EFFECTIVENESS OF CLIMATE CHANGE COPING STRATEGIES ON HOUSEHOLD VULNERABILITY TO FOOD INSECURITY IN LUSHOTO DISTRICT

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE.

MOROGORO, TANZANIA.

2014

ABSTRACT

In different parts of the world, farming households have evolved different climate change coping strategies (CCCS) to improve their livelihood. This study focuses on the effectiveness of CCCS that deal with household food insecurity (HFS). A cross sectional survey was performed on a random sample of 150 households in Lushoto District using structured questionnaire. Focus group discussions were conducted through which the commonly practised strategies were identified. Community perceptions on the effectiveness of the strategies were assessed using a Likert type scale. Data on HFS were collected using Household Dietary Diversity (HDD) and Household Food Insecurity Access Scale (HFIAS) which were also used to determine the incidence of food insecurity. Multiple regression models were used to establish the relationships between HDD/ HFIAS and CCCS. The commonly practised coping strategies were irrigation, the use of short-term crop varieties, sale of family labour, early planting, late planting, crop diversification, involvement in petty business, sale of livestock and poultry, tree planting and land intensification, purchase food on credits, borrowing food from friends or relatives, cultivation in wet areas and sending children to eat at neighbour houses. The study revealed that all the strategies were perceived effective in ensuring HFS with exception of the last two. Results of multiple regressions showed that HFS measured by HFIAS was significant and positively related to land intensification (*beta* = 0.34, $P < 0.05$) and early planting (*beta* = 0.20, $P < 0.05$). Also, HFS measured by HDD was significant and positively related to crop diversification (*beta* = 0.39, $P < 0.05$). Although majority of the strategies were perceived effective in ensuring HFS, only the above three were effective. Therefore, these strategies could be strengthened, advocated and integrated in different local and national developmental interventions to improve community members' resilience towards climate change and vulnerability to food insecurity.

DECLARATION

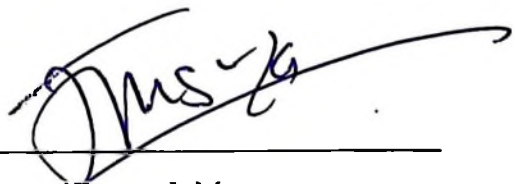
I Fortunata Methusela, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution

13/08/2014
Date

Fortunata Methusela

(M.A. Rural Development Candidate)

The above declaration is confirmed



13/08/2014
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Professor Msuya, J. M

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ACKNOWLEDGEMENTS

First and foremost, I wish to express my sincere thanks to my parents who laid the foundation of my education and devoted many of their resources to pay for my education. I am also pleased to express my thanks and appreciation to my supervisor Prof. Msuya, J.M. for his tireless efforts in supervising this study. His guidance, constructive ideas and readiness to assist contributed immensely to the completion of this work. Thank you for being kind to me because without you this work would not be possible. I say thank you very much.

Special thanks should go to my family: my husband John Richard, our two daughters Joyline and Josephine and our little son Richard for their moral support throughout my study. I am also thankful to my in laws Mr. and Mrs Richard John, for their moral support. You all had a role in this work, thank you very much.

I am indebted to say thank you to my beloved husband John Richard for financial support and encouragements which guided me through the entire period of my work. I don't have the right words to appreciate his love and support but let me just say, "Thank you very much and may God bless you and reward you accordingly". Last but most important, I thank the Almighty God for giving me courage, strength, protection and blessings during the whole period of my study, AMEN.

DEDICATION

This work is dedicated to my little son Richard who was born in the second year of my study, for his endurance in the whole period of writing this dissertation.

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LIST OF ABREVIATIONS AND SYMBOLS

CCCS	Climate Change Coping Strategies
FAD	Food Availability Decline
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
DFID	Department For International Development
FGD	Focus Group Discussion
HDD	Household Dietary Diversity
HFI	Household Food insecurity
HFIAS	Household Food Insecurity Access Scale
IPCC	Intergovernmental Panel on Climate Change
MAFS	Ministry of Agriculture and Food Security
PMO	Prime Minister's Office
SPSS	Statistical Package for Social Science
UN	United Nations
URT	United Republic of Tanzania
VFI	Vulnerability to Food Insecurity
WFP	Wold Food Program

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

The challenge of food insecurity is a growing phenomenon throughout the developing world, particularly in Sub-Saharan Africa and it is partly indicated by the high numbers of people who are under-nourished. Globally, it is estimated that 925 millions of people are food insecure (WFP and FAO, 2010), whereby 33% are in Sub- Saharan Africa (Graaf *et al.*, 2011). In Tanzania, 13.7 million individuals who are equivalent to 34% of the total population of 41.3 million are food insecure (WFP and FAO, 2010). Lyimchai *et al.* (2011) report that in Lushoto District; only 4% of households are food secure over the whole year, whereby over 33% encounter more than 6 months of food deficit per year.

Climate change is ranked among the highest drivers impacting food security in Sub-Saharan Africa, thus exacerbating the already-huge problem of food insecurity (IPCC, 2007; Easterling *et al.*, 2007; Hanjra and Qureshi, 2010). Climate change is impacting food and livestock production which are the main components of food security. These impacts are manifested through the rise of temperature, drought, heat waves, weather variability and floods (Easterling *et al.*, 2007). Owing to the effects of climate change, farming households in Tanzania have evolved coping strategies so as to improve food production (Mattee, 2000; Eriksen *et al.*, 2005; Mngare, 2009). Coping strategies in this context refer to activities aimed at obtaining food or income during climate change stresses either through crop production or through formal and informal exchange (Adger *et al.*, 2003). In Lushoto district, farming coping strategies are adopted as a result of several reasons. According to Lyimchai *et al.* (2011), climate change is among the primary drivers for employing different farming and non-farming coping strategies in the district. The study reported that,

climate change related factors account for 19% of the reasons for adopting certain coping strategies exceeded by market related factors which account for 20%, followed by land related factors which account for 18%, pests and diseases related factors which account for 17%, and 13% which is due to projects and programs.

Some of Climate Change Coping Strategies (CCCS) practised in Lushoto District include the use of new crop varieties (short cycle, drought resistance and high yielding), water management strategies (the use of irrigation farming and improved irrigation and drainage), and soil management strategies (introducing crop cover, mulching, terracing, stone lines, contour ploughing and intercropping). Others are early land preparation, early planting, late planting and agro-forestry management. During crop failure, sale of family labour and livestock and off- farm activities are also reported as means of earning money to access food (Shemdoe, 2011; Lyimchai *et al.*, 2011). However, the effectiveness of these coping strategies on household food security is not known yet and this was the concern of the present study.

1.2 Problem Statement

Climate change poses major threats to global food security due to changes in water supply and demand for agriculture production. The effects of climate change consequently increase uncertainties throughout the food chain and ultimately increase household vulnerability to food insecurity (Hanjra and Qureshi, 2010). While it is widely accepted that all communities have inherent coping strategies to deal with certain variations or changes in climate (Adger *et al.*, 2003), not all of these strategies can adequately provide them with sufficient food. For instance, despite the application of various CCCS, Lushoto District still faces food shortage mainly due to drought (PMO and MAFS, 2006). Due to the incidences of food shortage, the district has been receiving an average of 481.63 tons of relief food,

supplied to an average of 6.8% of the total population each year since the year 2000 (LDC, 2011).

Many studies (Eriksen *et al.*, 2005; Shemdoe *et al.*, 2009; Shemdoe, 2011; Lyimchai *et al.*, 2011) have recognized the existence of CCCS in counteracting the impact of food insecurity in Tanzania. There is a broad set of theoretical literature elsewhere that reflects on the relationship between CCCS and food insecurity. Some of these are entitlement and sustainable livelihood theories. Major emphasis in both theories is that entitlements/resources are prerequisites for effective coping strategies (Davies, 1996; Adger and Kelly 1999; Vincent and Cull, 2013). A number of studies have addressed constraints underpinning the adoption of various coping strategies, ranging from inadequate financial resources (IPCC, 2007) to social barriers (Paavola, 2008; Adger *et al.*, 2009; Jones and Boyd, 2011). Also, Eriksen *et al.* (2005) have recognised opportunities and limitations shaping variations of the coping strategies in temporal and spatial scales.

Despite the wide coverage of the subject, yet empirical evidences on effectiveness of these coping strategies in ensuring food security are missing. Furthermore, the extent to which these strategies contribute to household food security is poorly understood. This study therefore, assesses effectiveness of CCCS on household food security in terms of food accessibility.

1.3 Justification of the Study

The growing concern of the negative impacts of climate change on food security was a motivating factor for this study. With this regard, it is essential for the community to realize effective CCCS on household food security. This will increase community resilience to climate change and reduce vulnerability to food insecurity.

This study is in line with the second National Strategy for Growth and Reduction of Poverty (NSGRP II) cluster I, goal number IV which intends to ensure food and nutrition security, and climate change adaptation (URT, 2010). Therefore, results of this study will provide useful information to various development stakeholders at different levels in developing interventions and strategies that are required to address the problem of food insecurity.

1.4 Objectives of the Study

1.4.1 General objective

The overall objective of this study was to assess the effectiveness of CCCS in ensuring household food security in Lushoto District, Tanzania.

1.4.2 Specific objectives

To achieve the above general objective, the study had the following specific objectives:

i. To identify and characterize CCCS adopted by farming households.
ii. To assess the perception of community members on CCCS.
iii. To determine household food security status.
iv. To evaluate the relationship between CCCS and household food security status.

1.5 Research Questions

This study was based on the understanding that different communities have developed and adopted various CCCS over the years. However, it is not known yet of the effectiveness of each of these CCCS in ensuring household food security. Therefore, in order to achieve the general and specific objectives of the study, the following research questions were used:

i. What are the determinants of CCCS?

ii. How do community members perceive the CCCS?

iii. What is the status of food security in households under study?

iv. How do CCCS relate with household food security status

1.6 Conceptual Framework

The relationships between dependent and independent variables (refer Appendix 1) are depicted in Fig. 1 whereby the impacts of climate change variables on food security are presented. This study assumes that climate change variables are the stimuli for the adoption of different coping strategies. The framework illustrates that under climate change stress household food security is determined by the coping strategies. This relationship may be reflected through Household Dietary Diversity (HDD) and /or Household Food Insecurity Access Scale (HFIAS) which are the proxy indicators of access to food. However, the adoption of coping strategies is directly influenced by farm factors, social economic and demographic factors.

1.7 Study Limitation

It was noted that respondents had the expectations that the research was done as a prerequisite of either government or other donor food aid. To resolve this limitation, the research objective and scope of the study were explained to the respondents before commencing the interview. Also most of the respondents do not have the habit of keeping written records, much of the information collected relied on respondents' memories. Therefore, enumerators used probe questions to help them recall their memories.

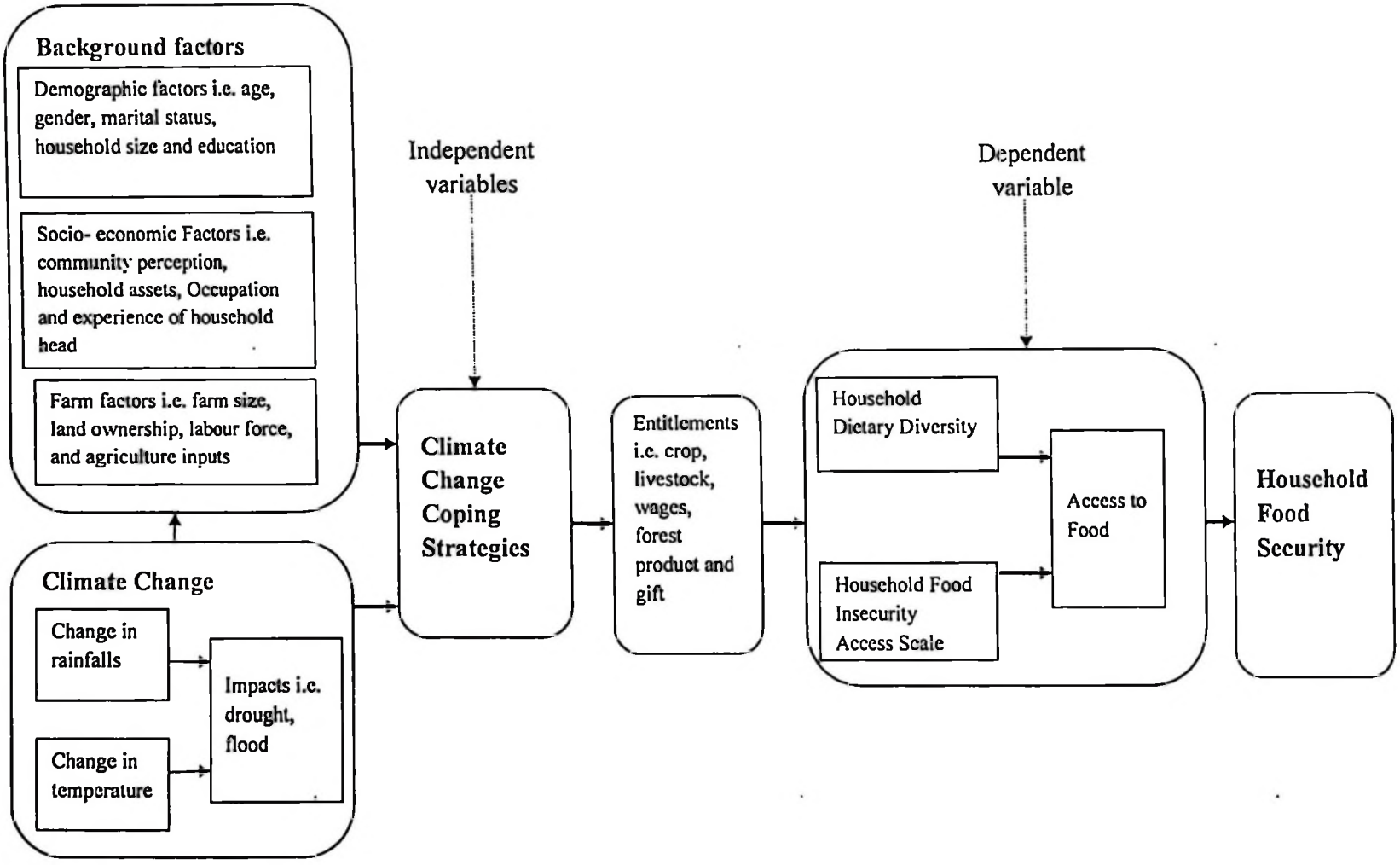

Figure 1: Conceptual framework

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1The Food Security Concepts

Food security has a long history as an "organizing principle" for social and economic development (Maxwell and Frankenberger, 1992). The concept of food security originated in the mid of 1970s during the discussion of international food problems at a time of global food crisis. The crisis prompted the UN organization of Food and Agriculture (FAO) to organize the World Food Conference in 1974. The initial focus of the conference in 1974 was primarily on food supply assuming the availability and price stability of basic foodstuffs at the international and national level. Therefore, the 1974's World Food Summit defined food security as: "Availability at all times of adequate world supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN, 1975).

In 1983, FAO analysis focused on food access, leading to a definition based on the balance between the demand and supply side of the food security equation hence it defined food security as: "Ensuring that all people at all times have both physical and economic access to the basic food that they need" (FAO, 1983). In 1986 a World Bank report on poverty and hunger defined food security by paying attention to the same challenges as those of the 1970s, which were ensuring access to food and hence the report defined food security as: "Access of all people at all times to enough food for an active healthy life" (World Bank, 1986).

In 1996, the World Food Summit in Rome defined food security in a multidimensional nature. The definition included food access, availability, food use and stability.

Hence food security was defined as follows: "Food security, at the individual, household, national, regional and global levels exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). The World Bank's and the World Food Summit's definitions have similar keywords which are access to food, sufficient food, and active healthy life. However, the World Food Summit's definition is multidimensional as it involves the four dimensions of food security namely food availability, accessibility, utilization and stability of supply.

The misconception of food security in the 1970's led to the concentration of increasing food production without considering other dimensions of food security. In this case, the concentration was on increasing the amount of food available (grain in particular) to feed the growing population. History shows that there was a huge increase in food output between the 1970's and the 1980's due to several reasons including cultivating high yielding crop varieties, the expansion of land under production and irrigation, greater use of fertilizers and pesticides and greater access to credits in an era that has come to be known as Green Revolution (Gregory and Ingam, 2000; FAO, 2008a). Although in many countries the revolution brought a greater achievement in grain yield, in some other countries the limits were not achieved due to complications brought by climate change which affect food availability, accessibility and food systems stability (USAID, 2000; FAO 2001; Schmidhurber and Tubielo, 2007).

2.2 Climate Change and Climate Change Coping Strategies

Climate change refers to a change in the state of the climate that can be identified (using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in

climate over time, whether due to natural variability or as a result of human activity (IPCC, 2012). According to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2007), climate change will increase the frequency of extreme weather events such as heavy floods and droughts, and increase food crisis resulting from depletion of water resources. Thus to combat the effect of climate change, people centred short and medium coping strategies are needed to ensure food security.

Coping strategies are often subsumed under adaptation strategies. Different scholars have analyzed the relationship of the two concepts. According to Adiger (2003), climate change coping strategy signifies responses employed by people in order to maintain well-being in the face of climate change stress. Elasha *et al.* (2005) contend that coping strategies are often a short-term response to a specific shock, such as drought. These are the mechanisms taken to address the impacts once they occur. These may include switching to cultivation of short-term crop variety, drought-resistant crops or reliance on external food aid. Adaptive strategies, on the other hand, entail a long-term change in behaviour patterns as a result of a shock or stress.

According to Smit *et al.* (2001) and Orindi and Eriksen (2005), adaptation to climate change refers to adjustments made in natural or human systems in response to actual or expected climate stimuli or their effects in order to moderate harm. Adaptation frequently involves changing the social and economic framework within which livelihood and coping strategies take place. Another scholar contends that factors that shape capacity to cope on timescales of days, months and years, may complement the factors that shape the ability to adapt over longer timescales (Eriksen *et al.,* 2005). Therefore, this study defines coping strategies as an integral part of the adaptation process, meaning that coping strategies are fundamental for adaptive strategies.

2.3 Perceptions about Climate Change Coping Strategies on Food Security

It is believed that community members' perceptions on climate change coping strategies are one of the key components for employing CCCS (Tologbonse *et al.*, 2010; Below *et al.*, 2012). A case study from Germany and Zimbabwe by Grothmann and Patt (2005) showed that people's perceptions influence coping behaviour. Another study by Below *et al.* (2012) found that there is a linear relationship between farmers' perceptions and adoption of CCCS. Ericksen *et al.* (2005) argue that coping strategies of small scale farmers vary between households and over time depending on choices, objectives, opportunities and constraints.

Farmers' perception on climate change is widely covered by a number of studies (Mngare, 2009; Tologbonse *et al.*, 2010; Mengistu, 2011). However few studies have assessed farmers' perception on climate change coping strategies. Different methods are currently used to measure people's perception on CCCS. For example, Likert type scale by Tologbonse *et al.* (2010) whereby the perception is measured using the Mean Sum Score and Coping Strategy Assessment tool by Regmi *et al.* (2010).

2.4 Climate Change Coping Strategies and Food Security

Climate change poses an unprecedented challenge to the aim of eradicating hunger in order to meet the growing demand for food security and nutrition under increasingly difficult climatic conditions. Local people are the on-site land managers who play central roles in adapting agriculture and food systems to meet their needs under changing climate conditions. The concept of adapting to climate impacts is not new to them. Traditionally, coping strategies to cop/adapt to seasonal and annual climate variability have included sharing local knowledge on varieties, farming systems, management technologies etc. but the need to increase production, coupled with the speed and magnitude of the changes in

climate, poses new challenges (WFP *et al.*, 2009). Julie and Matanga (2011) argue that, since the changing climatic conditions bring about trend declines in local production, the capacity of affected households to engage in traditional forms of coping strategies is likely to decline. With this regards, producers at different points of the food chain would have different vulnerabilities and access to coping strategies.

Other writers (WFP *et al.*, 2009), contend that traditional coping mechanisms will not be sufficient to ensure food security and prevent effects on nutritional status. They must be complemented by the introduction of technical innovations and enabling frameworks. However, the survival of different ethnic groups over centuries without external assistance is the evidence of the effectiveness of traditional coping strategies to climatic factors (Adger, 2003). According to Chambers (1989), analyzing vulnerability to food insecurity requires addressing two aspects, one external to the household, which includes climate change related stress such as drought and floods and the other is the internal aspects of vulnerability which has to do with people's capacity to cope with the external shocks.

2.5 Review of Theories

2.5.1 Food availability decline theory

The Food Availability Decline (FAD) theory explains that famine or food shortage occurs when there is an aggregate decline in food supply. According to this theory people starve because of a local, national or regional decline in food availability to a level below the minimum necessary for survival. Based on the FAD theory, a decline in food availability may be attributed to many factors. The two most important and frequently used factors are: Demographic i.e. population growth causes famine (Malthus, 1789) and climatic i.e. drought causes famine (FAO, 2008b). The two factors are described in section 2.5.1.1 and 2.5.1.2.

2.5.1.1 Demographic theories

Malthusian and Anti-Malthusian are competing theories regarding the relationship between population growth and food availability. The Malthusian theories argue that the population increases in a geometric progression while food production increases in arithmetic progression. Thus Malthusians contend that food insecurity is due to the presence of too many people compared to the amount of food produced. This argument is the work of Thomas Malthus who was criticized by Ester Boserup (Anti-Malthusian) for its failure to consider the technological improvements in agriculture which would enhance productivity (Devereux, 2001). Boserup argued that large population size is a positive stimulus for growth (Boserup, 1993). However, Malthusian and Anti-Malthusian FAD theories have been criticized by Amatya Sen for their only dealing with supply side and disregarding the demand side. They say nothing about people's income and purchasing power. Furthermore, they have failed to address the vulnerability differences and access to food from outside the affected area (Sen, 1981; Devereux, 2001).

2.5.1.2 Climate based factor

Several scholars (Ribot, 1995; Xie and Fu, 2004; WFP *et al.*, 2009) argue that climatic factors such as too much rainfall (flooding) or lack of rainfall (drought) cause crop failure and can lead to food shortage or famine. Climatic events like drought or flooding have adverse impact and can cause reduced crop yield, livestock losses, and shortage of drinking water. These have social consequences such as forced sale of household assets, ecological degradation, increase of food price and therefore food become inaccessible to poorest households (Ribot, 1995; FAO, 2008b). However, the opponents of climatic based explanations argue that famine could occur without any abnormal weather due to various socio-political and economic processes (Sen, 1981).

2.5.2 Theoretical aspects of climate change coping strategies on food security

Climate change coping strategies are mostly linked to the theories of vulnerability to climate change which draw from sustainable livelihood and entitlement approaches

2.5.2.1 Climate change coping strategies and the theory of entitlement

The theory of entitlement was developed by Amartya Sen in 1981 when he was challenging the theory of food availability decline which explains that famine or food shortage occurs when there is an aggregate decline in food supply. Sen argued that *"People do not usually starve because of an insufficient supply of food but because they have insufficient resources, including money (entitlements) to acquire it"*. Households become food insecure because of failure in entitlements. Hence, people are likely to cope well with climate change stresses by increasing their entitlements.

Various authors (e.g. Adger and Kelly, 1999; Vincent and Cull, 2013) concur with him on the use of the entitlement theory in analyzing climate change coping strategies. In an attempt to cope and recover from climate change impacts such as food production and/or exchange failures, people take sequential actions (coping strategies) which may include practices such as selling non-productive assets and use of common resources (such as collecting non-domesticated foods); selling productive assets such as capital or land; and migration (Adger, 1996). Based on this, Kelly and Adger (2008) contend that entitlements are prerequisites for coping with climate stresses and the vulnerability to food insecurity.

Sen (1981) defined entitlements as the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces. He sub-divided these entitlements as follows: production-based entitlements (crops and livestock); own-labour entitlements (waged labour and professions); trade-based

entitlements (trading artisan products and natural resources like forestry products); and inheritance and transfer entitlements (from the state, or private gifts and loans) (Young *et al.*, 2001).

However, Sen is not the only one who has analysed entitlements; Leach *et al.* (1999) have also analysed them by introducing the concept of environmental entitlements. These are alternative sets of utilities derived from environmental goods and services over which social actors have legitimate effective command and which are instrumental in achieving well-being. The environmental entitlements include direct uses of resources in the form of commodities, such as food, water or fuel and the market value of such resources or of rights to them, and the utilities derived from environmental services such as pollution sinks or properties of the hydrological cycle. Based on the examples of environmental entitlements given by Leach *et al.* (1999) above, it is possible to improve food security through the use of such entitlements. For example, people with free access to forests can obtain timber and non-timber forest products and sell them to get cash for buying food.

The entitlement theory has also certain weaknesses and is subject to criticism. The main limitations are its failure to consider intra-household distribution of food, exclusion of entitlement through aid food and non- legal transfer of resources (Devereux, 2001). The theory has been criticised on two further accounts. Firstly, it implies a straightforward sequence of entitlement failure leading to hunger and then to malnutrition, starvation and death. Secondly, it implies that people's actions are largely determined by their need to consume food (de Waal, 1990). But research into people's responses to famine, often referred to as 'coping strategies', has shown that their priorities in times of food stress are to preserve productive assets to protect livelihoods rather than to meet immediate food needs (Corbett,1988).

Although the entitlement approach has been criticised much, some writers support it. For example, Sijm (1997) commends Sen for bringing together and formalizing old ideas on hunger and poverty in a general framework, and for emphasizing the importance of factors other than aggregate food availability. Sijm adds that reading carefully Sen's writings can help understand why certain people suffer from hunger and under nutrition in a country where adequate food is available. Another writer supporting the entitlement approach is Osmani (1993) who asserts that Sen does not dismiss food availability decline (FAD); he simply says that it is usually not the ultimate cause of famine and endemic hunger. Osmani further argues that Sen's aim has been to prove that food availability decline should not be taken as a universal explanation for all famines.

But the reason for re-emphasising food availability decline as a cause of famine was to challenge the hegemonic position of the food availability approach. According to the entitlement theory, food availability at global or national level alone could not bring food security at household level. Thus, this theory has contributed significantly to the shift of emphasis to household and individual level of analysis. Therefore, the entitlement approach is useful for this study because it draws analytical attention to other sources of food apart from production, and focuses on the risk minimising strategies whose individuals or groups appear to adopt in many circumstances.

2.5.2.2 Climate change coping strategies and sustainable livelihood approach

The sustainable livelihood approach emerged from the concept of sustainable livelihoods. A sustainable livelihood is defined as: 'A livelihood that comprises the people, their capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base'

(Chambers and Conway, 1991). According to Scoones (2009), the term 'sustainable' in the livelihood perspectives, entails two main issues. First, it tends to refer to coping with immediate and short-term shocks where local capacities and knowledge would be sufficient if effectively supported. Second, it implies that livelihoods are stable, durable, resilient and robust in the face of both shocks and stresses, and do not undermine the livelihoods options of others.

The livelihoods framework shows the key elements of livelihoods and how they interact. They include assets, strategies, outcomes and policies, institutions and processes (DFID, 1999). Assets encompass what people have, including their natural resources (e.g. land, forest products, water); physical resources (e.g. livestock, shelter, tools, materials); social resources (e.g. extended family and other social networks); financial resources (e.g. income, credit, savings); and human assets (e.g. education, skills, health).

Livelihood assets are what determine the resilience of households to vulnerability. Livelihood strategies are what people do to make a living in normal situations, or what people are doing to meet their livelihood goals (Schafer, 2002). Coping strategies on the other hand are short-term responses of resilient livelihood systems to deal with periods of stress. They are characteristics of structurally secure livelihood systems (Davies, 1996). This study argues that livelihood strategies and coping strategies are intrinsically linked.

Although sustainable livelihood approach is central to development and poverty reduction, it has been widely used by different scholars to address adaptive capacity in the face of climate change (Elasha *et al.*, 2005; Jones *et al.*, 2010; Lamichhane, 2010). However, the approach has been criticised for its limitation in addressing the issues of adaptive capacity to climate change (scones, 2009; Hahn *et al.*, 2009). Based on this

limitation Hahn *et al.* (2009) have developed a new approach known as Livelihood Vulnerability Index which integrates climate exposures and accounts for household adaptation practices. As opposed to the sustainable livelihood approach, the Livelihood Vulnerability index (LVI) is a function of exposure, sensitivity and adaptive capacity.

Even though the livelihood approach has been challenged for its limitations in addressing climate change (Hahn *et al.*, 2009), it fully explains the realities of small-scale farmers struggling to adapt to climatic changes. According to Chambers (1989), the sustainable livelihood approach is reliable for case studies of poor small-scale farmers. Chambers argues that people do not simply draw on their assets but possess sophisticated skills in managing them, coping with adversity, adapting with flexibility and taking advantage of new opportunities over different timescales. Therefore, this study adopted the sustainable livelihood approach because it provides explanations of vulnerability and coping capacity at the grass root.

2.6 Methods of Measuring Food Security

According to Maxwell and Frankenberger (1992), methods of measuring food security are grouped into five main categories; these are: (i) measuring food sufficiency based on actual food intake; (ii) measuring food availability in terms of grains obtained; (iii) measuring food security using the entitlement to food approach; (iv) measuring food security based on access to enough food at all times, and (e) measuring food security based on process and outcome indicators. However, bearing in mind the comprehensiveness and complexity of the concept of food security, today there is no universal single standard for measuring food security, particularly food access at the household level.

Various indicators have been used to measure different components, determinants, and /or outcomes of food (in) security (Webb *at el.*, 2006; Coates *et al.*, 2006). The examples of simple derived measures are such as, assets and nutritional status (FANTA, 2003); indicators based on food availability, food expenditure, or food consumption; dietary diversity scores at the household level (Hoddinot and Yohannes, 2002; Smith *et al.*, 2006; Wiesmann *et al.*, 2008); food insecurity experience based indicators using coping strategies and behaviours (Maxwell *et al.*, 2008); and household food insecurity scales (Coates *et al.*, 2007). This study adopted two indicators of measuring food accessibility at household level. These are the household food insecurity access scale (HFIAS) and household dietary diversity (HDD).

2.6.1 Household food insecurity access scale

The Household Food Insecurity Access Scale (HFIAS) is a nine-item scale designed to measure the prevalence and severity of household food insecurity in developing countries. The scale is adapted from the Household Food Security Survey Module that has been used since early 1990s for assessing household food insecurity. HFIAS assesses changes in the quality and quantity of the diet that households undergo when resources for acquiring food are limited. This method is based on universal situations or experiences and responses a household may have undergone when limited with access to food. HFIAS has been used in several countries and appear to distinguish food insecure from food secure households across different cultural contexts (Coates *et al.*, 2007).

2.6.2 Household dietary diversity

Household Dietary Diversity (HDD) is defined as the number of food groups consumed over a given period of time (Ruel, 2003). It is a measure of household dietary adequacy, a central notion in the definition of food security (FAO, 2007). HDD is measured at the

household level through use of a questionnaire. The HDD measurement tool (questionnaire) originally was developed by FANTA (Swindale and Bilinsky, 2006) as proxies of quantitative dietary intake. Just recently FAO has published operational guidelines for measuring dietary diversity in a standardized way based on a tool developed by FANTA (FAO, 2010). Based on the FAO's HDD tool, data collection uses an open recall method to gather information on all food and drinks consumed by the household or individual over the previous 24 hours. Most often it is measured by counting the number of food groups consumed. This tool has been used by a number of studies (Becquey *et al.*, 2010: Oluwatayo, 2009) as a measure of households' economic ability to access a variety of foods, thus a measure of food accessibility (Kennedy *et al.*, 2010: FAO, 2010). In their study Hoddinott and Yohannes (2002) revealed that HDD score had a positive significant correlation with energy availability. The study results suggest that HDD is a varied indicator of food security. Therefore, HDD is a promising tool to provide important information about household food security in a very convenient way.

2.7 Determinants of Food Security

Food security is strongly determined by a number of factors. These include demographic factors (Oluwatayo, 2009), social economic factors (Gundersen and Gruber 2001; Ribar and Hamrick 2003; Faridi and Wadood, 2010; Guo, 2011) and farm factors (Omotesho *et al.*, 2010).

2.7.1 Demographic factors

A study conducted in rural Nigeria by Oluwatayo (2009) found that demographic factors such as marital status, age, and educational level, are positively related to food security status while household size is negatively related to it. The study also indicated that married respondents were more food secure than single, divorced or widowed

respondents. This may be attributable to the possibility of couples assisting each other to augment households' needs. Another study conducted by WFP, FAO and Palestinian Central Bureau of Statistics (PCBS) revealed that gender composition correlates with household's food security (WFP *et al.*, 2010). Female headed households and households with a higher number of female adult members were more likely to be food insecure due to limited access to job opportunities and lower salaries for women.

2.7.2 Socio-economic factors

A study conducted by Guo (2011) indicated that social economic factors like household assets have a significant association with food security in both high and low- income households. This is strongly supported by another research conducted by Ribar and Hamrick (2003) which revealed that assets provide resources to smooth food consumption. Occupation is another socio-economic determinant of food security which has been reported by Faridi and Wadood (2010). In their study they found that wage earners, both daily wage and salary wage earners, are worse off in terms of food security status as compared to self-employed - both in agriculture and non-agricultural sector. Other studies by Gundersen and Gruber (2001) and Ribar and Hamrick (2003) revealed that improved access to credit might help households maintain food sufficiency. Likewise off-farm activities like petty business have been reported to improve calorie supply at the household level. Babetunde and Martin (2010) revealed that off-farm activities have a positive net effect on food security and nutrition, which is in the same magnitude as the effect of farm income.

2.7.3 Farm factors

Along with other factors mentioned above, farm factors are also important determinants of food security. These factors may include farm size, agricultural inputs, labour inputs

and agricultural technologies. A number of studies have reported that, increase in farm size, use of modern farm inputs, land ownership and labour inputs increase household's probability of being food secure (Feleke *et al.*, 2003; Omotesho *et al.*, 2010). However, households with small farm size but with much labour, the labour can be used on own household's farm and work as off-farm labourers to earn money for food purchase.

Although the use of modern farm inputs such as fertilizers, insecticides and pesticides are said to enhance food security, Travis and Daniel (2012) argue that they have either direct or indirect link to climate change. Thus, the uses of such farm inputs should be minimized and promote the use of new crop varieties and drought and temperature tolerant traits which alter the impact of carbon emissions. The use of poor technologies such as land preparation using hand hoe constrain food production. On the other side, FAO (2005) argues that the use of drought animals for example oxen, while saving labour could also allow expansion of cultivated area which could lead to either higher volume of crop harvested or higher yields due to timely planting.

2.8 Empirical Literature Review

Several studies (Eriksen *et al.*, 2005, Paavola, 2008; Below *et al.*, 2011; Shemdoe *et al.*, 2009; Jerie and Matanga, 2011) unanimously agree that communities have over time developed strategies to cope with the changing climate in order to sustain their livelihood. For example a study by Eriksen *et al.* (2005) on the dynamics of vulnerability has looked at the opportunities and constraints that shape variation in coping strategies overtime and between households during drought. The study identified coping strategies such as charcoal making, casual labouring, food vendoring and collection of wild fruits that were developed by farming communities to cope with climate change. It was revealed that many households had limited capacity to adopt effective coping strategies due to lack of skills, labour and

capital. However, the study did not address explicitly how the identified coping strategies could insure household food security.

Another study by Below *et al.* (2011) found that productive assets (livestock, perennial crops and arable land) which are intrinsically linked to coping strategies are the best means of improving adaptation to climate by farmers in rural Morogoro. However, research into people's responses to famine showed that communities can acquire productive assets to protect their livelihoods yet suffer food insecurity (Corbett, 1988). Therefore, the current study provides a clear relationship between possessions of different livelihood/ productive assets and food security which was not shown by Below *et al.* (2011).

Also a comparative study carried out by Shemdoe *et al.* (2009) on tracking effective indigenous adaptation strategies on impacts of climate variability on food security of farmers in Lushoto and Mpwapwa identified different coping strategies practiced in these areas. He found that some coping strategies are practised in both areas and some are unique in respective areas. Perhaps limited to its objectives the study only used descriptive analysis which did not allow the researcher to analyse the relationship between food security and the identified coping strategies.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Study Area and Justification of the Study Area

This study was conducted in Lushoto District which is located between 4^0 25' – 4^0 55' S and 30^0 10' – 38^0 35' E in the Northern part of Tanga Region (URT, 2009). The district generally receives rainfall on a bimodal pattern. The main physical features are highlands which receive an average annual rainfall of 800 – 2000mm and lowlands which receive an average annual rainfall of 500-800 mm. The district is divided into 5 agro ecological zones namely the humid cold zone, humid warm zone, humid hot zone, dry warm zone and dry cold zone. The population of Lushoto District is 492 441 (URT, 2013). Agriculture is the main economic activity in Lushoto District and it depends on both rainfall and irrigation.

The district was selected to be the study area because in recent years it has been identified to be vulnerable to climate change (Shemdoe *et al.*, 2009; Shemdoe, 2011; Lyimchai *et al.*, 2011). Additionally the district is vulnerable to food insecurity as compared to other districts in the region (PMO and MAFS, 2006). The existence of different zones in the district provides a range of coping strategies which if proven effective can be scaled up in other areas having similar agro-ecological conditions.

3.2 Research Design

Based on the research objectives, the study used cross sectional research design. This design was adopted because it has a great degree of accuracy in describing the relationship of variables at a single point in time, yet fulfilling the objectives of the study (Bailey, 1994).

3.3 Sampling Procedures

3.3.1 Sampling techniques

Three out of 5 agro-ecological zones were purposively selected. These agro-ecological zones were selected based on their vulnerability to climate change. Purposive sampling was done to select three wards namely Shume from dry cold zone, Makanya from dry warm zone and Mng'aro from dry hot zone. The wards were selected because of their high potential in staple foods production, but also they are the most affected wards by food shortage (URT, 2009). From each ward, one representative village was randomly selected making a total of three villages which were Mdando, Viti and Mng'aro. The study population was faming households which had existed in these villages for at least five years while participating in farming.

A sampling frame of each village was developed from which the sample units were drawn randomly by proportion. Purposive sampling was done again to select key informants and participants in Focus Group Discussions (FGDs). The key informants included village leaders (one from each village) and local agricultural officers (one from each village). Members of the FGDs included senior residents (elders) men and women and youth aged between 25-35 years. Three FGDs from each village were conducted. Each FGD comprised of twelve members.

3.3.2 Sample size

The sample size of the study was 150 farming households. As indicated in Table 1, this sample size is 7.5% of the total population of the study area which exceeds 5% of the population recommended by Bartlett *et al.* (2001) for statistical relevant results to be obtained.

Table 1: Summary of the chosen sample from the study population

Ward	Village	No. of households per village	7.5 percent of households sampled
Makanya	Mdando	600	45.0
Shume	Viti	1000	75.0
Mng'aro	Mng'aro	400	30.0
Total		2000	150

Source: Lushoto District Council - Planning department (2012)

3.4 Data Collection Methods

3.4.1 Primary data

Primary data was collected using both quantitative and qualitative data collection techniques. Structured interview schedule and Focus Group Discussion (FGDs) were used in combination. The FGD was used to generate information on climate change and its related hazards. Participants in FGD identified different Climate Change Coping Strategies (CCCS) employed by farming households. They also explained the merits and demerits of the strategies. The identified coping strategies were then included in the household questionnaire so as to gather information on the adoption and perception on the CCCS. A five level (1-Strongly disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree and 5-Strongly agree) Likert type scale was used to collect information on community perception on CCCS.

Information on household food security status was collected using Dietary Diversity Questionnaire and the widely accepted nine questions of Household Food Insecurity Access Scale (HFIAS), which has been used in several developing countries (Coates *et al.*, 2007). The combination of these two methods aimed at providing a holistic picture on the status of food security in the study area.

3.4.2 Secondary data

Secondary data such as relief food reports and demographic data were collected from the district agricultural department and district planning office respectively. Other reports were solicited from the respective wards and villages.

3.5 Data Analysis

3.5.1 Descriptive analysis

The household survey data were coded and analysed using version 16 of Statistical Package for Social Sciences (SPSS) computer programme. Descriptive analysis involved computation of frequencies, percentages and cross-tabulation of quantitative data such as socio-economic data and the identified CCCS. Content analysis on the other hand was used to analyze information recorded during focus group discussions, which were synthesized into meaning, values and attitudes and used for interpretation of the results.

A five point Likert type scale of strongly agree, agree, undecided, disagree and strongly disagree which were assigned weights of 5, 4, 3, 2, and 1 respectively was used to measure perception of the effectiveness of CCCS. When calculating the perception, a mid-point value of the scale (i.e. 3) was taken as a cut-off point. The mean of each CCCS was obtained by multiplying the weight of each point scale with the number of respondents in each point scale divided by the total number of respondents. The CCCS with mean scores above the cut-off point were perceived as effective while those with mean scores less than the cut-off point were perceived not effective in ensuring household food security.

3.5.2 Determination of food security in the sampled households

The status of food security of each sampled household was assessed using household food insecurity access scale (HFIAS) and household dietary diversity (HDD) indices. Based on

household food insecurity access scale questionnaire (Appendix 6), the HFIAS category for each household was determined as recommended by FANTA (Coates *at el.*, 2007). Therefore categories were assigned as below.

i. HFIAS category 1= food secure: it included households which scored [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

ii. HFIA category 2 = mild food insecure: those households which scored [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

iii. HFIA category 3= moderate food insecure: those households which scored [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]:

iv. HFIAS category 4= severe food insecure: those households which scored [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3].

With regard to the HDD index, currently there is no cut-off point upon which the international community agrees for a broad use in all contexts (Kennedy *et al.*, 2010). Therefore, in this study, households were categorised into food secure and food insecure as suggested by FANTA, whereby the average diversity of the 33% of households with the highest diversity (upper-tercile of diversity) was taken as a cut-off point (Swindale and Bilinsky, 2006). Twelve households had the highest diversity of 10. Thirty three percent of the twelve households were 3.94 households; hence ten was the average diversity which was taken as a cut-off point. Therefore, all households that scored below 10 were in the category of food insecure.

3.5.3 Determination of the relationship between CCCS and food security

The linkage between CCCS and household food security was determined using multiple regression models. The dependent variable HFIAS score (a proxy indicator for food security) was subjected in the model against the independent variables which were marital status, household size, number of years a household has lived in the study area and the adopted CCCS (Appendix 1). Again, the HDD score (another proxy indicator for food security) was tested against the same independent variables. Before establishing this relationship, independent variables explaining food security indicators were subjected into the Principal Component Analysis (PCA) to check for redundant variables (refer Appendix 2). A Kaiser's criterion (the Eigenvalue rule) was used to extract variables. Thus variables with an Eigenvalue of 1.0 or more as suggested by Pallant (2005) were retained for the regression analysis. The Multiple regression models were based on the following equation:

$Y = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} \ldots\ldots\ldots\ldots\ldots + \beta_k X_{ki} + \varepsilon_i$

Where, Y = food security measured by Household Food Insecurity Access Scale,

i = 1, 2, 3 150

β_o = constant of the regression equation without the independent variables

β_1 to β_k = coefficients of the independent variables

k = number of independent variables

X_1 = Marital status (1=married, 2= otherwise)

X_2 = Household size measured in total number of individuals living in the household

X_3 = Number of years household lived in the place

X_4 = Irrigation farming strategy (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_5 = Early planting (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_6 = Sale of family labor (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_7 = Sale of livestock and poultry (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_8 = Petty business (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_9 = Send children to eat with neighbour (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_{10} = Borrow food from friends or relatives (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_{11} = Land intensification (1= if a household practices the strategy, 0 = if does not practice the strategy)

X_{12} = Cultivating in wet areas (1= if a household practices the strategy, 0 = if does not practice the strategy)

ε_1 = Error term

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characteristics of Sampled Respondents

4.1.1 Demographic characteristics

The demographic characteristics of the sampled households considered here includes age of household head, level of education of household head, marital status, household size and duration of stay in the study area.

4.1.1.1 Age

As indicated in Table 2, the minimum and maximum ages of the interviewed household heads were 21 and 78 years respectively. The average age was 41.8 years. This indicates that there was no any household headed by a person with an age less than 18 years who is regarded as a child in Tanzania. About 33% of the respondents were between 21 and 35 years of age and 48% of the respondents were in the age between 36 and 50 years. Nearly 19% of respondents were above 50 years of age who are considered as aged/old people. According to Mashindano and Maro (2011), the latter age group is less involved and dependent in production activities. The other two age groups which form large percent of the respondents fall within the productive age.

Table 2: Distribution of respondents by demographic characteristics in Lushoto District

Variables	Frequency	Percent	Min.	Max.	Mean	STD
Age						
21-35 years of age	50	33.3				
36-50 years of age	72	48.0	21.00	78.00	41.83	11.12
Above 50 years of age	28	18.7				
Marital status						
Married	128	85.3				
Divorced	9	6				
Widowed	9	6				
Widower	3	2				
Single	1	0.7				
Gender						
Female headed	18	12				
Male headed	132	88				
Years of schooling						
None	27	18.0				
Primary	119	79.3	0	12	6	2.4
Secondary	4	2.7				
Household size						
1-4 members	35	23.3				
5 - 9 member	109	72.7	1.0	10.0	6	1.9
More than 9 members	6	4				
Number of years a household has stayed in the area						
Less than 10 years	20	13.3				
10-30 years	98	65.3	5	55	21	11.31
Above 30 years	32	21.3				

4.1.1.2 Years of schooling

Results presented in Table 2 show that the average number of years of respondents attended school was 6.2. The minimum and maximum years of schooling were zero and 12 respectively. Eighteen percent of the respondents never attended school. Seventy nine percent of respondents had attained primary education, and only 2.7% attained secondary education. The smaller percent of respondents who attained secondary education could be attributed by the fact that most of people completing secondary education do not remain in the village. However over 80% of respondents attained at least a minimum level of education. These findings are in line with Shemdoe (2011) and Ngware *et al.* (2008) who also reported low level of education in the study area.

4.1.1.3 Gender and marital status

Table 2 also shows that 88% of households were headed by males whereas 12% were headed by females. Results also revealed that majority of the respondents (85.3%) in the study area were married. The rest 14.7 % had various marital statuses; 6% were divorced and another 6% were widowed, 2% were widowers and 0.7% were single. As pointed out by Oluwatayo (2009), married people are more likely to employ coping strategies effectively because they help each other in production activities. Likewise married people are more likely to be food secured than unmarried. This can be attributed to the possibility that couples do assist each other to augment households' needs.

4.1.1.4 Household size

The average size of the sampled households was 6 persons per household. This is greater than the national average household size and that of the district which are 4.9 and 4.7, respectively (URT, 2013). The distribution of household size per household was grouped as shown in Table 2. More than seventy percent of the households had up to nine household members, 23.3 % had at most four household members and only 4% had more than nine household members.

4.1.1.5 Duration of stay in the study area

The distribution of respondents by the number of years a household has stayed in the study area is also presented in Table 2. It was found that 65.3% of households have stayed more than 10 years. About 21% of the households have stayed more than 30 years and 13.3% have stayed less than 10 years. This indicates that most of the households have stayed longer enough to experience weather variations and climatic changes that the area has undergone; and have probably employed different CCCS to sustain their living.

4.1.2 Socio-economic characteristics of the sampled households

4.1.2.1 Main occupation of household head

The occupations of household heads can have important role in coping with climatic stresses and hence affect household food security. For example, a household head with a well paying non-farm activity is likely to cope well with food shortage because he is capable of buying food and/or agricultural inputs so as to produce more food. Findings in Table 3 show that majority (96.6%) of the respondents were engaged in crop production and this is a primary activity to 89.3% of the respondents. Crop trading involved 67% and it is a primary activity to 48% of the respondents. A reasonable number (28%) rely on casual labour as their primary activity and this has engaged 62% of the respondents. Both livestock keeping and wage employment are secondary activities to 41.3% of the respondents. Only 4 % of the respondents rely on petty business as their primary activity and this is a typical example of most rural areas in Tanzania.

Table 3: Primary and secondary economic activities of household head in Lushoto District (n =150)

Economic activities	Percentage of household engaged	Primary	Secondary	Nil
Crop production	96.6	89.3 (134)	7.3 (11)	3.3 (5)
Livestock keeping	49.3	8.0 (12)	41.3 (62)	50.7 (76)
Wage employment	49.3	8.0 (12)	41.3 (62)	50.7 (76)
Casual labour	62	28.0 (42)	34.0(51)	38.0 (57)
Petty business	16	4.0 (6)	12.0 (18)	84.0 (126)
Crop trading	67.3	48.0 (72)	19.3 (29)	32.7 (49)
Collecting and selling fire wood	1.3	0 (0)	1.3 (2)	98.7 (148)
Collecting and selling edible fruits	2.7	0.7 (1)	2.0 (3)	97.3 (146)
Art or raft work	6.7	0 (0)	6.7 (10)	93.3 (140)
Masonry	4	1.3 (2)	2.7 (4)	96.0 (144)
Crop middlemen ("dalali")	1.3	0 (0)	1.3 (2)	98.7 (148)

*The values in brackets are number of respondents

A different scenario can be seen in urban areas of Tanzania, where petty business is a primary activity to majority of the population with primary education (Mfaume and Leonard, 2004). In general, crop production and crop trading are the main primary

economic activities in the study area, whereas livestock keeping, wage employment and causal labour are the main secondary activities. During household survey it was revealed that secondary economic activities were mainly for coping with stresses of climate change.

4.1.2.2 Land owned and cultivated

A comparison between the size of land owned by households and the size of land under cultivation showed that there was no significant difference between the two (paired sample *t*-test, *p=0.051*). While the average size of land owned was 3.8 acres, the average size of land cultivated was 3.3 acres. It was noted that the slight difference is attributed by the land left for fallow which had an average of 0.5 acres. The minimum and maximum size of land owned and cultivated was 0 and 20 acres respectively, while the minimum and maximum land left for fallow was 0 and 13 acres respectively. It was also noted that half of respondents owned land of between 1 and 3.9 acres and very few (3.3 %) did not own any land (Table 4). However, the difference of land owned and cultivated across villages was significant (F= 31.41, P=0.00 and F=25.08, P=0.000 respectively).

Table 4: Land owned and cultivated per household in Lushoto District (n=150)

Size of land	Percentage of households that owned land	Percentage of households that cultivated land
0 acres	3.3	2.0
Less than 1 acres	15.3	14.7
1-3.9 acres	50.0	53.3
4-9.9 acres	18.0	20.0
10 and above acres	13.3	10.0
Minimum	0	0.0
Maximum	20	20.0
Mean	3.80	3.34

As indicated in Fig. 2, a large land is owned in Mdando village as compared to the land owned in Mng'aro and Viti villages. This is because the former village has low population density as compared to the latter villages (URT, 2004).

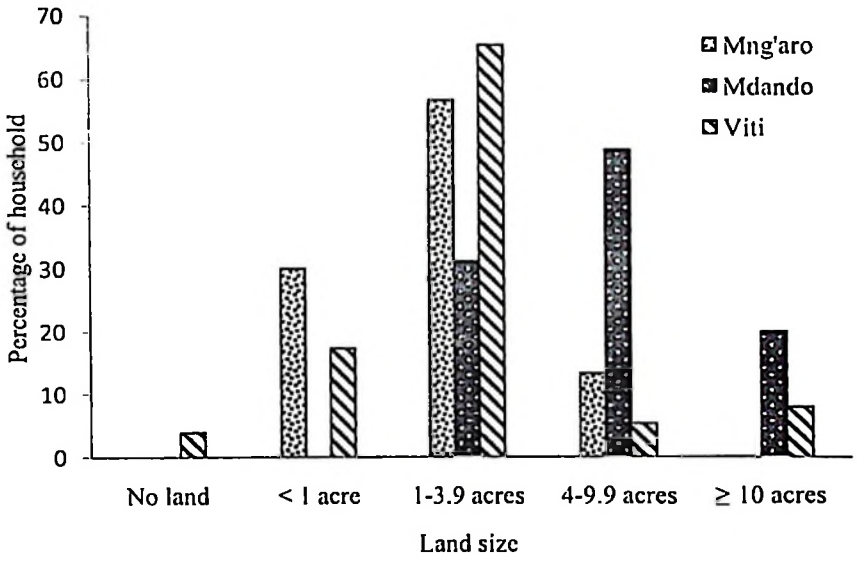

Figure 2: Land owned per household across studied villages in Lushoto District

4.2 Climate Change Coping Strategies (CCCS) Employed by Households

4.2.1 Identification of climate change coping strategies

Participants in the FGD confirmed climate change to be a reality in the study area. A number of climate change indicators were reported. These indicators included prolonged droughts, change in patterns of rainfalls, presence of floods, rise in temperatures and poor regeneration of grazing pastures. The most frequently mentioned weather events indicating change in climate which seems to be common to all the three villages were droughts and unpredictable rainfalls. It was revealed that there is an endless list of coping strategies employed by community members to overcome the effects of climate change in the study area.

Normally, under adverse conditions of these hazards, new strategies emerge adding to the existing ones. Therefore, coping strategies are dynamic and are continually evolving to overcome the effects of climate change. However, with the aid of FGD, the commonly

used coping strategies were identified. These included irrigation cultivation, cultivating in elevated areas during heavy rains, cultivation in low lands (wet areas), the use of short-term crop variety, sale of family labour, early planting, late planting, crop diversification, and involvement in petty business. Others are sale of livestock and poultry, tree planting and land use intensification. Also there are others like purchase of foods on credit, borrowing food from friends or relatives and sending children to eat with neighbours.

As indicated in Table 5, the most frequently used CCCS is sale of family labour. This strategy is employed by 68.7% of respondents as a means of earning money to purchase food. Others are early planting employed by about two-thirds (60%) of respondents as a way of coping with changes in patterns of rainfalls, followed by purchasing food on credit by 59.3% of respondents. The least practised strategies are cultivating in wet areas, land intensification and sending children to eat with neighbours practiced by 7.3 %, 6.7% and 4% respectively.

Table 5: Identified climate change coping strategies in Lushoto District

Coping strategies	Frequency	Percent
Irrigation cultivation	37	24.7
Crop diversification	45	30.0
Early planting	90	60.0
Late planting	45	30.0
Tree planting	25	16.7
Sale of family labour	103	68.7
Sale of livestock and poultry	42	28.0
Short- term crop variety	32	21.3
Petty business	19	12.7
Purchase food on credit	89	59.3
Send children to eat with neighbours	6	4.0
Borrow food from a friend or relative	59	39.3
Land intensification	10	6.7
Cultivating in elevated areas	41	27.3
Captivating in wet areas	11	7.3

The low percentages of respondents practicing these strategies might be due to the following reasons. First, there are few wet areas in the study area, hence a smaller proportion of community members have access to these areas. Second, land

intensification requires cultivation with enough agricultural inputs. Economic resources to buy agricultural inputs such as fertilizers, pesticides and improved seed varieties might hinder community members to practice the strategy. Third, in their context, interviewees and participants of the FGD considered sending children to eat with neighbours a great shame. However, the strategy was mentioned as the last alternative to cope with food shortage. Several studies (Eriksen, 2005; Paavola, 2008; Mngare, 2011; Below *et al.*, 2012) have also reported similar coping strategies in different parts of Tanzania.

Differences were noted in the adoption of CCCS in the three study villages. As indicated in Table 6, majority of respondents (80%) in Mng'aro adopted irrigation cultivation; however, none of respondents in Mdando village adopted this strategy. This difference is brought by the fact that in Mng'aro there is irrigation scheme which provides an opportunity for the adoption of the strategy. While land intensification is neither practiced in Mdando nor in Viti village, early planting is highly practiced in Mdando (95.56 %) followed by Mng'aro (63.33%) and lastly by Viti (37.33%).

The absence of permanent water bodies for irrigation in Mdando may be the motivating factor for the adoption of early planting. During the FGD in Mdando, participants reported that due to changes of rain patterns, early planting is the most effective strategy. This is due to the fact that early planted crops mature before the soil moisture disappears and thus increases the chances of adequate harvests. It was noted that Viti village dominated in practicing the least resort strategies such as sale of family labour, purchasing food on credits, and borrowing food from friends or relatives.

Table 6: Adoption of coping strategies across studied villages in Lushoto District

Coping strategies	Percentage (%)		
	Mng'aro (n=30)	Mdando (n=45)	Viti (n=75)
Irrigation cultivation	80.00	0.00	17.33
Crop diversification	43.33	42.22	17.33
Early planting	63.33	95.56	37.33
Late planting	20.00	53.33	20.00
Tree planting	00.00	4.44	20.00
Sales of family labour	80.00	37.78	82.67
Sales of livestock	20.00	40.00	24.00
Short term crop variety	40.00	26.67	10.67
Petty business	13.33	4.44	17.33
Purchase food on credits	60.00	46.67	66.67
Children eating with neighbours	0.00	0.00	8.00
Borrow food	40.00	20.00	50.67
Land intensification	33.33	0.00	0.00
Cultivating in wet areas	16.67	0.00	8.00
Cultivating in elevated areas	36.67	42.22	14.67

4.2.2 Characterization/determinants of CCCS

The study revealed that employing any CCCS is determined by households' characteristics which include gender of household heads, duration of stay in the village, age and economic status of a household.

a) Gender of head of household

The adoption of the common identified coping strategies differ significantly across the proportions of male and female headed households practicing the strategies ($\chi^2 = 144.5$, df = 14, $P < 0.05$). As indicated in Table 7, the heterogeneity is seen in proportion of households practicing irrigation cultivation, sales of livestock and planting short term crop varieties in which more than 20% of male headed household practice the strategies and non of the female headed household was reported to practice the strategies. With exception of short term crop varieties, the other two coping strategies are not practiced by female headed household probably due to intrinsic differences in resources ownership. This finding confirm the findings by Eriksen *et al.* (2005) who found that women in Tanzania and Kenya have limited skills and access to capital needed to engage in most

desirable and income generating coping activities, hence they lack ability to engage in most favoured coping strategies.

Table 7: Percentage of male and female headed households practicing CCCS in Lushoto District

Coping strategies	Gender	
	Female headed household (n=18)	Male headed household (n=132)
Irrigation cultivation	0(0)	28.03(37)
Crop diversification	16.67(3)	31.82(42)
Early planting	61.11(11)	59.85(79)
Late planting	22.22(4)	31.06(41)
Tree planting	0(0)	18.94(25)
Sales of family labour	100(18)	64.39(85)
Sales of livestock	0(0)	31.82(42)
Petty business	0(0)	14.39(19)
Short term crop variety	0(0)	24.24(32)
Purchase food on credits	72.22(13)	57.58(76)
Children eating with neighbours	11.11(2)	3.03(4)
Borrow food	61.11(11)	36.36(48)
Land intensification	11.11(2)	6.06(8)
Cultivating in elevated areas	5.56(1)	7.58(10)
Cultivating in wet areas	16.67(3)	28.79(38)

*The values in brackets are numbers of respondents

b) Duration of stay of households in the area of study

The adoption of coping strategies also varied significantly with the households' duration of stay in the study area ($\chi^2 = 176.9$, df = 14, $P < 0.05$). Table 8 shows that households which have stayed for a short period are dominant in practising irrigation (35 %), sale of family labour (85%), purchase food on credit (75%), borrowing food (50%) and in land intensification (25%). On the other hand, households which have stayed for a long time in the area are more dominant in crop diversification (56.25%), early planting (71.88%), late planting (43.75%) and sales of livestock (40.63%). This could have been attributed by the household's longer stay in the area because all these strategies require experience of household heads in the area. Tree planting, involvement in petty businesses and cultivation in wet area were not employed by households which have stayed for less than 10 years. This also could be due to the limited resources because most of these

households are headed by young male and female who have not accumulated enough wealth. Additionally cultivation in the elevated area was not adopted by households which have stayed long in the area.

Table 8: Percentage distribution of households according to practices of CCCS and duration of stay in the studied villages of Lushoto District

Coping strategies	Number of years stayed		
	< 10 years (n=20)	10-30 years (n=98)	>30 years (n=32)
Irrigation cultivation	35.00 (7)	21.43(21)	28.13(9)
Crop diversification	20.00 (4)	23.47 (23)	56.25 (18)
Early planting	40.00 (8)	60.2 (59)	71.88 (23)
Late planting	15.00 (3)	28.57(28)	43.75(14)
Tree planting	0.00 (0)	23.47 (23)	6.25 (2)
Sales of family labour	85.00(17)	75.51(74)	37.5 (12)
Sales of livestock	25.00(5)	24.49(24)	40.63(13)
Petty business	0.00 (0)	16.33 (16)	9.38 (3)
Short term crop variety	30.00 (6)	17.35 (17)	28.13 (9)
Purchase food on credits	75.00 (15)	61.22 (60)	43.75 (14)
Children eating with neighbours	0.00 (0)	4.08 (4)	6.25 (1)
Borrow food	50.00 (10)	37.76 (37)	37.5 (12)
Land intensification	25.00(5)	4.08 (4)	3.13 (1)
Cultivating in elevated areas	0.00 (0)	2.04 (2)	0 (0)
Cultivating in wet areas	5.00 (1)	9.18 (2)	3.13 (0)

*The values in brackets are number of respondents

c) Age group

Different age groups employ CCCS differently. The relationship between the age of household heads and CCCS was highly significant ($\chi^2 = 142.7$, df = 14, $P < 0.05$). Results in Table 9 indicate that household heads of lower age (21- 35 years) featured more in sale of family labour (76%), sale of livestock (40.76%), purchase food on credit (74%) and cultivation in wet areas (30%) as compared to aged household heads. On the other hand, aged household heads were more dominant in irrigation (29%), crop diversification (33%), and tree planting (18%). The reason for this scenario can be explained by the fact that strategies adopted by household heads in the higher age group require resources for their adoption.

Table 9: Percentage distribution of household according to practices of CCCS and age group in Lushoto District

Coping strategies	Age category	
	21 - 35 years (n=50)	> 35 years (n= 100)
Irrigation cultivation	16(8)	29(29)
Crop diversification	24 (12)	33(33)
Early planting	60 (30)	60(60)
Late planting	30 (15)	30(30)
Tree planting	14 (7)	18(18)
Sales of family labour	76 (38)	65(65)
Sales of livestock	40 (20)	22(22)
Petty business	16 (8)	11(11)
Short term crop variety	32 (16)	16(16)
Purchase food on credits	74 (37)	52(52)
Children eating with neighbours	4 (2)	4(4)
Borrow food	40 (20)	39(39)
Land intensification	6 (3)	7(7)
Cultivating in elevated areas	2 (1)	10(10)
Cultivating in wet areas	30 (15)	26(26)

*The values in brackets are number of respondents

This is also reflected by the proportion of heads of households in the higher age group being greater in the non-poor category (33%) compared to their counterparts of lower age group (24%) as shown in Table 10.

Table 10: Distribution of age categories of household heads and Economic status in Lushoto District

Economic status	Percentage (%) Age category	
	Lower age group (21-35 years) (n=50)	Higher age group (Above 35 years) (n=100)
Poor	76	67
Non- poor	24	33

d) Economic status

Furthermore, economic status of a household had an implication in the adoption of CCCS. Results in Table 11 show that there is a significant variation ($\chi^2 = 150.4$, df=14, $P < 0.05$) in adoption of CCCS between the two economic statuses of households. The non-poor

households were more engaged in the favoured coping strategies such as irrigation cultivation, crop diversification, early planting, late planting, tree planting, sale of livestock, short term crop varieties, land intensification, and cultivation in wet areas. On the other hand, the poor households were leading in sale of family labour, purchase food on credit, sending children to eat at neighbours, borrowing food and cultivation in wet areas. Certainly, coping strategies dominated by the non-poor households require economic resources for their practice as opposed to the strategies dominated by the poor households.

Table 11: Percentage distribution of households according to practices of CCCS and economic status in Lushoto District

Coping strategies	Economic status	
	Poor (n=105)	Non poor (n=45)
Irrigation cultivation	5.71 (6)	68.88 (31)
Crop diversification	22.86 (24)	46.67 (21)
Early planting	52.38 (55)	77.78 (35)
Late planting	26.67 (28)	37.78 (17)
Tree planting	16.19 (17)	17.78 (8)
Sales of family labour	84.76 (89)	31.11 (14)
Sales of livestock	21.90 (23)	42.22 (19)
Petty business	15.24 (16)	6.67 (3)
Short term crop variety	14.29 (15)	37.78 (17)
Purchase food on credits	63.81 (67)	48.89 (22)
Children eating with neighbours	5.71 (6)	0.00 (0)
Borrow food	46.67 (49)	22.22 (10)
Land intensification	0.95 (1)	20.00 (9)
Cultivating in wet areas	3.8 (4)	15.55 (7)
Cultivating in elevated areas	30.00 (32)	20.00 (9)

*The values in brackets are number of respondents

Generally, the study revealed that, adoption of any CCCS is determined by socio-demographic characteristics of households. The findings are consistent with the findings by Below *et al.* (2011) and Olayemi (2012) who also reported that adoption of CCCS is influenced by socio economic characteristics of household heads.

4.3 Perception of Community Members on the Effectiveness of CCCS

Perception on the effectiveness of CCCS to ensure household food security was rated using Likert type scale. Each strategy was rated by respondents who either practised or did not practise the strategy. The results presented in Table 12 show that more than 40% of respondents had agreed that the identified coping strategies were effective, except for strategies such as late planting, sending children to eat with neighbours, and cultivation in elevated areas.

Table 12: Distribution of respondents according to their perception on the effectiveness of coping strategies in Lushoto District

Climate change coping strategies	Percentage of perception		
	Agree	Undecided	Disagree
Irrigation cultivation	99 (148)	1(2)	0 (0)
Crop diversification	89 (134)	11 (16)	0 (0)
Early planting	47 (71)	34 (51)	19 (28)
Late planting	31 (47)	40 (59)	29 (44)
Tree planting	53 (80)	31 (46)	16 (24)
Sale of family labour	80 (120)	8 (12)	12 (18)
Sale of livestock and poultry	99 (149)	1 (1)	0 (0)
Petty business coping	70 (105)	26 (39)	4 (6)
Short term crop variety	81(122)	19 (28)	0 (0)
Purchase food on credit	63 (94)	17 (26)	20 (30)
Send children to eat with neighbours	9 (13)	31 (47)	60 (90)
Borrow food from a friend or relative	53 (79)	18 (27)	29 (44)
Land intensification	100(150)	0 (0)	0 (0)
Cultivating in wet areas	76 (114)	8 (27)	6 (9)
Cultivation in elevated areas	35 (53)	26 (39)	39 (58)

*The values in brackets are number of respondents

Further analysis of the Likert scale index (Table 13) shows that almost all CCCS had a weighted mean score above the cut-off point i.e. 3 (see section 3.5), except sending children to eat with neighbours and cultivating in elevated areas which scored below the cut-off point. This indicates that most of the CCCS were perceived positively; meaning that they were considered to be effective in ensuring household food security. Some reasons can be thought for the negative perceptions of sending children to eat at

neighbours and cultivation in elevated areas. Firstly, in elevated areas the soil might be infertile due to soil erosion leading to poor crop harvest. The strategy could probably work better if complimented with soil conservation strategy which is not adopted as a coping strategy. Secondly, sending children to eat at neighbours is a strategy used to reduce the number of household members during the meal hence reducing the amount of food to be consumed. However, it was perceived as a weak strategy that does not guarantee food security to households. Also, the strategy may not be reliable because it is a shame for a household head to rely on this strategy.

Although irrigation cultivation, crop diversification and sale of livestock and/or poultry received a very high positive perception with weighted mean of 4.64, 4.57 and 4.49 respectively, they are still among the moderately practiced strategies. Likewise, land intensification was perceived positively with a high weighted mean of 4.5 but it is among the least practiced strategy. This might be due to the fact that the adoption of these strategies requires economic resources of which most of the respondents in the study area could not afford. The results are in harmony with other research findings conducted in Morogoro by Below *et al.* (2012) who also found that irrigation received a very high positive perception followed by tree planting, short term crop variety and sale of family labour. However, irrigation could only be effective in areas where there were abundant water and financial resources to purchase necessary agricultural inputs such as water pumps and irrigation pipes.

Table 13: Reported perception on the effectiveness of CCCS in Lushoto District

Coping strategies	SA	A	U	D	SD	WS	WM	OP
Irrigation cultivation	98 (65.3)	50 (33.3)	2 (1.3)	0(.00)	0 (.00)	696	4.64	Positive
Crop diversification	101 (67.3)	33 (22.0)	16 (10.7)	0 (.00)	0 (.00)	685	4.57	Positive
Early planting	18 (12.0)	54 (36.0)	50 (33.3)	28 (18.7)	0 (.00)	512	3.41	Positive
Late planting	18 (12.0)	29 (19.3)	61 (40.7)	42 (28.0)	0 (.00)	473	3.15	Positive
Tree planting	15 (10.0)	65 (43.3)	46 (30.7)	24 (16.0)	0 (.00)	521	3.47	Positive
Sale of family labour	60 (40.0)	59 (39.3)	12 (8.0)	13 (8.7)	6 (4.0)	604	4.03	Positive
Sale of livestock and poultry	75 (50.0)	74 (49.3)	1 (.7)	0 (.00)	0 (.00)	674	4.49	Positive
Petty business	43 (28.7)	62 (41.3)	39 (26.0)	6 (4.0)	0 (.00)	592	3.95	Positive
Short term crop variety	54 (36.0)	67 (44.7)	29 (19.3)	0 (.00)	0 (.00)	625	4.17	Positive
Purchase food on credit	28 (18.7)	67 (44.7)	25 (16.7)	22 (14.7)	8 (5.3)	535	3.57	Positive
Send children to eat with neighbours	0 (.00)	13 (8.7)	47 (31.3)	54 (36.0)	36 (24.0)	337	2.25	Negative
Borrow food from a friend or relative	34 (22.7)	45 (30.0)	27 (18.0)	31 (20.7)	13 (8.7)	506	3.37	Positive
Land intensification	80 (53.3)	70 (46.7)	0 (.00)	0 (.00)	0 (.00)	680	4.53	Positive
Cultivating in wet areas	52 (34.7)	62 (41.3)	27 (18.0)	9 (6.0)	0 (.00)	607	4.05	Positive
Cultivating in elevated areas	5 (3.3)	48 (32.0)	39 (26.0)	5 (38.0)	1 (.7)	345	2.30	Negative

*SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree, WS=weighted Score, WM=Weighed Mean, OP=Overall Perception

4.4 Food Security Status of the Sampled Households

Before conducting an interview, it was important to assess local perceptions pertaining to food security. During the focus group discussions, participants were asked how they perceive food security. From the participants' point of view food security was primarily the function of having sufficient maize as staple food from their own farm production. However, due to the effect of climate change, now food security is not only the function of sufficient maize from their own farm production but also an ability to access any kind of food from other sources such as purchasing food from market, gifts from friends or relatives and /or borrowing from friends or relatives. With regard to the local perception of food security, two indicators of food security that were reviewed earlier in chapter two, were used to determine food security status of the sampled households. These are Food Insecurity Access Scale (HFIAS) and Household Dietary Diversity (HDD). Procedures of determining food security using both indicators are described in section 3.5.

4.4.1 Food security situation based on household food insecurity access scale

Based on Household Food Insecurity Access Scale (HFIAS), the food security situation of households is as summarized in Fig. 3. Only 3% of the sampled households could be considered to be food secure. Nine percent of the sampled households were mild food insecure, 30% were moderate food secure and 58% were severe food insecure. Generally majority (96.70%) of households in the study area were food insecure.

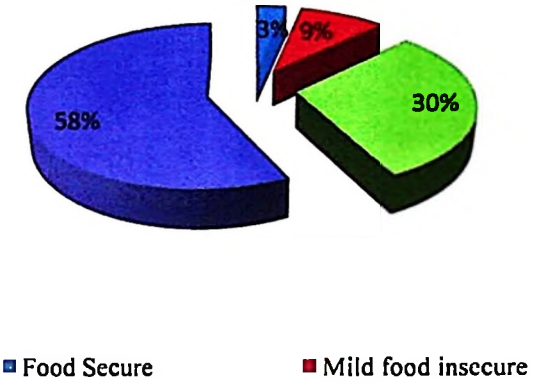

Figure 3: Distribution of households according to HFIAS assessment tool in Lushoto District

The sampled households had different experiences of food insecurity. As indicated in Table 14, majority of the sampled households (84.7%) were worried of not having enough food in the house. On the other hand, more than 70% of households were eating insufficient quality food. That is, they had experienced situations such as unable to eat preferred food, eating just a few kinds of foods, and eating foods they really do not want. More than two thirds were cutting back the quantity of food, thus 64% and 61% of the sampled households were respectively eating smaller meals and eating few meals in a day. Also, less than 50% had experienced the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating).

Table 14: Experience of occurrence of situations when household had limited access to food in Lushoto District (n=150)

Situation	Percentage	
	No	Yes
Worry about enough food	15.3	84.7
Unable to eat preferred food	12.7	87.3
Eat just a few kinds of foods	11.3	88.7
Eat foods they really do not want to eat	20.7	79.3
Eat a smaller meal	36.0	64.0
Eat fewer meals in a day	38.7	61.3
No food of any kind in the household	69.3	30.7
Go to sleep hungry	81.3	18.7
Go a whole day and night without eating	98.7	1.3

4.4.2 Food security situation based on household dietary diversity

The determination of food security based on Household Dietary Diversity (HDD) was done using procedures described in section 3.5.2. As shown in Fig. 4, eight percent of the sampled households were food secure and 92% were food insecure.

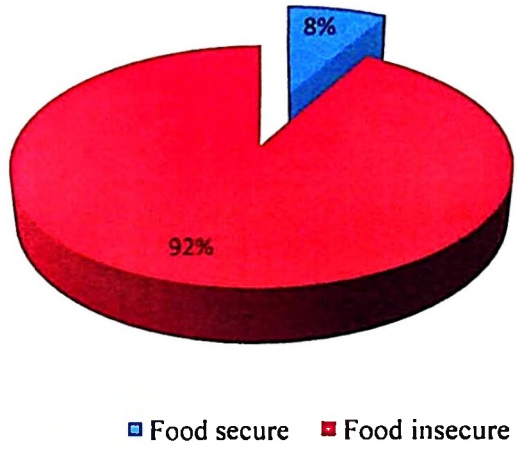

Figure 4: Distribution of households according to HDD in Lushoto District

The minimum and maximum food groups eaten were 1 and 10 respectively. The average number of food groups consumed was 6.8 groups. Results in Table 15 show that cereal group was consumed by the entire sampled population. Other food groups which were consumed by more than 90% were condiments, oil and fats and vegetables. Only 7.3% and 9.3% of the sampled households consumed meat and eggs respectively. Nonetheless, further analysis shows that, there is a significant differences (χ^2 =18.96, df = 2, $P = 0.00$ and χ^2 = 6.897, df = 2, $P = 0.032$) of food security status between villages based on both HDD and HFIAS indicators respectively.

Table 15: Distribution of consumption of food groups associated with dietary diversity in Lushoto District (n=150)

Food group	Percentage	
	No	Yes
Cereals	0	100
White roots and tubers	83.3	16.7
Vegetables	4.7	95.3
Fruits	46	54
Meat	92.7	7.3
Eggs	90.7	9.3
Fish and other seafood	74.7	25.3
Pulses, legumes and nuts	44.7	55.3
Milk and milk products	46.7	53.3
Oils and fats	2.7	97.3
Sweets	24.7	75.3
Spices, condiments and beverages	1.3	98.7

Results in Table 16 show that residents from Mng'aro and Mdando villages have food secure households, but Viti village has none food secure households for both indicators of food security (HFIAS and HDD). This can be associated with severe drought followed by shortage of rainfall which have strucken Viti village for three consecative years as it was reported during the FGD. It is important to note that, the variation of food security between villages may be linked to the type of CCCS adopted across villages. For example, households in Viti village have shown dominance in practicing the least resort strategies as seen in section 4.2.1. In general, the prevalence of food insecurity based on both indicators is consistent with findings by Lyimchai *et al.* (2011) who also found that more than 90% of households in Lushoto District were food insecure.

Table 16: Distribution of households according to food security situation across studied villages in Lushoto District

Villages	Status of HFIAS		Status of HDD	
	Food secure (%)	Food insecure (%)	Food secure (%)	Food insecure (%)
Mng'aro (n=30)	10	90	6.67	93.33
Mdando (n=45)	4.44	95.56	22.22	77.78
Viti (n=75)	0	100	0	100

4.5 Socio- economic Characteristics of Respondents and Food Security

As indicated in Table 17, all households whose heads aged 21-35 years were food insecure. Although only 5.56% of households whose heads aged between 36-50 years were food secure, this accounts for 80% of the food secure households in the study area. All female headed and large size households were food insecure. Also, households whose heads never attended formal education and those who had secondary education were all food insecure. Several studies (Oluwatayo, 2009; Dauda, 2010; Guo 2011) have reported food insecurity for families with household head who never attended school. The food insecurity in families of household head with secondary education in this study can be attributed to young age, lack of resources and negative attitude toward farming. Almost all the respondents who had secondary education were young people who have just completed their education, got married and have not accumulated adequate resources to sustain and provide for members of their households.

Table 17: Food security status based on HFIAS among different demographic characteristics in Lushoto District

	Food secure (%)	Food insecure (%)	Total (%)
Age of household head			
21-35 years of age (n=50)	0	100	100
36-50 years of age (n=72)	5.56	94.44	100
Above 50 years of age (n=28)	3.57	94.43	100
Gender of household head			
Female headed (n=18)	0	100	100
Male headed (n=132)	3.79	96.21	100
Education level of household head			
Non to school (n=14)	0	100	100
Primary education (n=132)	3.94	96.06	100
Secondary education (n=4)	0	100	100
Marital status			
Married (n=128)	3.91	96.09	100
Otherwise (n=22)	0	100	100
Household size			
1-4 member (n=35)	2.86	97.14	100
5-9 members (n=109)	3.67	96.33	100
10 and above (n=6)	0.00	100	100

4.6 Relationship between CCCS and Food Security Situation

The relationship between adopted climate change coping strategies and household food security situation were analysed using multiple linear regression models. Before running the regression analysis, a Principal Component Analysis (PCA) of independent variables was done to check for redundant variables. The PCA results are presented in Appendix 2 and 3. Using Kaiser's criterion (the eigenvalue rule) of factor reduction, only variables with an eigenvalue of 1.0 or more ware retained for the regression analysis. (refer section 3.5.3). Therefore, nine predictor variables were entered in the model against the response variable HFIAS. Results in Table 18 show that 60.8% (adjusted r^2= 0.608) of variation of the HFIAS was explained by predictor variables. The model is highly significant ($P = 0.000$) with F-value = 20.28 depicting the fitness of the model. It is important to note that based on HIFAS, a household which is food secure should have a smaller value of HIFAS and vice-versa. Therefore, a predictor variable which would affect household food security positively should have a negative sign and the vice-versa also holds true.

Among the nine predictors subjected in the model seven of them were statistically significant implying that they had a significant relationship with HFIAS. These variables include marital status, household size, irrigation cultivation, early planting, sale of family labour, sale of livestock and poultry, and land intensification. On the other hand, variables such as number of years a household has stayed in the study area and crop diversification were not significant implying that there was no enough evidence to suggest that there is relationship between these predictor variables and HIFAS.

Table 18: Multiple regression model to explain relationship between CCCS and HFIAS indicator of food security in Lushoto District

Variables	Coeff.	Std. Error	Beta	t	Sig.
(Constant)	10.356	2.036		5.087	0.000**
Marital status	-4.914	1.305	-0.288	-3.765	0.000**
Household size	2.370	0.902	0.191	2.628	0.010*
Number of years household lived in the place	-0.033	0.038	-0.061	-0.870	0.386
Irrigation cultivation	2.557	1.084	0.182	2.360	0.020*
Crop diversification	-0.298	0.986	-0.023	-0.302	0.763
Early planting	-2.408	0.892	-0.195	-2.700	0.008**
Sale of family labour	4.639	0.956	0.356	4.852	0.000**
Land intensification	-8.165	1.702	-0.337	-4.798	0.000**
Sale of livestock and poultry	3.392	0.971	0.252	0.252	0.001**

Adjusted R^2= 0.608, F-value = 20.28, P-value = 0.000. Note: * statistically significant at ($P < 0.05$), ** statistically significant at ($P < 0.01$)

Land intensification and early planting are the only coping strategies which were significant ($P = 0.000$ and $P = 0.008$ respectively) with negative influence on the response variable as would be expected. This implies that as the household intensifies the land use, the HFIAS becomes smaller, thus the household is more food secure. It is also important to note that among the significant factors with positive influence to food security, land intensification contributes more to the model (*beta* = 0.34) followed by marital status (*beta* = 0.29), and early planting (*beta* = 0.20). This finding confirms another finding by La Rovere *et al.* (2008) who reported that land intensification improves food and nutrition security of farming households.

Strategies such as irrigation cultivation, sale of family labour and sale of livestock and poultry were statistically significant but with a positive influence on HFIAS. This implies that the more these strategies are practised the more the households are likely to be food insecure. These results are strange, for instance, sale of family labour with $P = 0.00$, one would expect that it would have increased household's economic capacity to access food. The result contradicts with other research findings by Babatunde and Qaim (2010) who reported that sale of family labour improves household food security. However, this finding is in line with the information given in the FGD that sale of family labour was not

worthy. Another reason for the unexpected finding is that selling of family labour might reduce labour input in own household farming activities leading to a decline in own agricultural production, which would cause lower food availability at the household level.

Likewise, sale of livestock and poultry (*P=0.001*) did not improve household food security. This result contradicts with the information given in the FGD. Participants in the FGD explained that livestock operate like savings account that may buffer a household against the effects of drought and crop failure. However, the contradiction might be due to the fact that, the amount of money obtained from selling livestock and/ or poultry is not only spent for food but also to cater for some other expenses such as school fees, clothing and/or medical costs. The negative influence of irrigation cultivation on food security was also not expected. Several studies (Bagson and Kuuder, 2013; Barbir and Leal, 2012) have shown a positive contribution of irrigation cultivation on household food security. Results of this study could be attributed by the small size of land under cultivation. During the FGD it was reported that few households own lands under irrigation and there was none who own more than 0.3 ha of the land.

Three demographic variables were also regressed together with the coping strategies as independent variables on the predictor variable HFIAS. These included marital status, household size and number of years a household has stayed in the study area. Variables such as marital status and household size had a significant relationship (*P= 0.000* and *P=0.01* respectively) with HFIAS. The negative sign of the coefficient of marital status is consistent with other studies (Oluwatayo, 2009). It confirms that, married respondents are less likely to experience food insecurity than it would be with unmarried (single, widowed and/ or divorced). This might be attributed by the possibility of couples assisting each other to augment households' needs. The positive sign of coefficient of household size indicates that an increase in the household size increases the probability of

a household becoming food insecure. This result shows consistency with the information given in the FGD. Participants in the FGDs reported that climate change hazards have persistently diminished food production in Lushoto. Hence increase in a number of family members results in increased food requirements considering that in most households the largest proportion of its members is expected to be children who are dependants. Moreover, the sign of the coefficient shows consistency with previous research findings (Feleke *et al*, 2003; Omotesho *et al.*, 2010; Babatunde and Qaim, 2010).

An attempt was done to determine the relationship between food security based on HDD indicator and CCCS using the same model. Again the same nine independent variables were entered in the model against HDD indicator as the response variable. Results in Table 19 shows that, this time crop diversification coping strategy is significant (*P=0.000*) with a positive influence on HDD indicator. It was also noted that crop diversification contributed more to the model (*beta* = 0.40) followed by sale of family labour and sale of livestock and poultry, at *beta* weights of 0.28 and 0.18 respectively. This implies that crop diversification increases dietary diversity. This finding is consistent to the findings by Mbwambo (2008) who also reported significant relationship between crop diversification and food security measured by HDD indicator.

Table 19: Multiple regression Model explaining relationship between CCCS and HDD indicator of food security in Lushoto District

Variables	Coeff.	Std. Error	Beta	t	Sig.
(Constant)	6.725	0.696		9.667	0.000**
Marital status	0.146	0.446	0.028	0.326	0.745
Household size	0.118	0.308	0.031	0.382	0.703
Number of years household lived in the place	0.002	0.013	0.010	0.125	0.901
Irrigation cultivation	0.191	0.370	0.045	0.516	0.607
Crop diversification	1.552	0.337	0.385	4.605	0.000**
Early planting	0.199	0.305	0.053	0.652	0.516
Sale of family labour	-1.095	0.327	-0.275	-3.351	0.001**
Land intensification	1.080	0.582	0.146	1.858	0.065
Sale of livestock and poultry	-0.720	0.332	-0.175	-2.169	0.032*

Adjusted R^2= 0.218, *F*-value = 5.62, *P*-value = 0.000.Note: * statistically significant at (*P* <0.05), ** statistically significant at (*P* <0.01)

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Results of this case study revealed that there is a high prevalence of food insecurity in the study area. This situation is worsened by drought and change in rainfall patterns. Due to the impacts of these climate change indicators, different coping strategies are practised by community members to overcome the resulting food vulnerability effect. The commonly practiced strategies are irrigation cultivation, cultivating in elevated areas during heavy rains, cultivation in low lands (wet area), the use of short-term crop varieties, sale of family labour, early planting, late planting, crop diversification, involvement in petty business, sale of livestock and poultry, tree planting and land intensification. Others are purchase of food on credits, borrowing food from friends or relatives and sending children to eat at neighbours' houses.

While sale of family labour and purchase of food on credits are highly practiced, other strategies such as sending children to eat with neighbours, land intensification and cultivation in wet areas are least adopted. Results also show that adoption of CCCS is determined by socio-economic characteristics of household heads. These characteristics include age, gender, duration of stay in the area and economic status. It was found that there are significant variations in the adoption of CCCS across these characteristics of households.

Although almost all the strategies with exception of sending children to eat at neighbours and cultivating in wet areas were perceived effective in ensuring household food security, only land intensification and early planting were actually positively related with food

security measured in terms of HFIAS. Moreover, crop diversification was the only strategy that was positively related with household food security measured in terms of HDD. Generally, these findings concur with the entitlement theory and the livelihood approach because most of the effective coping strategies were highly adopted by the non-poor households as compared to the poor households. Therefore, effectiveness of CCCS is a function of resource/ livelihood assets that are available.

5.2 Recommendations

Based on the findings of the study, the following recommendations are relevant for enhancing community coping capacities to ensure household food security.

i. As far as the challenge of food security in the changing climate is concerned these strategies need to be strengthened, advocated and integrated in different local and national developmental interventions. This will help to improve community members' resilience towards climate change and food insecurity vulnerability.

ii. It has been shown that, in the context of this case study, most of communities' own strategies were ineffective to managing climate stress. This is because of heterogeneity of different groups facing different opportunities and limitation in resource ownership. Thus technical and/or economic empowerment must be a key component for the coping strategies.

iii. Based on the factors determining adoption of CCCS, some groups of the population are excluded in adoption of the most effective strategies. Thus policy and institutional arrangement should address factors which are limiting households from adopting the strategies effectively.

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APPENDICES

Appendix 1: Operational definition of key variables, their Indicators and level of measurements

Variables		Operational definition	Measurable indicators	Level of measurement
A :Background variables				
i) Demographic variables	Age	Absolute years since one was born	Number of years attained	Ratio
	Sex	Biological state	1=Male 2=female	Nominal
	Marital status	Current status of marriage	1=married 2=single 3=separated 4=widow 5=widower	Nominal
	Household size	Number of adults and children residing in the household	Total number of people	Ratio
	Education	Level of education one attained in schooling	Number of years attended in school	Ratio
ii)Socio Economic variables	Household asset	Durable materials possessed by a household -Land ownership and control -Capital equipment and other valuables	Number acres Value in Tsh.	Ratio
iii) Farm variables	Farm size	Land that is used for cultivation in acreage	Number of acres used in cultivation of food crops	Ratio
	Labour force	Individuals aged 15-65 engaged in agriculture production	Number of individuals	Ratio
B: Independent variables	Climate change Coping strategies	Ways in which respondent respond to climate change variables: Irrigation farming Crop diversification Early planting Later planting Agro-forestry management Sale of family labor Sale of livestock and poultry Off-farm activities (petty business) Short term crop variety.	1=if a strategy is practiced 0= if a strategy is not practiced	Nominal
C: Dependent variables	Food security	The current household food accessibility:	Dietary diversity score Food insecurity access Scale	Ratio
	Dietary diversity	-Number of food groups eaten by household members (variety of food diet)	Total number of food group	Ratio
	Food insecurity access scale	Predictable reactions against decline in food accessibility	Total number of score	Ratio

Appendix 2: Pearson Correlation table (N= 150)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Irrigation copping															
Crop diversification	.30**														
Early planting	-.101	.119													
Late planting	-.037	.460**	.356**												
Tree planting	-.173*	-.137	.146	-.059*											
Sale of family labour	.086	-.091	-.258**	-.091	.109										
Sale of livestock and poultry	.022	.337**	.115	.337	.000**	-.091									
Short term crop variety	.117	.085	.159	-.092	-.015	-.034	.219								
Petty business	-.125	-.118	.065	.057	.368	.128	.120	.095							
Purchase food on credit	.127	-.080	-.066	-.021	-.103	.231	.184	.034	-.011						
Send children to eat with neighbours	-.117	-.134**	-.250**	-.134	-.091**	.138**	-.127	-.106**	-.078**	.030					
Borrow food from a friend or relative	.299**	.128	-.206*	.068**	-.104	.309*	-.016**	-.319	-.307*	.472**	.254				
land intensification	.281**	-.058	.055	-.175**	-.120	.123	-.048**	.252	.059	.004**	-.055	-.106			
Cultivating in wet areas	-.042	-.128	.230	-.184	.286	-.031	-.175	-.022	-.030	-.132	-.057	-.069	.027		
Cultivated in elevated area	-.004	-.042**	.012**	.088	-.154**	-.005**	-.016	.046**	.036**	.021	-.049**	-.096**	.136	-.115**	

**Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed)

Appendix 3: Principal component analysis for factor extraction

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Irrigation copping	2.254	15.027	15.027	2.254	15.027	15.027
Crop diversification	2.118	14.119	29.146	2.118	14.119	29.146
Early planting	1.618	10.785	39.931	1.618	10.785	39.931
Late planting	1.455	9.697	49.628	1.455	9.697	49.628
Tree planting	1.308	8.720	58.348	1.308	8.720	58.348
Sale of family labour	1.039	6.930	65.278	1.039	6.930	65.278
Sale of livestock and poultry	0.987	6.582	71.860			
Short term crop variety	0.854	5.692	77.552			
Petty business	0.699	4.661	82.213			
Purchase food on credit	0.644	4.297	86.509			
Send children to eat with neighbours	0.580	3.866	90.375			
Borrow food from a friend or relative	0.494	3.293	93.668			
land intensification	0.382	2.544	96.212			
Cultivating in wet areas	0.322	2.146	98.358			
Cultivated in elevated area	0.246	1.642	100.000			

Appendix 4: Checklist for focus group discussion

1. Is there any form of climate change in your zone? If your answer is yes, please can you explain?
2. What are the common climate change hazards in your area?
3. What are the adverse effects resulting from climate change stresses in household's food security?
4. What are the local coping mechanisms used to reduce the impacts of climatic hazardous in ensuring food security?
5. How are the existing coping strategies working?
6. What are the necessary condition for the coping mechanisms applied by households to work better in ensuring household food security

Appendix 5: Checklist for key informant interviews

1. In your pinion has weather of this area changed in the last 20 years?
2. What has been changing over time?
3. Have you observed any climate stresses in your area?
4. What are the common climate change hazards in the area?
5. How would you rate the frequency of occurrence?
6. How do people in the community currently cope to the effects of climate change in order to ensure household food security?
7. What are the necessary condition for the coping mechanisms applied by households to work better in ensuring household food security

Appendix 6: Questionnaire for household survey

Questionnaire No.

Date of ☐ interview_____

District:_____ Ward:_____ Village:_____Sub-Village:_____

Section A: General Information

1. Demographic information

1.1 Name of household head:_____1.2 Name of respondent:_____ 1.3 Age of respondent:_____1.4 Year of birth_____

1.5 Sex of respondent: (1) Male_____(2) Female_____

1.6 Education: Years of education of respondent_____

1.7 Marital status:(1) Single___ (2)Married____ (3)Widow___ (4)Widower____ (5)Divorced___

1.8 Household size_____

1.9 How many years have you lived in this place?_____years

2. Socio economic factors

2.1 Please indicate what among the listed do your household possess

Type of asset	owned	borrowed	Ranted/hired	Number/size	Monetary value
House					
Vehical					
Motorcycle					
Bicycle					
TV					
Radio					
Land or plot					
Oxen curt					
Sewing machine					
Mobile phone					
Furniture				Chair ..... Table ..... Bed ..... Others	
Others (specify)					

2.2 What is your Primary and Secondary economic activity in your household?

S/N	*Economic activity*	*Primary economic activity*		*Secondary economic activity*		*Rank**
		Monthly income	Annual Income	Monthly income	Annual income	
1	Agriculture (crop production)					
2	Livestock keeping					
3	Wage employment					
4	Casual labour					
5	Petty business (kiosks, food vending)					
6	Crop trading					
7	Beekeeping					
8	Making and selling bricks					
9	Making and selling charcoal					
10	Collecting and selling firewood					
11	Collecting and selling edible fruits					
12	Collecting wild plants					
13	Art and Craft work (specify)					
14	Hunting					
15	Tourism					
16	Masonry					
17	Carpentry					
18	Mechanics					
19	Others (Specify)					

***Order of importance to household: 1= most important, 2= less important**

3. Farm factors

3.1 What is the size of the land you cultivate (in acres)?

(1) □ 1

(2) 1 – 3

(3) 4 – 5 [ ]

(4) 6-8

(5) 9 – 10

(6) More than 10 acres_____

3.2 What is your household main land use activity?

(1) Crop production

(2) Livestock production [ ]

(3) Forest production

(4) Others (specify)

3.3 How many people are working in farm? 1=family labour_____ 2=hired labour_____3 = both family and hired labour_____ 4= Others_____

3.4 How long have you been in farming activates? _____years

3.5 What is the size of the farm?_____acre

3.6 What type of food crops do you grow?

1=maize

2= paddy

3=Irish potatoes [ ]

4=cassava

5= others (specify)

3.7 What type of cash crops do you grow?

1=coffee

2=sunflower [ ]

3=tea

4= others specify

3.8.1 Do you use pesticides on your produce?

(Y/N)_____

3.8.2 Do you use fertilizers on your produce?

(Y/N)_____

3.8.3 If yes which type?

(1) Organic

(2) Inorganic [ ]

(3) Others (specify)

3.9.1 Do you preserve your farm produce? (1) Yes (2) No [ ]

3.9.2 If yes how _____

3.9.3 If no why _____

Section B. Climate change coping strategies and community perception

4. Identification and assessment household's perception on climate change coping strategies

Coping strategies	Which of the following climate change strategies are practiced by your household 1= if a strategy is practiced 0=other wise	How often do you use the strategy 1=none 2=rarely 3= some times 4=often	Please indicate a number on each of the strategy to show how you agree or disagree with the effectiveness of the strategies in ensuring household food security. 1=Strongly Agree 2 = Agree 3 = Neither agree nor Disagree 4 = Disagree 5= Strongly Disagree
Mixed cropping			
Irrigation farming			
Crop diversification			
Early planting			
Later planting			
Agro-forestry management			
Sale of family labour			
Sale of livestock and poultry			
Dependence on salary or remittances from household members working and living elsewhere			
New crop varieties.			
Off-farm activities such as skilled jobs, business, bricks making, charcoal burning and handcraft			
Others (specify)			
Total Score			

Section C: Household Food Security Status

5.1 Household dietary diversity score (HDDS12)

5.1.1 What types of food you or anyone else in your household ate yesterday during the day and at night.

Read The List Of Foods. Place A *One* in the Box if Anyone in the Household Ate the Food in Question, Place A *Zero* in the Box if No One in the Household Ate the Food

Question number	Food group	Examples	YES=1 NO=0
1	Cereals	Bread, noodles, biscuits, cookies or any other foods made from millet, sorghum, maize, rice, wheat + . *ugali, porridge or pastes ,any other locally available grains*	1.....|___|
2.	White roots and tubers	White potatoes, white yams, cassava, or foods made from roots.	2.....|___|
3.	Vegetables	**Dark green leafy vegetables** cg. dark green/leafy vegetables, including wild ones + *locally available vitamin-A rich leaves such as cassava leaves etc.* **Other vegetables** (e.g. tomato, onion, eggplant) , including wild vegetables **Vitamin a rich vegetables and tubers** (eg, pumpkin, carrots, squash, or sweet potatoes that are orange inside and *other locally available vitamin-A rich vegetables(e.g. sweet pepper)*	3..... |___|
4.	Fruits	Ripe mangoes, avocados, pineapples, oranges, pawpaw and any other fruits including wild fruits	4.....|___|
5.	Meat	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds, liver, kidney, heart or other organ meats or blood-based Foods	5..... |___|
6.	Eggs		6.....|___|
7	Fish and other seafood	Fresh or dried fish or shellfish	7.....|___|
8.	Pulses, legumes and nuts	Beans, peas, lentils, nuts, seeds or foods made from these	8.....|___|

Question number	Food group	Examples	YES=1 NO=0
9	Milk and milk products	Milk, cheese, yogurt or other milk products	9.....|___|
10	Oils and fats	Oil, fats or butter added to food or used for cooking (and red palm oil if applicable)	10.....|___|
11.	Sweets	Sugar, honey, sweetened soda or sugary foods such as chocolates, sweets or candies	11..... |___|
12.	Spices, condiments and beverages	Spices(black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages OR *local examples*	12.....|___|
	Total.		

5.2 Household Food Insecurity Access Scale (HFIAS) Measurement Tool

No	Question	Response Options	Code
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	....|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	....|___|
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	....|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	....|___|
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|

No	Question	Response Options	Code
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	....|___|
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	....|___|
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 4 = Often (more than ten times in the past four weeks)	....|___|
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	....|___|
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	....|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No 1 = Yes	....|___|
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
	Total score		