credit would also enhance their ability to adopt more advanced and more input-demanding technologies.

8.4 ADDRESSING GENDER GAP AND SOCIAL DIFFERENTIATIONS IN RESOURCE CONTROL

The study revealed that when women's control of agricultural and pastoral resources is low, the ability of households to adopt some practices is limited. Because women play an important role in ensuring household's livelihoods during severe climate events, addressing gender differences in the control of land resources could help to increase the adoption of certain drought control strategies and thereby reduce household vulnerabilities.

8.5 IMPLEMENTING MECHANISMS FOR RISK SHARING AND TRANSFER IN SUPPORT OF ADAPTATION (RISK REDUCTION) STRATEGIES

In spite of their best adaptation efforts, the study showed that local people still suffer from the adverse effects of climate change. Mechanisms for risk sharing and transfer such pooled insurance schemes, food and cash transfer, and social security programs could supplement other drought risk reduction

strategies. In addition, the existing mechanisms for risk sharing such as cereal banks and local-or community-level food reserves should be strengthened.

8.6 TRAINING AND CAPACITY BUILDING

The study clearly showed that training on climate change adaptation and/or land and water management practices are a determining factor in farmers' ability to adopt coping strategies. Many farmers are not still aware of ways to cope with climate change impacts. It is therefore crucial to increase extensive services that would improve all farmers' capacity through training and awareness of land and water management practices and climate change adaptation strategies.

8.7 ENCOURAGING INTEGRATION OF CROPPING AND BREEDING SYSTEMS

Many farmers and agro-pastoralists described ways in which they are supplementing their primary form of livelihood with secondary forms of livelihood—e.g., agro-pastoralists invest in limited agricultural production to help ensure food security while cattle remains their primary source of revenue generation. Integrated agriculture-livestock systems help diversify communities' livelihoods and therefore reduce their vulnerability to many of the adverse impacts of climate change. Integrated systems also improve farmers' access to some important inputs such as manure and mulching. Efforts to enhance system integration will therefore play a significant role in communities' resilience to climate change. In this context as well, attention should be also given to addressing gender issues of women's control of pastoral resources. Also, the use of multipurpose crop varieties (food and forage), techniques of composting and manure production, and techniques of forage and crop residues should be promoted to help improve soil fertility and crop and breeding production.

8.8 ADDITIONAL RESEARCH EFFORTS

It is particularly important to enhance research efforts on agro-forestry and land and water resource management. The most woody-species used by people are *Tamarindus indica*, *Combretum glutinosum*, *Diospyros mespiliformis*, *Faidherbia albida*, *Acacia sp*, *Terminalia sp*, and *Parkia biglobosa*, and their further integration into mixed farming systems should be explored. Although perceptions of the efficacy of most of the practices studied were positive, the literature review did not reveal any relevant and strong scientific evidence of the long-term cost-effectiveness or environmental sustainability of these practices. An assessment of the cost-advantage and environmental impacts of the different adaptive practices is therefore needed to inform decision makers' choices of the most suitable measures to build communities' longer-term resilience to climate change. These can be tested through field and farm-level research, ideally carried out hand-in-hand with the farmers.

For pastoral production, developing supplemental animal feeds through research trials with resources/inputs available at the local level is a great way to explore alternative responses to increased scarcity of pasture in Sahelian area. Such locally available resources include crop residue (millet, sorghum and cowpea), woody forage (Pods of *Acacia raddiana, Piliostigma reticulatum, Faidherbia albida*, etc.), and *Cassia tora.*

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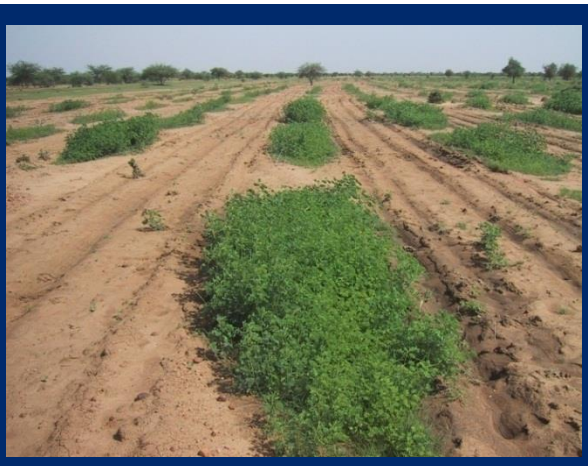
APPENDIX 1: EXAMPLES OF ADAPTATION TECHNIQUE USES IN THE STUDY AREA

Half-moon technique

Forage crop cultivation

Mulching technique



Half-moon technique

Stone lines technique

Half-moon making by Delfino tractor

Half-moon before rainy season

Half-moon during rainy season

Scarification technique

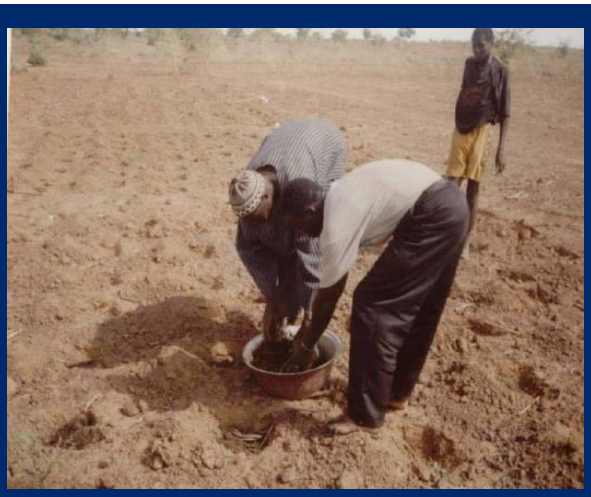
Forage storage and conservation

Sheep fattening

Traditional fattening place

Crop residue use by cattle herd after harvesting

Manure and stone lines techniques



Manure application on *zai* hole

Crop residue storage for dry season use

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