FINAL RESEARCH REPORT

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

MARCH 2014

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

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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. 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 smallholder agricultural systems of Ghana's Transition Zone found in the middle of the country, known as Ghana's "breadbasket." This 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 climate change. Methods for data collection and analysis consisted of a combination of qualitative methods (focus group discussions and validation workshops) 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 and 10 focus group discussions (FGDs) were conducted. In addition, two validation workshops were held after the survey data had been collected and analyzed.

SUMMARY OF FINDINGS

This study looked at 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 and that the majority of farmers were commercially oriented, selling more than one-half of harvested produce. With about half of respondents cultivating two hectares or less, and the majority cultivating less than four hectares, the small farm size makes households 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 their livelihood.

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 peaks 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, plant diseases, deforestation, a decrease in soil fertility, and an increase in soil loss. The literature review 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 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. 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 changes in 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 a 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 was 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 the 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 of agronomic practices and the reason for their use. 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.

Men tended to have easier access to agricultural resources such as land, information, agro-chemicals, and improved seed as compared to women. However, 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.

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 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 to climate change. Since 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 decrease households' ability to cope with climatic shocks.

HOUSEHOLD INCOME

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 have a significant change on household income. 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 food 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 of the services, and lack of funds to meet the demands of purchased inputs that new services require. The major recommendations of ways 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. The majority of agricultural producers are smallholders with rain-fed crops that are highly vulnerable to changes in climate. 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 questions 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.

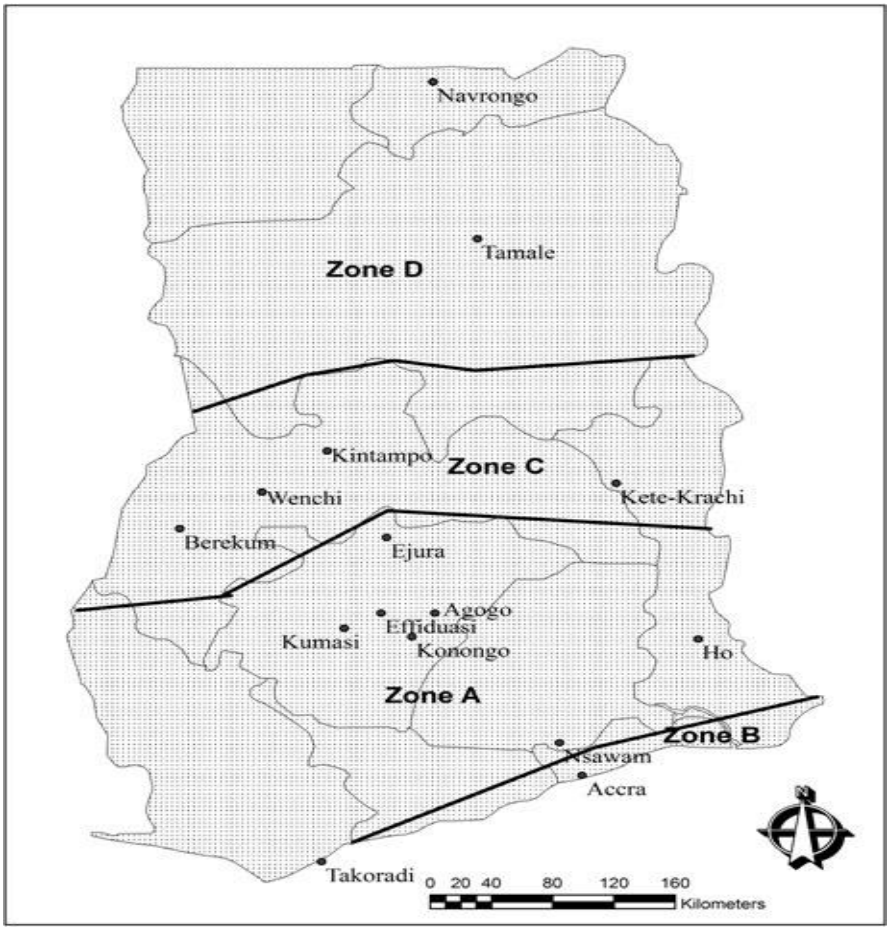

Figure 3.1: Agro-Ecological Zones of Ghana showing the Transitional Zone (Zone C) based on Ghana Meteorological Agency Classification.

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.

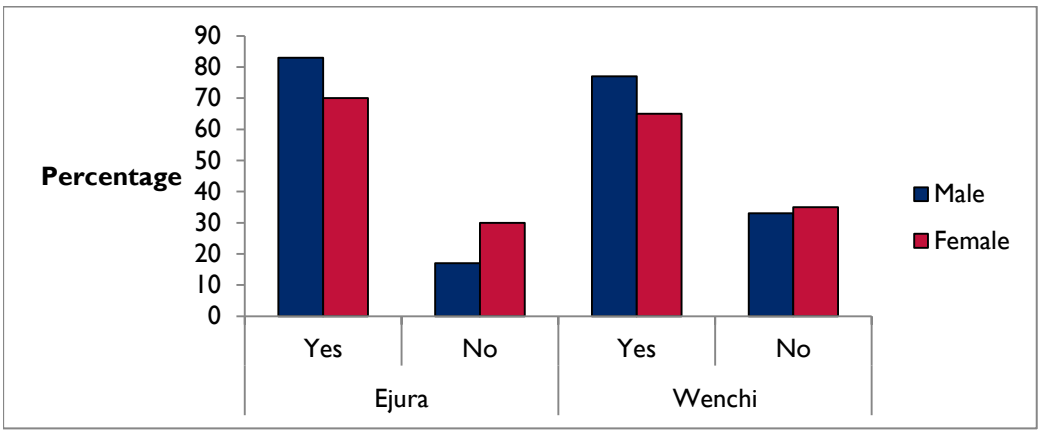

Figure 4.1: Farmers' response to use of chemical fertilizers over the last five years.

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.

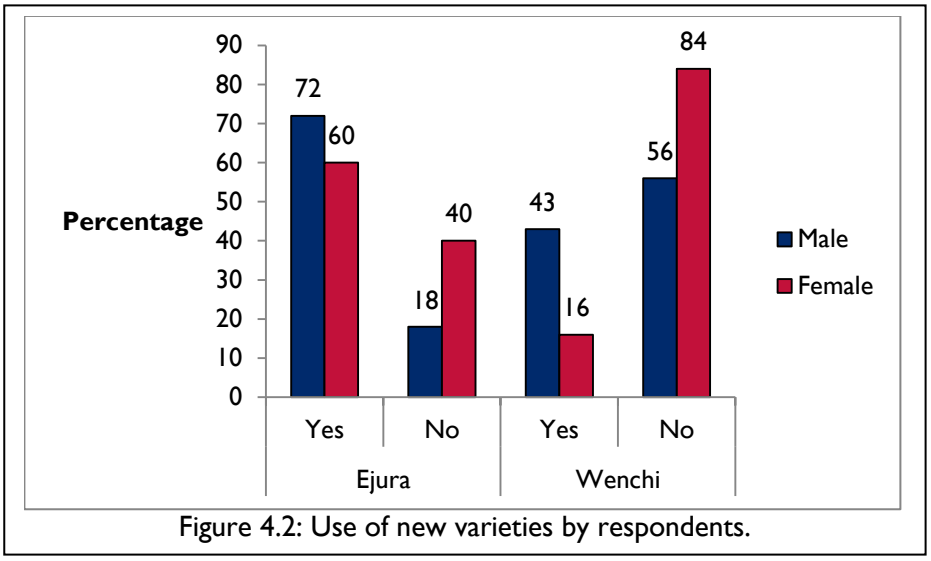

Figure 4.2: Use of new varieties by respondents.

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.

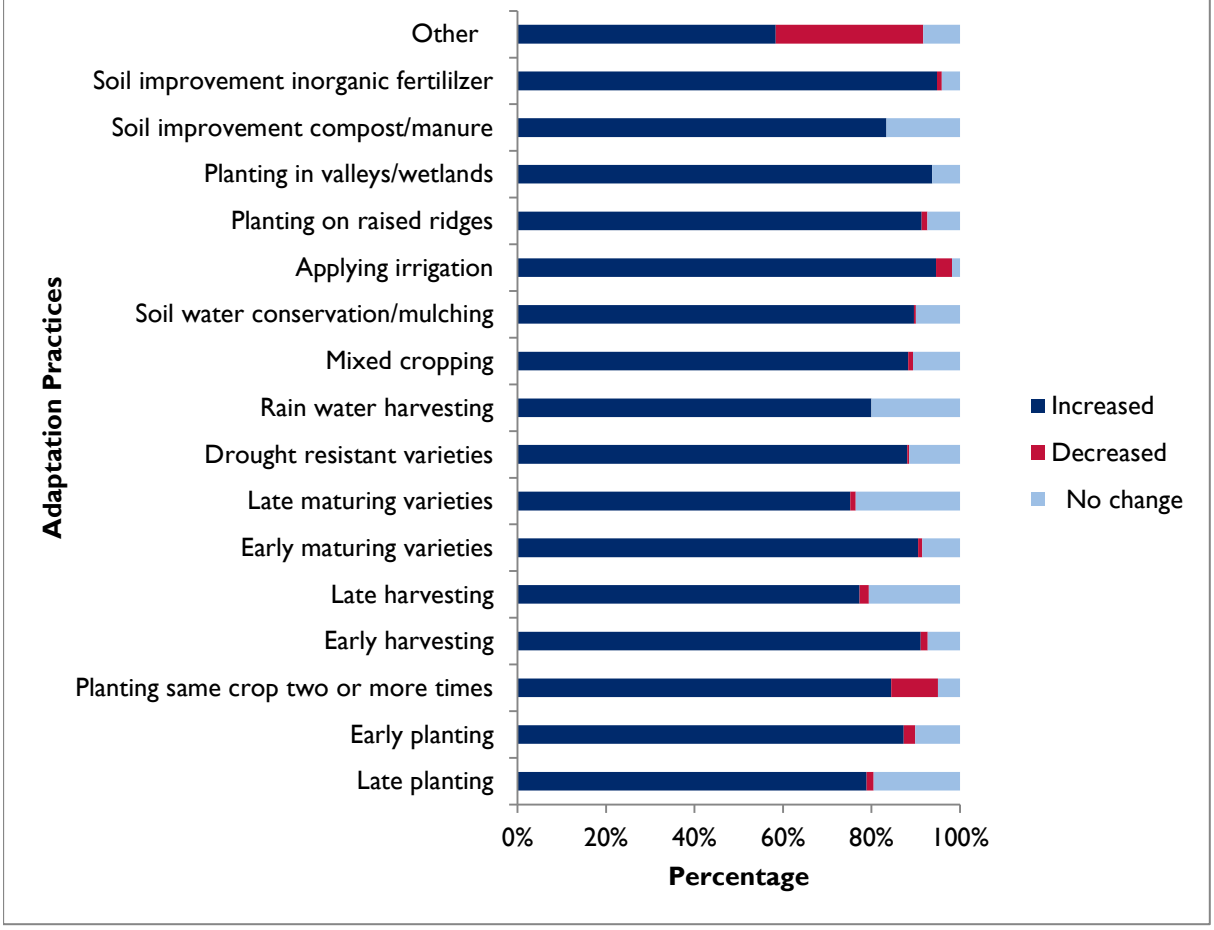

Figure 4.3: Farmers' perception of effectiveness of adaptation practices in increasing crop yield.

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.

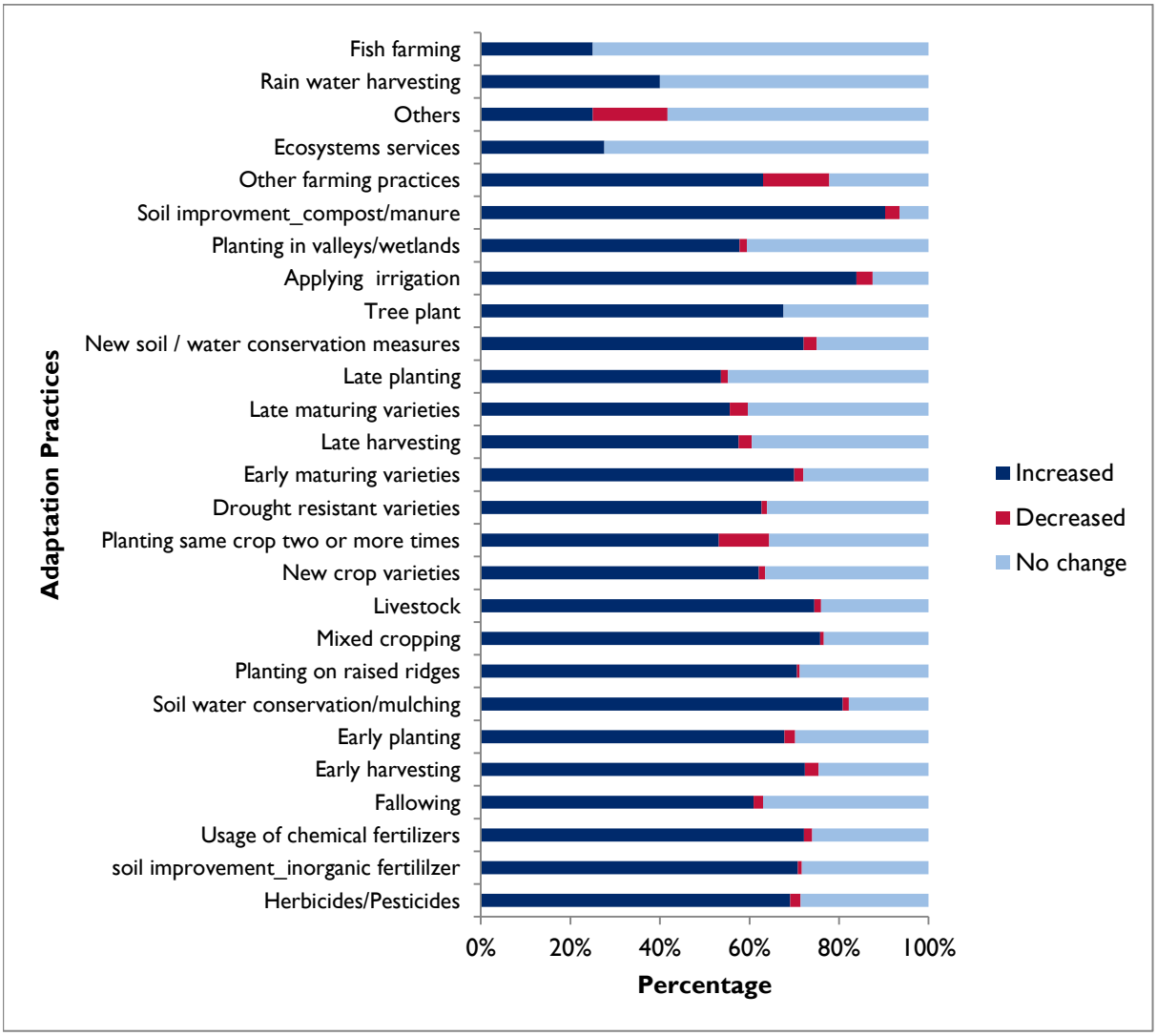

Figure 5.1: Farmers' perception of effectiveness of adaptation practices in increasing household food consumption.

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.

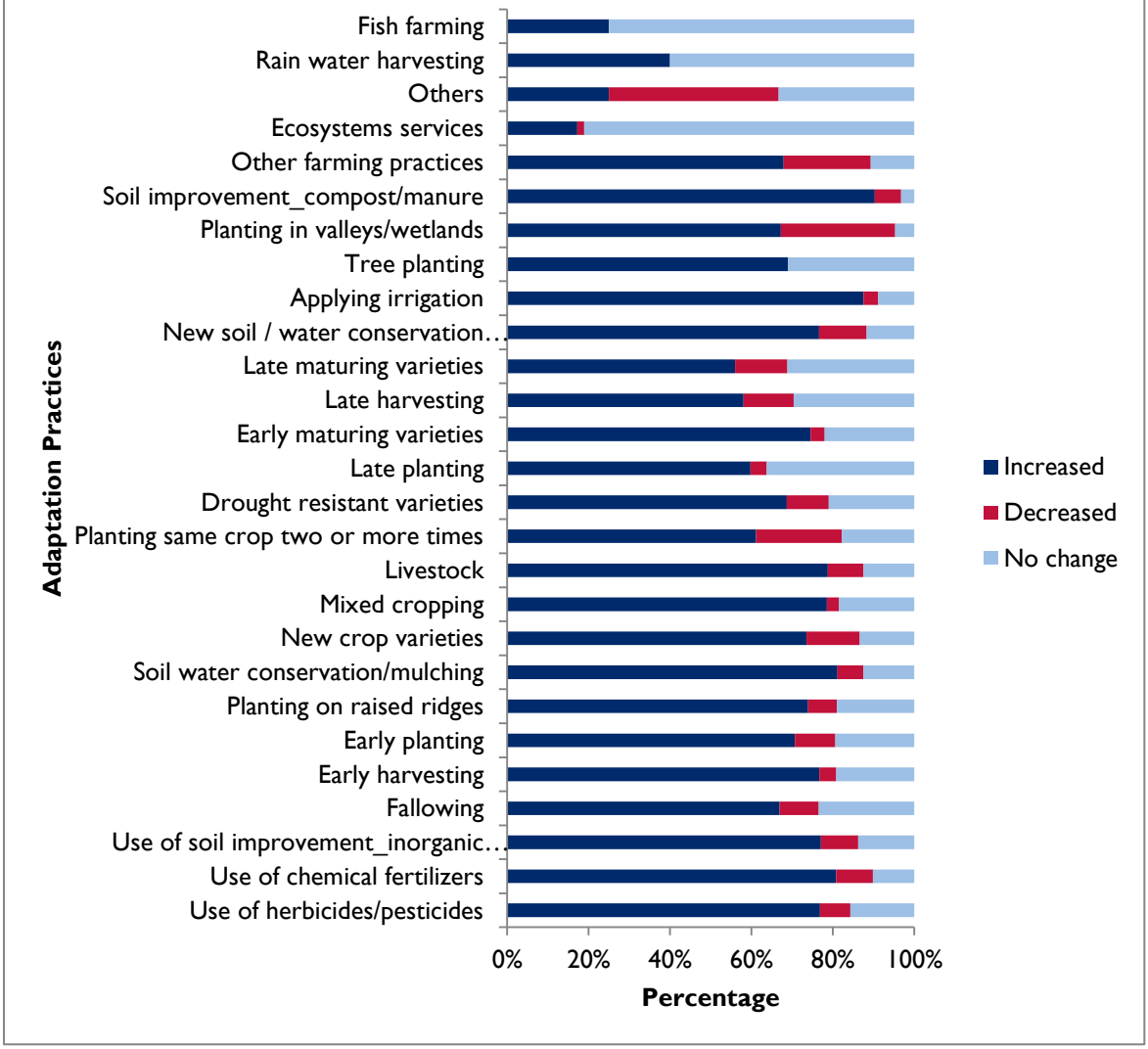

Figure 5.2: Farmers' perception of effectiveness of adaptation practices in increasing crop income.

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.

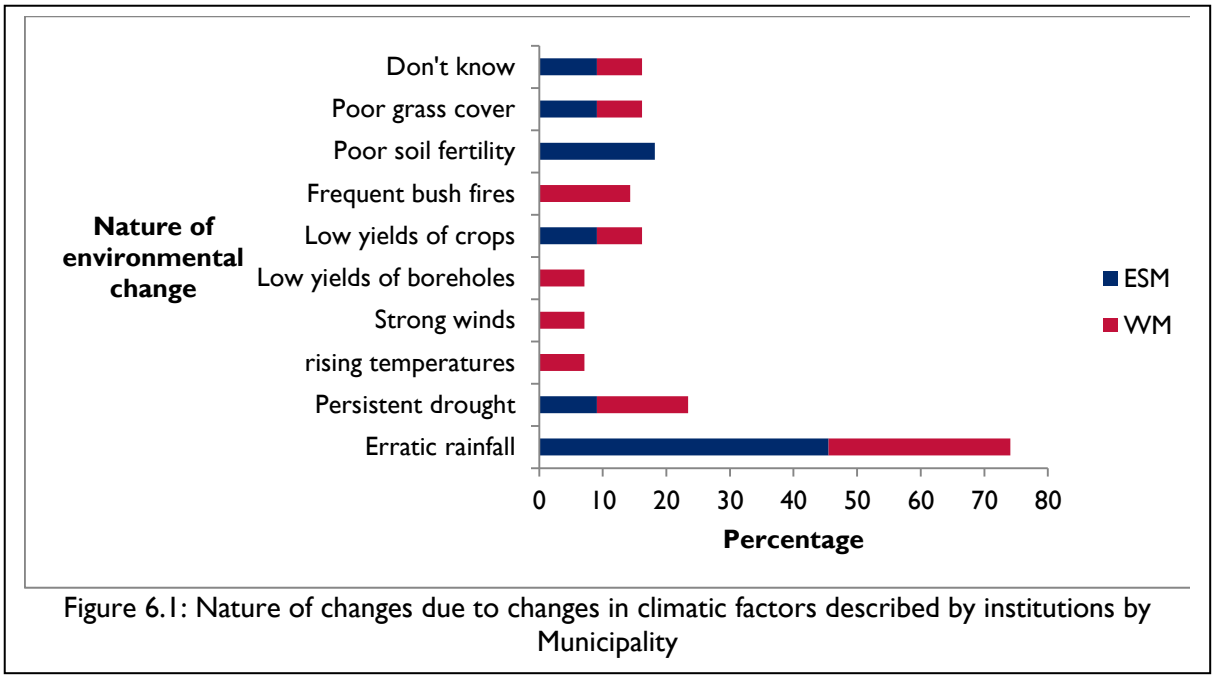

Figure 6.1: Nature of changes due to changes in climatic factors described by institutions by Municipality

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.

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)

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.

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.

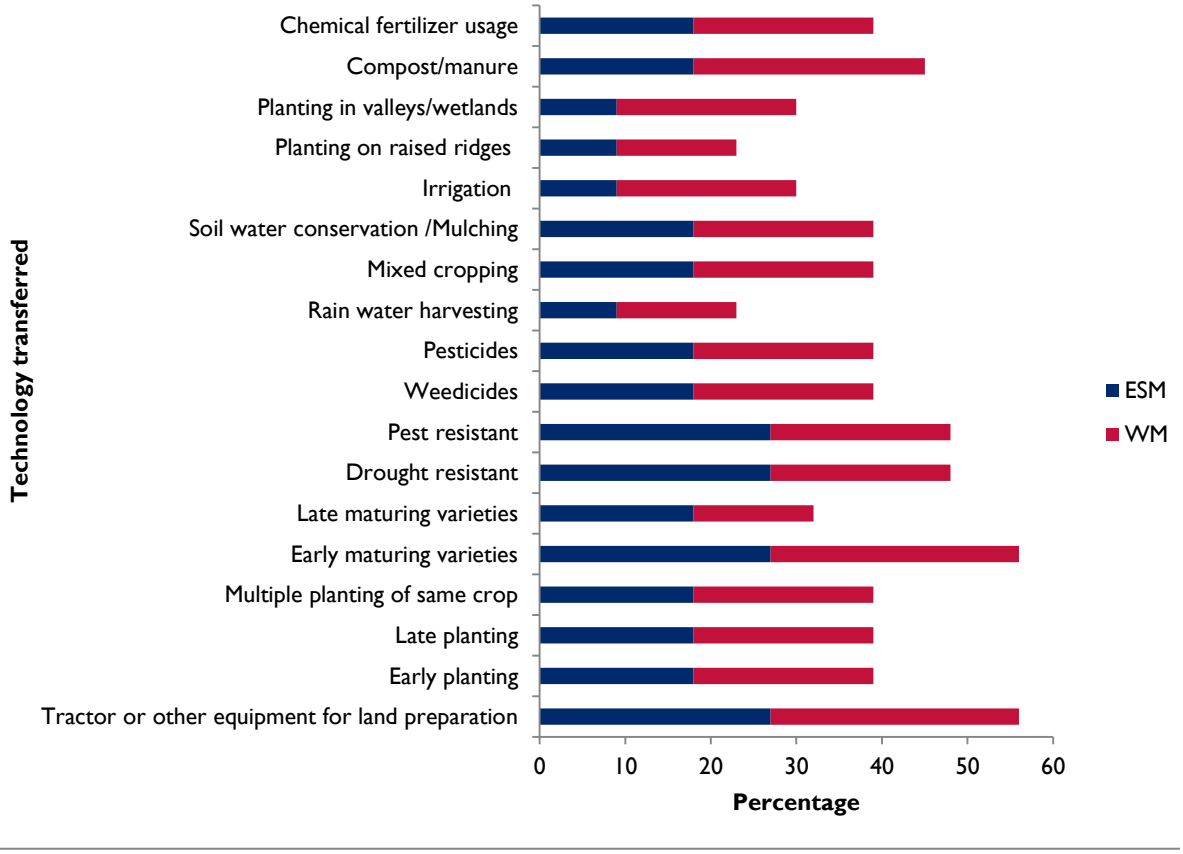

Figure 6.2: Kind of farm technologies or innovations institutions have transferred to smallholder farmers in order to address the effect of changes in climatic factors.

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.

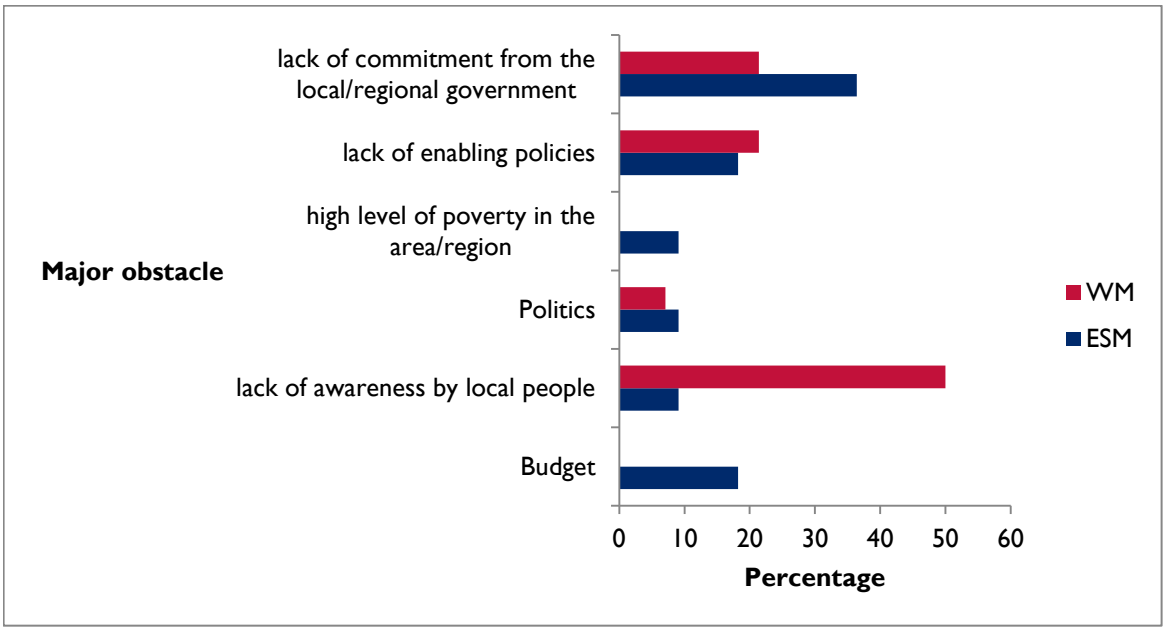

Figure 6.3: Perception of organizations of the major obstacle for addressing impacts of climate change in successful and sustainable manner

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.

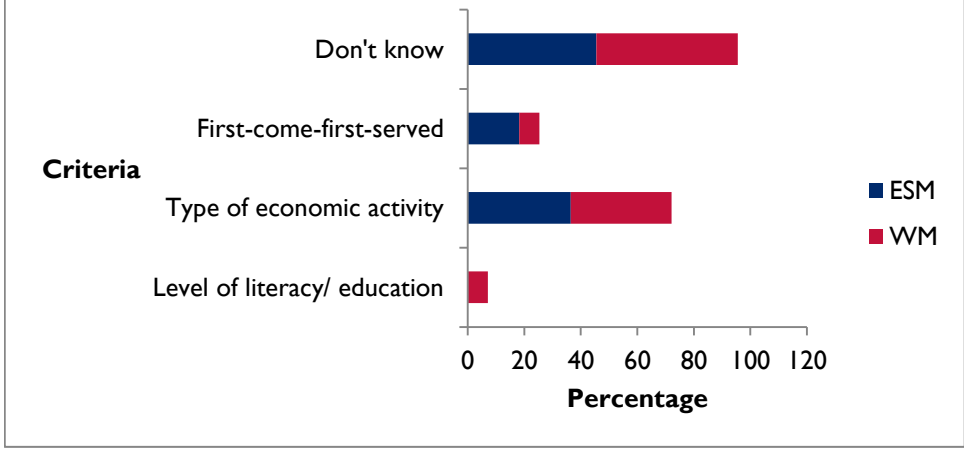

Figure 6.4: Criteria used by organizations to select beneficiaries.

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.

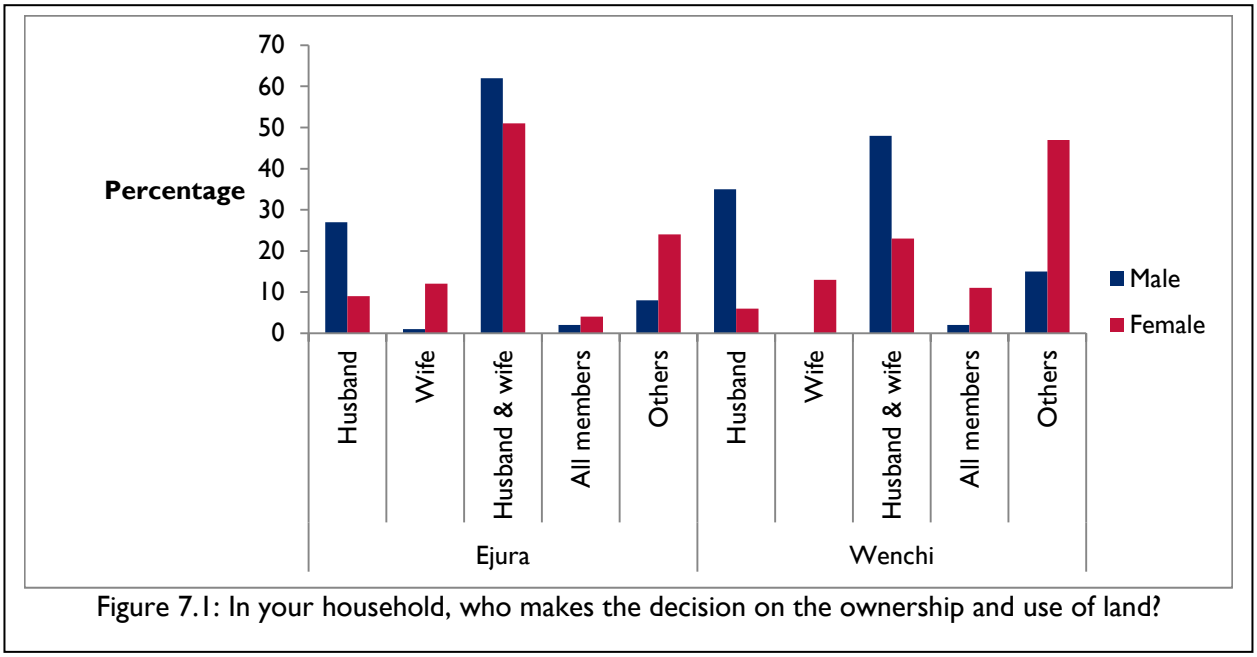

Figure 7.1: In your household, who makes the decision on the ownership and use of land?

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.

8.0CONCLUSIONS

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:

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?

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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