GENDERED ANALYSIS OF THE DETERMINANTS OF ADAPTIVE CAPACITY TO CLIMATE CHANGE AMONG SMALLHOLDER FARMERS IN MEATU AND IRAMBA DISTRICTS, TANZANIA

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ABSTRACT

This study was conducted to examine determinants of adaptive capacity to climate change among men, women and other vulnerable groups of smallholder farmers in Meatu and Iramba districts, Tanzania. Purposively the study intended to analyze community perception to climate change; analyze adaptation practices developed and used by farmers for livelihood; examine elements of adaptive capacity including institutions and knowledge; and determine factors responsible for adaptive capacity. Data were collected from randomly selected 63 men and 57 women to make a total of 120 respondents in three purposively selected villages from Meatu and Iramba District using a structured and non structured questionnaire. Descriptive and regression analyses using Statistical Package for Social Sciences were employed to determine the factors for adaptive capacity. Adaptive capacity of men and women in the study area was measured using two proxies: household factor and farm factor. Determinants of adaptive capacity were measured by adaptive capacity index of access and control over assets. Results of descriptive analysis suggest that adaptive capacity of men and women in Meatu and Iramba was influenced by sex of respondents, age of household head, education, household size, household labour, farm size, land ownership, household asset and household income. Although income did not show influence on adaptive capacity, asset ownership within the household indicated high influence. A multinomial Logit model (MLM) revealed that adaptive capacity of men and women in Meatu and Iramba was attributed to factors of age, sex, household size, household labour, land ownership, household asset and household income which were statistically significant at $p<0.1$, $p<0.05$ and $p<0.01$ regression coefficients. The study revealed respondents were either positively or negatively adapting using three levels of adaptive capacity such as highly, moderately or low. For individual to cope either highly/moderately and/or low it depended on access and control over household assets. Therefore individual with low access and control over assets were more experiencing

climate change effects than others. The study recommends among other things, that adaptive capacity is gendered and multiplicity, meaning that adaptive capacity of men and women varies depending on access and control over resources.

DECLARATION

I, Angelina Ibrahim, 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.

_____ _____

Angelina Ibrahim Date

(Candidate)

The above declaration confirmed by

_____ _____

Dr. J. S. Mbwambo Date

(Supervisor)

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DEDICATION

This dissertation is dedicated to my parents, my mother Nyabumbasi Bwire Mageje and my father Nyamulyo Maira Soligi who laid the foundation of my education. Also it is dedicated to my kid Michael.

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LIST OF ABBREVIATIONS

AFAAS	African agricultural Advisory services
AIDS	Acquired Immune Deficiency Syndrome
COP	Conference of Parties
DFID	British Department for International Development
ETS	Emission Trading Scheme
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HIV	Human Immunodeficiency Virus
IDRC	International Development Research Center
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
IISD	International Institute for Sustainable Development
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
MDG	Millennium Development Goals
MLM	Multinomial Logit Model
NAPA	National Adaptation Program of Action
NGO	Non Governmental Organization
PANNAR	Pannar Seed Company
PCA	Principle Component Analysis
SEEDCO	Seed Company
SNAL	Sokoine University of Agriculture
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa

TMA	Tanzania Metrological Agency
UNAIDS	United Nation Program on HIV/AIDS
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nation Framework Convention on Climate Change
URT	United Republic of Tanzania
USAID	United States Agency for International Development
VEOs	Village Executive Officers
WHO	World Health Organization
WMO	World Meteorological Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Climate change in developing countries has significant impacts on the populations, particularly amongst smallholder farmers, who have limited adaptive capacity because of socio-economic and demographic factors (Mutekwa, 2009)**.** Smallholder farmers in many developing countries are predominantly dependent on rainfed agriculture for their farming activities, with highly exposed to extreme events, and wide spread poverty and marginalization (IPCC, 2007). Studies indicate that smallholder farmers in sub-Saharan Africa especially those in semi arid areas are particularly more vulnerable to the effects of climate change, yet the impacts of climate change are felt disproportionately between gender and among different socio-economic groups (IPCC, 2007; Nelson, 2010 and Marioka, 2012). In additional, semi-arid areas are historically known for the socio-economic setbacks and agricultural failures caused by dry spell and severe droughts (Lindoso *et al*., 2012).

In Tanzania like in other developing countries in Africa, the effects of climate change such as droughts and floods (most often in semi arid areas) has serious environmental, economic and social impacts on smallholder farmers whose livelihood depend largely on rainfall (Deressa, 2007; Shemdoe and Mwanyoka, 2010). As a result, men and women smallholder farmers in Meatu and Iramba District are experiencing different levels of vulnerability and adaptive capacity to climate change due to differences in access to resources (Denton, 2002). Generally, agricultural activities of men and women in Meatu and Iramba District differ in terms of resources utilizations and capitalization; a gap that

reduces efficient investments in agriculture and constrains investment that enhance resilience to climate change and variability between them (FAO, 2011).

Some attempts have been made to study determinants of adaptive capacity to climate change impacts on smallholder farmers in Tanzania (Dungumaro and Hyden, 2010; Morris *et al.*, 2009; Nelson and Stathers, 2009; Meena and O'Keefe, 2007; Meena and Sharif, 2008; Swai, Mbwambo and Magayane, 2012; Lyimo and Kangarawe, 2010). The studies have been linking these determinants of adaptive capacity as also determinants of adaptation strategies used by smallholder farmers as their responses to the negative impacts of climate change. These include use of new crop varieties and livestock species that are better suit to drier conditions, irrigation, crop diversification, adoption of mixed crops and livestock farming systems and change planting dates (Bradshaw, Dolan and Smit, 2004; Kurukulasuriya and Mendelsohn, 2006; Nhemachena and Hassan, 2007; Eriksen *et al.*, 2005). However, it is not clear on the determinants of adaptive capacity to climate change impacts between men and women smallholder farmers in Meatu and Iramba Districts. Understanding these determinants would inform gender sensitive adaptation policies and strategies.

1.2 Problem Statement

Farmers especially those located in semi arid areas are highly vulnerable to the effects of climate change and suffer the impacts disproportionately due to low adaptive capacity (IPCC, 2007). The livelihoods' of men and women are highly threatened by the effects of climate change as the areas are semi arid. Literature suggests some adaptation options in agriculture that are used by men and women smallholder such as crop diversification, and intensive cash crop-yielding (Gbetibouo, 2009; Nhemachena and Hassan, 2007; Below *et al.*, 2010; And Nyanga *et al.*, 2011). However, adaptation and associated practices are

likely to be engendered. Furthermore, the failure of the system result into different outcome such as social relations that leads to the exclusion of certain groups from access to resources necessary for adaptation. This has resulted into gendered adaptive capacity among smallholder farmers. Yet, there is limited data showing the differences in adaptive capacity between men and women and among smallholder farmers (Davies and Thornton, 2011). Although farmers in the study area have developed some adaptation measures using their indigenous knowledge system, the capacity of developed adaptation practice to address the effect of climate change are not known. Hence this study intends to analyse adaptive capacity from a gendered perspective. Barrow *et al.* (2003) argue that semi-arid conditions and the agro-pastoral land-use system exacerbate existing problems of clearing land for cultivation which may render the areas unable to sustain households' livelihoods in the future. Thus small-holder farmers in Meatu and Iramba districts face several challenges in relation to adapting to the effects of climate change. The study conducted in Saweni sub-village in Same District by Ericksen *et al.* (2005) identifies determinants of adaptive capacity in drought prone areas of Tanzania where smallholder farming is a dominant economic activity. However, there is still lack of empirical evidence on the determinants of adaptive capacity between men and women smallholder farmers to the effects of climate change. Therefore, this study entails to examine determinants of adaptive capacity to the impacts of climate change between men and women smallholder farmers in Meatu and Iramba District, Tanzania.

1.3 Justification for the Study

Gender issues are important in the development agenda including climate change. However, while data on determinants of adaptive capacity are available there is scant information on gender segregated data. This is more so in the studies related to climate change. Therefore, this study generates information on determinants of adaptive capacity and it increases the understanding of the determinants of adaptive capacity between men

and women smallholder farmers and among different socioeconomic groups. Data in this case is useful for policy makers and implementers of strategies such as Tanzania National Adaptation Programme of Action (NAPA) and MDG number 1-Eradicate extreme poverty and hunger, 3-Promote gender equality and empower women and 7-Ensure environmental sustainability.

1.4 Objectives

1.4.1 Genera objective

To examine determinants of adaptive capacity to climate change among men, women and other vulnerable groups of smallholder farmers in Meatu and Iramba Districts.

1.4.2 Specific objectives

i. To analyze community perception to climate change
ii. To analyze adaptation practices developed and used by farmers for livelihood
iii. To examine elements of adaptive capacity including institutions and knowledge
iv. To determine factors responsible for adaptive capacity

1.5 Research Questions

i. How do men and women perceive climate change?
ii. What are the (If any) adaptation practices developed and used by men and women for their livelihood?
iii. Why men and women smallholder farmers use those adaptation practices for their livelihood?
iv. What are the elements of adaptive capacity?
v. What factors are responsible for adaptive capacity?

1.6 Conceptual Framework

To address specific objectives and research questions the study adopted a conceptual framework presented in Figure 1. The conceptual framework is adopted from the DFID (1999) framework for analysis of livelihood. The framework sees livelihood assets being the causes or limit to the adaptive capacity of men and women smallholder farmers to climate change impacts. It is based on the following assumption:

- Semi arid areas are characterized by climate change variability,
- farmers adapts using assets and livelihood options
- Use of assets results into adaptive capacity
- Adaptive capacity is gendered and is influenced by transforming structures.

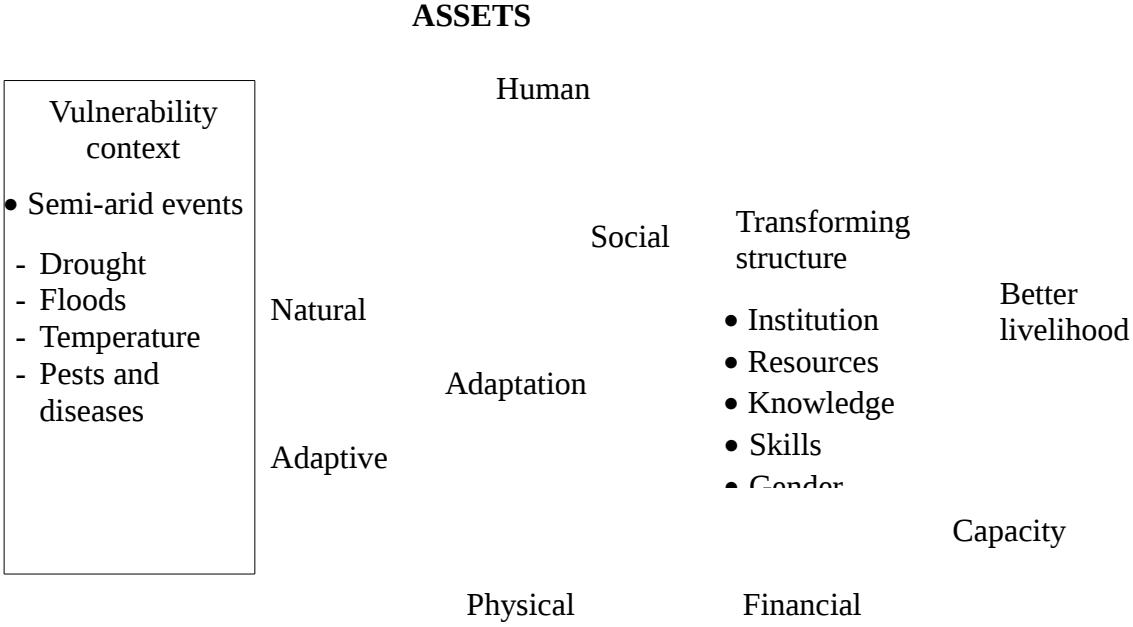

Figure : Conceptual Framework

Source: Adapted and modified from DFID (1999)

In this study adaptive capacity as defined as the ability of a system to adjust, modify or change its characteristics or actions to moderate potential damage, take advantage of opportunities or cope with the consequences of shock or stress (Brooks, 2003). The livelihood outcome in this framework will be adaptive capacity which is used as a dependent variable and in this case differential adaptive capacity between men and women. Adaptive capacity is centered on access and control of assets and entitlements, institutions and knowledge and skills as transforming structures and household farm characteristics will be used as intervening variables. It is assumed that the vulnerability context will be the climate variability and change imparted differently between men and women as a result of differential access to assets and transforming structure, in this case institutions. The reason for using this conceptual framework is that it assists in establishing the resources available to assist adaptation, and has room to include intangible assets and power relation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Key Concepts

2.1.1 Gender

The term gender has been acknowledged by different people as males and females largely referring to sexes. The value of the distinction between the terms ‘sex’ and ‘gender’ has been challenged more recently as ‘sex’ has also been seen to be socially constructed (Haslanger, 2000). Reeves and Baden (2000) defines the term sex as a biologically determined as female or male according to certain identifiable physical features which are fixed. Different scholars have defined the word gender. Saringe (2011) defines gender by referring to the social roles and relations between women and men, which include different responsibilities of women and men in a given culture and location. Reeves and Baden (2000) defines gender as by referring to socially determined ideas and practices of what it is to be female or male. They go beyond by saying that, ‘Gender’ is how a person’s biology is culturally valued and interpreted into locally accepted ideas of what it is to be a woman or man. ‘Gender’ and the hierarchical power relations between women and men based on this are socially constructed, and not derived directly from biology. Gender identities and associated expectations of roles and responsibilities are therefore changeable between and within cultures. Gendered power relations permeate social institutions so that gender is never absent. This study is also in line with the definition given by Reeves and Baden as gender is culturally determined and it includes hierarchal power relations and socially constructed roles.

2.1.2 Smallholder farmers

Smallholder farmer is a type farmer whose farming system and associated activities together form a livelihood strategy where the main output is consumed directly, there are

few if any purchased inputs and only a minor proportion of output is marketed (Morton, 2007). This study defines smallholder farmer by referring to Tanzania's context whereby a smallholder farmer is the one who operates between 0.2 and 2.0 hectares and traditional livestock who keep cattle and utilize approximately 85% of arable land (MAFS, 2001).

2.1.3 Livelihood

When asked to define the term livelihood every individual might come up with his/her own definition like "making a living", "supporting a family", or "my job" all describe a livelihood. Different scholars have defined the term livelihood.

Chambers and Conway (1992) define livelihood as it "comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation: and which contributes net benefits to other livelihoods at the local and global levels in the long and short term".

More recently the Institute for Development Studies (IDS) and the British Department for International Development (DFID), (1999) have defined livelihood as "comprises the capabilities, assets (including both material and social resources) 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".

This study also is in line with this new definition given by the IDS and DFID, (1999). Because this new definition does not include the requirement that for livelihoods to be

considered sustainable they should also ‘contribute net benefits to other livelihoods’. With some minor changes the DFID and IDS suggested that this definition includes: Livelihood resources, Livelihood strategies, and Institutional processes and organizational structures.

2.1.4 The asset base

The ability of a community to cope with and respond to change depends heavily on access to, and control over, key assets (Jones *et al.*, 2010). Assets or capital plays a key role in determining adaptive capacity of a given context to the climate change impacts. In developing country communities, often highly dependent on agriculture and natural resources, climate change have a detrimental impact on availability of assets (Ospina and Heeks, 2010). Typically, it is the poorest men and women smallholder farmers who are most vulnerable to the impacts of climate change and wider developmental pressures, in large part because of their lack of, or restricted access to, key assets and capitals (Jones *et al.*, 2010). Furthermore poverty has many dimensions, not merely income. Assets include both tangible capitals such as natural, physical and financial as well as intangible ones such as human and social (Prowse and Scott, 2008).

In addition, the relationship between assets and adaptive capacity is complex. Lack of availability and access to appropriate resources may significantly limit the ability of a system to cope with the effects of climate change (IISD, 2003). On the other hand, the more varied the asset base (such as the means of production available to generate resources sufficient to reduce poverty), the more sustainable and secure is the livelihood, and the stronger the ability of the population to respond to the impacts of climate change is (Ospina and Heeks, 2010). Therefore, livelihoods assets form the basis of both adaptive capacity and realized adaptation strategies (IISD, 2003). However, the role of assets within

adaptation cannot be analyzed in a vacuum, as institutions, structures and capabilities also constitute important components of livelihood systems (Ospina and Heeks, 2010).

2.1.5 Institutions and structures

Institutions are the ‘rules’ that govern belief systems, behaviour and organizational structure (Ostrom, 2005). Institutions have been formed throughout history to create order and reduce uncertainty. These can be formal such as sanctions, taboos, customs or codes of conduct, all of which are found within the notion of culture as well as formal rules such as laws, property rights or government policies (Ospina and Heeks, 2010). Institutions are components of adaptive capacity of a system that can either block or enable access to assets, and thus play an important role in the adaptive capacity of communities to cope with climate change. Conversely, communities with well-developed social institutions are typically better able to respond to a changing environment than those with less effective institutional arrangements. At the community level these are generally ‘informal’ local-level institutions or rules, and may include: land tenure rules, such as claims to common property resources; the ways in which farmers share knowledge; family, clan and church networks through which assets are shared; and ‘rules’ (unwritten) governing the rights of women (Jones *et al.*, 2010).

This suggests that institutions are mediators in determining access to resources in adaptation processes. Thus adaptive capacity of a system is socially differentiated along the lines of age, ethnicity, class, religion and gender’ (Adger *et al.*, 2007: 730). Equally, institutions that ensure equitable opportunities to access resources are likely to promote adaptive capacity among different socioeconomic groups and between men and women smallholder farmers. Institutions cannot, however, be measured solely according to asset distribution. Dimensions such as participation in decision-making; how institutions

empower or disempower people; and the extent to which individuals, groups and communities have the right to be heard may prove key in determining both the degree to which a community is able to adapt, and the direction in which it does so (Jones *et al.*, 2010).

Therefore within systems affected by climate related stress and shocks institutions play a key role in determining access to resources, mediating the effects of hazards, and enabling the decision making frameworks required for adaptation processes to take place (Nelson *et al.,* 2007). However, social barriers to adaptation and the norms, rules and behaviour are all shaped by informal institutions, and can in many instances influence how individuals choose to cope and adapt to climate variability and change (Jones *et al.,* 2010). Thus the combination of assets and institutions present constitutes part of the enabling foundation of adaptive capacity within complex developing environments.

2.1.6 Vulnerability

There is much debate about the definition of vulnerability. Adger (2006: 268) defines vulnerability as “the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt”. This study adopts the definition given by Carter *et al.* (2007) who defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. This definition of vulnerability depend critically on context, and the factors that make a system vulnerable climate change depend on the nature of the system and the type of climatic change in question. For example the factors that make a rural community in semi-arid developing countries vulnerable to drought is not identical to those that make areas of a wealthy industrialized nation vulnerable to flooding, wind storms and other extreme weather events. Isolation

and income diversity are important determinants of vulnerability to drought for rural communities in many developing countries, whereas the dominant factors mediating vulnerability to storms and floods in wealthy industrialized nation are the quality of physical infrastructure and the efficacy of land use planning. Nonetheless, there are certain factors that are likely to influence vulnerability to a wide variety of climate change in different geographical and socio-political contexts. These are developmental factors including poverty, health status, economic inequality and elements of governance. These factors are referred to as generic determinants of vulnerability, as opposed to specific determinants relevant to a particular context such as the price of a particular food crop, the number of storm shelters available for the use of a coastal community, or the existence of regulations concerning the robustness of buildings. Although the relative importance of different generic factors exhibits some variation, such factors may be viewed as the foundation on which specific measures for reducing vulnerability and facilitation adaptation are built. For example, a rural community is more likely to be serviced by transport infrastructure if it is effectively represented at the political level. Building codes are more likely to be enforced if corruption in the building industry and regulatory agencies is minimized. Therefore this definition of vulnerability tells us how well a certain community can be equipped to cope with and adapt to climate change and its variability.

2.1.7 Adaptation

Climate change adaptation and gender refers to the different ways in which men and women contribute to climate change, the different impact that climate change has on men and women, the different ways that men and women respond to and are able to cope with climate change, and the differences in how they are able to shift from short term coping mechanisms to resilience. Therefore indicators which highlight the differences between men and women are useful to ensure that the most vulnerable are being included in all

interventions and assistance programmes. In this study livelihood resources developed by the DFID (1999) are used as indicators to disaggregate the gendered adaptation to climate change impacts.

2.1.8 Adaptive capacity

According to the IPCC (2001), adaptive capacity is defined as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. This study uses the definition by Smith and Pilifosova (2001), and Levine *et al*. (2011), who defines adaptive capacity as the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. However, there is still much debate around the definition of adaptive capacity (Jones *et al.,* 2010). Broadly speaking, adaptive capacity denotes the ability of a system to adjust, modify or change its characteristics or actions to moderate potential damage, take advantage of opportunities or cope with the consequences of shock or stress (Brooks, 2003). Adaptive capacity describes the ability to respond to challenges through learning, managing risk and impacts, developing new knowledge and devising effective approaches. Adaptive capacity is one of the determinants of a system that have influence, the occurrence and nature of adaptations (Smit *et al.,* 2000:236). Others include sensitivity, vulnerability, susceptibility, coping range, critical levels, stability, robustness, resilience and flexibility (Smit *et al.,* 2000).

2.1.9 Climate

Climate is a natural phenomenon that is always dynamic and varies at a global scale of time and space. This study adopts the definition by Saringe (2011) who define climate as average weather experienced over a long period, typically 30 years. This includes

temperature, wind and rainfall patterns. The climate of the Earth is not static, and has changed many times in response to a variety of natural causes (ibid).

2.2 Climate change

2.2.1 Evidence of climate change

It is now scientifically proven that climate change poses serious consequences for humans and ecosystems (IPCC, 2001). The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural climate variability observed over comparable time periods (IPCC, 2007; UNDP, 2009). This study is in line with the IPCC which defines climate change as any change in climate over time, whether due to natural variability or as result of human activity (IPCC, 2001).

Brown *et al.* (2007) argues that climate change represents the latest in a series of environmental drivers of human conflict that have been identified in recent decades. Following others including drought, desertification, land degradation, failing water supplies, deforestation, fisheries depletion and even ozone depletion. The research community began to uncover worrying evidence of human-induced climate change in the 1970s and 1980s. The emerging problem of global warming was seen by policy makers, when it was not ignored altogether, as an environmental issue of peripheral concern, to be dealt by environment ministries (Nwanze, 2008).

By the 1990s, climate modeling had become more sophisticated, patterns of change in regional climate condition were being observed and policy-makers began accepting that ways must be found to reduce greenhouse gas (GHG) emissions. Given that doing so

would necessitate drastic changes to the use of fossil fuels, climate change quickly becomes an economic and energy policy issue. However, in the past few years, the language of climate change has shifted once again. Climate change now being recast as a threat to international peace and security; and the region seen as most likely to suffer worst effects is Africa particularly SSA endangering its Millennium Development Goals (Von Broun, 2008).

Concerning the MDG individually, UNDP (2007) reports that climate change may pose a threat to food security through erratic rainfall patterns and decreasing crop yields, contributing to increase hunger. Furthermore, adverse climate change impacts on natural systems, and resources, infrastructure and labour productivity may lead to reduced economic growth, exacerbating poverty. These effects threaten the achievement of MDG 1. Loss of livelihood assets, displacement and migration may lead to reduced access to education opportunities, thus hampering the realization of MDG 2. Depletion of natural resources and decreasing agricultural productivity may place additional burdens on women's health and reduce time for decision making processes and income generating activities, worsening gender equality and women's empowerment MDG 3. Increased incident of vector born diseases, increases in heat-related mortality, and declining quantity and quality of drinking water leads to adverse health effects threatening the achievement of MDG 4, 5, 6, and 7. In general the realization of MDG 7 may be jeopardized through climate change negatively impacting quality and productivity of the natural resources and ecosystems, possibly irreversibly, threatening environmental sustainability. Climate change, a global phenomenon, calls for a collective response in the form of global partners (MDG 8). However according to Amentrout (2008), we cannot stop climate change but we can reduce humankind's contribution to the accelerated rate of atmospheric pollution.

2.2.2 Climate change impacts

Climate change and its impacts are well documented by various organizations such as the IPCC, World Health Organization (WHO), the World Meteorological Organization (WMO), United Nations Environment Programme (UNEP), Unites Nations Development Programme and United Nations Educational Scientific and Cultural Organization (UNESCO). Literature also documents the key impacts of climate change are associated with sea level rise, changes in the intensity, timing and spatial distribution of precipitation, changes in temperature and the frequency, intensity and duration of extreme climate events such as droughts, floods, and tropical storms (IPCC, 2001; IPCC, 2007; USAID, 2009; UNDP 2009).

Despite the fact that climate change is a global issue as it affects the world globally in its nature, the impacts of climate change are not expected to be globally homogeneous but rather differentiated across regions, generations, age classes, income groups, occupations and between men and women (IPCC, 2001; Babugura, 2010). As highlighted in literature the consequences of climate change are predicated to be potentially more significant for the poor in developing countries than for those living in more prosperous nations (Olmos 2001; Boko *et al.*, 2007; IPCC, 2007; USAID, 2007; UNDP, 2009; USAID, 2009). Africa being one of the poorest nations, has already demonstrated its vulnerability to the effects of current climate variability (e.g. effects of events such as droughts and floods). Climate variability according to (IPCC, 2007) refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Based on knowledge generated from studies on impacts and vulnerability to climate variability, societies that are most vulnerable are usually those deprived of mechanisms and resources to prepare for and adapt to climate variation (IPCC, 2000; Babugura, 2005). The continent not only faces

the challenge of dealing with the possible consequences of future climate change but it is also exposed to multiple stressors (socio-economic, health, political and environmental factors), which serve to exacerbate climate stress events (O'Brien and Leichenko, 2000; Kunfaa *et al.,* 2002; Khogali, 2002; Drinkwater, 2003; Frankenberger *et al.,* 2003; UNAIDS, 2003; Babugura, 2005). These stressors affect ability to anticipate, prepare for and respond to current climate variability and may further heighten vulnerability to future climate change. Therefore addressing the threat of climate change has become a global priority.

2.2.3 Regions mostly affected by climate change

Morton (2007) contends that the threats of climate change are more severe in developing countries, partially due to geographical location. Many low-income countries are located in the tropical and sub-tropical regions, which are particularly vulnerable to rising temperatures, and in semi desert zones, which are threatened by decreasing water availability (Tubiello and Fischer, 2007; Heltberg, 2008). By 2080, agricultural output in developing countries may decline by 20 percent due to climate change, while output in industrial countries is expected to decrease by 6 percent (Cline, 2007; Fischer *et al.,* 2005).

Taking into account the effects of climate change, the number of undernourished people in the SSA may triple between 1997 and 2080 (Table 1). Climate change shocks also erode the long term opportunities for human development and could exacerbate inequalities within countries (UNDP, 2007). In its recent report on vulnerability to climate change, the Intergovernmental Panel on Climate Change states that those with the least resources have the least capacity to cope and are the most vulnerable (IPCC, 2007). African vulnerability to climate change is generally acknowledged that and that it is largely depends on its current low coping and adaptive capacities the vulnerability of Africa to climate change is

not only caused by climate change but through a combination of social, economic and other environmental factors that interact with climate change (Ericksen, 2008; Adger, 2006).

The vulnerabilities include regions with high population growth rate (the highest in the world), pervasive and growing poverty, the high prevalence to malnutrition, low literacy rates, high burden of disease, and prevalence of environmental disasters such as floods and drought. The region is also characterized by poor governance, corruption, conflict and weak institutions (Nkoma *et al.,* 2007; IPCC, 2007; Thornton and Farrow, 2008). Table 1 presents levels of region nourishment incorporating climate change.

Table : Number of undernourished, incorporating climate change effect (in millions)

	1990	**2020**	**2050**	**2080**	**2080/1990**
Developing countries	885	770	579	554	0.6
Asia, Developing	659	390	123	73	0.1
Sub-Saharan Africa (SSA)	138	273	359	410	3.0
Latin America	54	53	40	23	0.4
Middle and North Africa	33	55	56	48	1.5

Source: Adapted from Tubiello and Fischer (2007)

2.2.4 Vulnerability of Smallholder Farmers to Climate Change

There is much debate about the definition of vulnerability. Houghton *et al.,* (2001) and McCarthy *et al.,* (2001) define vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Section 2.1.6 of this study defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

It is argued that climate change have effect in all sectors of development including agriculture (Nampinga, 2008; Lyimo and Kangarawe, 2010). Although the sector is marked as one of climate change problem, contributing about 13.5% of annual greenhouse gas emissions (with forestry contributing an additional 19 percent), compared with 13.1% from transportation (Nelson, 2009). Yet it is part of the solution, offering promising opportunities for mitigating emissions through carbon sequestration, soil and land use management, and biomass production (Ngigi, 2009).

Despite being part of the solution to climate change agricultural has been the more vulnerable sector to the threats of climate change through changes in temperature, precipitation patterns and increased occurrences of extreme events like droughts and flood. In Africa Agriculture represents 30% of the GDP and climate change threatens this economy because it is highly dependent on agriculture (Nampinga, 2008). Therefore smallholder farmers have no alternative but to adapt to climate change and climate variability. However the poor lack that capacity of adapting to the effects of climate change since the ability to adapt to climate change is determined by resources availability and accessibility.

Smallholder agriculture is used more generally to describe rural producers, predominantly in developing countries, who farm using mainly family labour and for whom the farm provides the source of income (FAO, 2008). Pastoralists, all of whom almost depend on sale of livestock and livestock products to buy food, and other necessities, and people dependent on artisanal, fisheries, forests, and aquaculture enterprises, are all included in this category. All suffer, in varying degrees; similar problems associated with isolated and

low level of technology, unpredicted exposure to world market and severe impact brought by climate change (Ellis and Freemen, 2004; FAO, 2008).

According to Morton (2007) and Heltberg *et al.* (2007) smallholder farmers who are mostly located in the tropics are vulnerable to climate change because they face various socio-economic, demographic, and a policy trend that limits their capacity to cope with climate change. These farmers are characterized with complex, diverse and risk prone environment, they have generally small subsistence farms, often held under traditional or informal tenure and are in marginal place (Adger *et al.,* 2003). It is also true that smallholder farmers face several other challenges such as complex and diverse production systems usually in combination of plant and animal species exploited, the type of integration between them, the production objectives and the institutional arrangements for managing natural resources. The risks are also various including drought and floods, crop and animal diseases and market shocks. All these may be felt by individual households or entire communities (Holzman and Jorgensen, 2000; Scoones, 2001).

Smallholder farmers especially those located in semi-arid areas are likely to be vulnerable to climate change through impacts on food production, and natural resources, consequently people's livelihoods (IPCC, 2007; Mwandosya, 2007; Lyimo and Kangarawe, 2010). Fischer *et al.* (2005), Thornton *et al.* (2006), and IPCC (2007) reported that some countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will likely reduce the length of growing seasons, as well as force large regions of marginal agricultural potential out of production.

In many parts of Tanzania, households have to contend with other extreme natural resource challenges and constraints, such as poor soil fertility, pests, crop diseases, and

lack of access to agricultural inputs. These challenges are usually aggravated by the impact of climate change, such as periods of prolonged droughts and/or floods. Yanda *et al.* (2005), Mwandosya (2007) Wisner *et al.* (2004), reported that Tanzania has shown a general increase in temperature over the last 30 years, as well as decreasing rainfall over the same period in most parts of the country. The frequency and intensity of extreme weather events, such as drought and floods, has been increasing affecting climate sensitive sectors, such as agriculture. Hence, the risk associated with climate change in Tanzania is real and affect human livelihoods a situation which cannot be neglected.

According to URT (2007), Tanzania's national adaptation programme of action (NAPA) has ranked agriculture as top in the list of sectors, whose dependent population is most vulnerable to foreseeable climate change. Although, smallholder farmers have developed several adaptation options to climate change and variability, such adaptations are not sufficient for future changes of climate. Enhancing their adaptive capacity to the impacts of climate change will, thus, require concerted and long-term efforts by various stakeholders.

Smallholder or subsistence farmers and pastoralists often practice hunting, gathering of wild resources as well as crop and livestock production to fulfill body energy requirement, clothing, health, and cash income needs as well as direct food requirements. They also widely participate in off-farm employment such as small business to support their daily lives (Ellis, 2000; Scoones, 2001). However, small farms can have some advantages over large farmers in certain transaction costs: the supervision of labour, local knowledge, and food purchases and risk management particularly when subjected to severe climate change (Hazell *et al.*, 2007).

Slater (2007) argues that climate change is just an additional challenge to which smallholder farmers will have to respond. However, smallholder farmers are viewed as being able to cope with risk and uncertainty in the short-term than in long terms. Examples of short term responses include drawing on temporary measures such as entering the causal labour force, delaying planting, sale of livestock to purchase food, or buying from income obtained from off-farm activities (Morton, 2007; Slater, 2007). On the other hand, Morton (2007) and Slater (2007) contend that smallholder farmers cannot cope (*ex-post*) and adapt in the long term unless they can access state or private initiatives to support adaptation. This kind of support includes micro-insurance, credit, new technology and market information. Morton (2007) asserts that smallholders, subsistence, and pastoralists system, especially those located in marginal environments, area of high variability of rainfall or high risk of natural hazards, are often characterized by the livelihood strategies that have been evolved. These include reduction of overall vulnerability to climate shocks (adaptive strategies) and management of climate change impacts (*ex-post* or coping strategies). However, the distinction between these two categories is blurred because what start as a coping exceptional years become adaptation for households or whole community.

2.2.5 Global Response to Climate Change

According to Armentrout (2008), climate science is challenging and intriguing, and how it impacts our future is a critical issue. The Intergovernmental Panel on Climate Change (IPCC, 2007) notes that fossil fuel based carbon dioxide emission is “virtually certain to be dominant influence on the trends in the atmospheric CO_2 concentration during the 21^{st} century. Over the past decades, and especially over the past few years, climate change has emerged as one of the most important issue facing the international community (Albritton and Meira, 2001).

The observation has been made that climate change issue broke into the international policy making agenda in the mid 1980s between 1985 and 1988. The issue moved from the realm of science to the realm of politics. As such, this period provides fertile ground for exploration of the relationship between science, knowledge, and action on international environmental issues. Several policy and science entrepreneurs advocated on action to address problems of global climate change. Their conclusions coincided with a number of other developments, including extreme weather in the United States and the successful negotiation of an international agreement to protect the ozone layer, which pressed in the direction of further international attention to environmental problems (Justus and Fletcher, 2006). By 1988, a variety of international players were involved in shaping the debate about responses to climate change. These were headed by the formation of international organizations to deal with the problem of global warming leading to the climate change. Such organizations include the IPCC established in 1988, UNFCCC adopted in New York in 1992, WMO, and UNEP to mention a few (Fletcher, 2005).

The world action on climate change has been undertaken through two major protocols; the Montreal Protocol-1987 (Velders *et al.,* 2006) aimed at protecting stratospheric ozone layer; Kyoto Protocol-1997 commonly known as Kyoto Protocol of United Nations Framework Convention on Climate Change with the goal of CO_2 emission reduction by 2020. These protocols aimed at providing emission property right and emission entitlement based on the past emission level. The actors of climate change recognized that climate change is a global externality requiring global cooperation; international emissions trading lowers costs for all nations and emissions pricing is the key to the development of new, climate-friendly technologies. Such thinking clearly shaped the design of the Kyoto Protocol, a climate treaty negotiated by more than 140 nations that establishes a global emissions trading system for greenhouse gases (Velders *et al.,* 2006; Andersen and Sarm,

2002). Yet, despite reports of success following the most recent negotiations on the Kyoto Protocol and U.N. Framework Convention on Climate Change (UNFCCC), there are some clear indications that this architecture is not working well.

Most obviously, the United States is out of the system, and developing countries successfully have avoided any discussion of future commitments under the protocol. Among countries that have implemented or are on the way to implement mandatory programs, only the EU Emission Trading Scheme (ETS) is designed to parallel Kyoto's cap and trade architecture. Apparently, a nation's compliance with international agreements is tied more to its domestic politics than the agreement's intended incentives (making it different than the familiar case of a firm complying with a domestic policy). However, despite this observed disconnect between domestic actions and Kyoto commitments and architecture, the impetus for domestic policies seems unquestionably tied to the protocol (UNFCCC, 2006).

The experience matches that of the global efforts for instance, on ozone depleting substances, trade, and human rights where has been a much clearer set of domestic responses before significant global institutions have been built around these responses. In these, international agreement moved alongside, if not behind, domestic policy developments without constraining them. Applied to climate change, this might look like the "bottom up" or "pledge and review" approach rather than the current Kyoto protocol. That is, the first step is for countries to pursue domestic climate policies consistent with their own domestic pressures, reinforced by an international agreement that stimulate without constraining.

According to UNFCCC (2007) and IPCC (2007), important issues to be dealt in the short run up to 2012 particularly in developing countries including coping and adaptation to climate change, financing, technology, and reducing emission from deforestation and forest degradation. FAO (2008) contends that the goals set forth by the World Food Summit, the Millennium Development Goals and the UNFCCC is that agriculture, rural livelihoods sustainable management of natural resources and food security are inextricably linked with the development and climate change challenges of the 21st century. Indeed, not only is food security an explicit concern under climate change: successful coping, adaptation and mitigation responses in agriculture can only be achieved within the ecological, economic and social sustainability (Ericksen, 2008; Helteberg, 2008).

Among the efforts to address climate change in the developing countries, the United Nation Developing Programme (UNDP) is working with African Countries to help them develop their capacity to plan and monitor flexible, long term development policies designed to weather the uncertainties of climate change, with the primary focus of ensuring that the most vulnerable people (smallholder farmers) do not fall victim to rising temperature and climate induced health risk will hit the poorest the hardest, hence a need to address on smallholder farmers seriously (UN, 2008; Justus and Fletcher, 2006). According to FAO (2008), strategies that help reduce the potential negative impacts of climate change on smallholder farmers production systems with focus on rural livelihoods in poor developing countries serve to maintain global and regional food insecurity and must be a priority of climate policy responses. It is also important to note that smallholder farmers have developed adaptation practices and mitigation options which are discussed in the next section.

2.3 Climate Change and Adaptation Practices in Agriculture

Farmers have long term history of responding to climate change and variability. According to Below *et al.* (2010), traditionally and newly introduced adaptation practices helps small-holder farmers to cope with climatic change and variability. Smit and Skinner (2000) defines adaptation practices as, are activities that represent changes in some attribute of the agricultural system (the agriculture sector or farms within it) directly related to reducing vulnerability to climate change. However, the debate about the adaptation of smallholder farmers in Africa including Tanzania to climate change has occurred to absence of knowledge about existing and potential practices. This study therefore, tried to include those components in understanding farmers' adaptation to climate change Meatu and Iramba Districts in Tanzania.

When Below *et al.* (2010) reviewed 17 studies covering data from more than 16 countries in Africa, the America, Europe and Asia they found 104 different practices relevant to climate change adaptation. The practices address a wide range of adjustments in the behaviour of individuals, groups and institutions as well as in the use of and development of technologies. Below sub-sections are detailed elaborations of the practices mentioned.

2.3.1 Farm management and technical option

This type of adaptation practice considers a wide range of adjustments in land use and livelihood strategies that go beyond the usual agricultural practices available for coping with varying biophysical and socio-economic conditions. In this farmers may consider shifting from farming to raising livestock which may serve as a marketable insurance in times of hardship for example, farmers may consider introducing different livestock breeds that are more resistance to drought. Farmer may also develop new crop varieties. However this is a macro-level research programme undertaken or sponsored by the

government or NGOs and private companies. Scholars of farmer innovation behaviour points out that agricultural producer also play a decisive role in the development of new technologies (Doppler *et al.*, 2000).

2.3.2 Adaptation of On-farm Management

This is based on crop selection depending on regions. Literature suggests that farmers vary significantly in cooler, moderate warm and hot regions (Below *et al.*, 2010). For example Kurukulasuriya and Mendelsohn (2006) said that farmers select sorghum and maize-millet in the cooler regions of Africa; maize-beans, maize-groundnut and maize in moderate warm regions; cowpeas, cowpeas-sorghum, and millet-sorghum in hot regions. Another finding based on the study by Thomas *et al.* (2007) is that farmers are increasingly trying to exploit the spatial diversity of their landscape. On the other hand, controlling erosion by using contour planting, mulching, and the construction of cutoff drains and sluices was popular only in the Mbulu highlands, where the fields are on a slope (Tengö and Belfrage, 2004).

2.3.3 Technical options new plant varieties

This is based on the use of improved crop varieties that have considerable potential for strengthening the adaptive capacity of farmers. For example the use of improved drought resistance varieties that have high yielding, early maturing, weed competitive and tolerant to major pests , drought and iron toxicity (Rodenburg *et al.*, 2006). Another example of adaptation to climate change by using new technologies is the use of weather forecast information which gives support for rain-water harvesting (Mbilinyi *et al.*, 2007).

2.3.4 Adoption of new technologies

This depends on farmer’s economic interests, social and ecological values and norms, awareness of the problem, and self-perception. A farmer’s ability comprises all the

objectively verifiable factors that influence his or her decision, including the type and organization of the farm, farm economics, tenure, and farm size, as well as the biogeographically conditions of the farmland and its surroundings. Furthermore, it includes specific characteristics of the farmer, that is, the farmer's age, education, and experience (Siebert, Toogood, and Knierim 2006). Boko *et al.* (2007) highlights the critical importance of new technologies for adaptation to climate change. McLeman *et al.*, (2008) also adds that the adaptation can take place through terracing sloping fields.

2.3.5 Willingness to accept weather forecasts

Studies show that willingness to accept weather forecast is based on farmers' self-perception as decisive factors in acceptance. According to Roncoli, Ingram, and Kirshen (2002); Roncoli *et al.,* (2004; 2005) on farmers' understanding of seasonal rainfall forecasts in Burkina Faso. They found that farmers think of rainfall as a process rather than in terms of a quantity, as scientists do. Thus, Roncoli and colleagues argue, farmers will not accept forecasts, unless they are adjusted to their understandings. Patt and Gwata (2002) confirm these findings. A study in Zimbabwe (Grothman and Patt 2005) revealed that farmers' acceptance of seasonal climate forecasts increased when they were provided as part of local indigenous climate forecasts. Farmers are more likely to adopt external climate forecasts when they can see them in the context of existing practices.

2.3.6 Ability to accept weather forecasts

Farmers' ability to accept and apply climate forecast information is influenced by farm characteristics on the one hand and by the individual farmer's disposition on the other. Little literature exists on the characteristics that influence acceptance. Roncoli, Ingram, and Kirshen (2002) and Roncoli *et al.* (2004; 2005) found in their case study in Burkina Faso that cognitive factors, such as experience, influence farmers' processing of the

probability of climate events, as well as their ability to apply climate. But Archer (2003) found for South Africa that gender is a determinant of farmers' ability to accept climate forecasts. The findings of Barbier *et al.* (2009) suggest that farmers had quite elaborate knowledge of climate-related factors, such as wind, rainfall, and heat, and their impact on crops.

2.3.7 Farm financial management

This is based on the use of farm income strategies to support adaptive capacity to small-scale farmers. It is argued that the government and other private sectors can give support to farmers in increasing the adaptation measures through the necessary resources such as credit that can help in reducing the risk of climate-related income loss McLeman *et al.*, (2008). This is done when drought causes the loss of income.

2.3.8 Diversification on and beyond the farm

Diversification includes both nonagricultural livelihood strategies that are carried out on the farm, such as the sale of non-timber forest products, and activities that farm families undertake beyond the farm, such as petty trade or seasonal migration. . Paavola (2004) reports that excessive use of natural resources in the Morogoro Region of Tanzania undermines sustainable land use. The strategies are directed toward earning much-needed cash. However, ethnicity and gender appear to be significant influences on the forms that diversification takes place and provide a good example of the issues involved. The major drivers of diversification were structural adjustment and market liberalization policies that international financial institutions had initiated, and Bryceson (2002) identifies several perverse outcomes that resulted although she acknowledges that drought also has played a role in diversification in some cases. In the face of drought people diversify into the production of charcoal, which increases rates of deforestation, and into artisanal mining,

which leads to soil erosion and water depletion (Paavola, 2004). According to Bryceson (2002), increased diversification has influenced the division of labor and decision making power within smallholder households and has caused a widening of wealth differentials between households.

2.3.9 Government investments in infrastructure, health and public welfare

These are macro-level responses which have strong influence to farmer's risk caused by climate change and variability. Institutional responses to the risks associated with climate change primarily address issues involving infrastructure, market, health and public employment, and welfare programs. One example of institutional response to climate change is bridge construction to help farmers get accessible to the market.

2.3.10 Adaptation by using indigenous knowledge

Kelbessa (2007) defines indigenous knowledge as something which was created and preserved by previous generation, and has been inherited wholly or partially and further developed by successive generations over the years. It involves both old and new ideas and beliefs and is sometimes called traditional knowledge.

In climate change view; indigenous knowledge are unique knowledge to a given culture or society acquire by human beings to regulate stresses brought by climate change, which should be able to bring relief to the stressed community. Indigenous knowledge is the basis for local level decision making in rural communities. It has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in local localities. According to Gyamphoh (2008), indigenous knowledge or traditional knowledge, has over the year played important roles in solving problems, including

climate change and have immense knowledge to contribute to the micro-environment of the community. Pickersgill (2008) contends that domestication of wild plants is a result of the co-evolutionary relationships between humans and activity and their environment. Through the evolutionary trend human domesticated wild plant which in turn becomes their staples.

However, indigenous people may not understand the science of climate change but they rightly observed and feel its effects and some response demonstrate appreciable knowledge of global climate changes. Societies have a long record of coping to climate change and risks. Household asset portfolios and livelihood choices are shaped by the need to manage climate risks, especially in rural areas and for low income households (Heltberg, 2008). IK is capable of observing the activities around and first to identify changes, and associated/related coping strategies and/or practices. It is capable of understanding very well changes in the time and seasons through their traditional Knowledge. For example, the appearance of certain birds, mating of certain animals, flowering of certain plants and sprouting of some plants are all signals, informing individuals and community on how to cope accordingly.

Srinivasan (2005) observes that the important of IK is to enhance coping and adaptation to climate change; local practices and tools are easily understood, handled and maintained; IK or combination of IK and modernized technology can provide effective and feasible solution; IK draws on local resources such as less dependence on outside supplies which can be costly and scarce; IK and technologies and practices are often more cost effective than modern technologies. They rely on locally available skills and materials and often require little or no cash outlay; both protection and utilization of IK are important for communities in all countries particularly in the developing countries.

However, in spite of the significant role played by IK in different areas of climate change still traditional knowledge is usually neglected in academics, policy and public discourses on climate change (Gyamphoh, 2008 and Srinivasan, 2005). Examples of IK commonly used in developing countries are cultivation of more than one type of grain staple, mixed land use, intercropping; cultivation tillage and mixed cropping; cropping pattern decisions on local predictions of climate change; varying cropping dates based on complex cultural models of weather; using local germ-plasm highly acclimated to withstand harsh climates; and micro-climate manipulation such as afforestation. In general incorporating IK into climate change policies can lead to development of effective coping strategies that are cost effective, participatory and sustainable (Nyong *et al.*, 2007).

Communities are often more likely to cope with change if they have appropriate knowledge and skills about potential future threats and how to adapt to them. Successful adaptation of a community requires understanding of likely future change and its complexity. Therefore, knowledge and skills about adaptation options and the ability to adapt to the impacts of climate change are key feature of community adaptive capacity. Knowledge can also play a role in ensuring local empowerment and raising awareness of the needs of particular groups within a community (Ospina and Heeks, 2010). Therefore, the way in which a system generates, collects, analyses and disseminates knowledge is an important determinant of adaptive capacity.

Local knowledge of the community about changes in climate that is informal learned through experiences and formal that is provided by the external actor are important for ensuring community adaptive capacity. Communities need systems that can both optimize ‘informal’ knowledge generation and sharing, and maximize their uptake and use of

external, ‘formal’ knowledge sources. In many contexts, adaptation requires effective services from outside the community to support or in pack new knowledge (Nagy, 2003).

2.4 Review of the Status of Research on Climate Change and Determinants of Adaptive Capacity between Men and Women

Although a body of literature shows how the projected adverse consequences of climate change are affecting developing countries due to poor resources which determine country’s adaptive capacities, still research on what determines the adaptive capacity of men and women is very limited (Davies and Thornton, 2011). Therefore integrating gender issues is critical, not only to ensure equal access to resources but also to ensure that external finance considers the issue of gender.

As the global temperature is increasing because of the long reaction time in the climate system including other climatic events, adaptation to climate change is seen as an important response option, along with mitigation (Smit and Pilifosova, 2001). However, it appears that mitigation alone cannot prevent climate from changing over the coming decades and centuries; hence adaptation is necessary to dampen the impacts of climate change on human and natural system (Grothman and Patt, 2003; Prowse, Grist and Sourang, 2009). Therefore, more attention is given to the so-called determinants of adaptive capacity. According Prowse, Grist and Sourang 2009, determinants of adaptive capacity are also seen as determinants of adaptation.

2.4.1 Research in the world

Individuals, organizations and institutions are focusing research on determinants of systems or national adaptive capacity by referring on economic resources, level of technology, information and skills, infrastructure, institutions and empowerment. It is

reported that countries with poor of the above mentioned resources have little adaptive capacity and are highly vulnerable to the effects of climate change (Adger, 2003).

Several organizations and institutions have conducted research on climate change and adaptation. For example FAO (2007) conducted a research on Building Adaptive Capacity to Climate Change. IPCC-a summary for policy paper "Climate Change: Adaptation and Vulnerability also the organization conducted an assessment of the impact, Vulnerability and adaptation to Climate Change in Developing Countries (Parry *et al.,* 2007). IUCN – The World Conservation Union (2007), research on Climate Change and Development: Recognizing the Role of Forest and Water Resources in Climate Change Adaptation. International Institute for Sustainable Development (IISD), research on Indicators of Adaptive Capacity to Climate Change for Agriculture in the Prairie Region of Canada (Swanson *et al.*, 2009). Another research include: the International Food Policy Research Institute (IFPRI). This is an International Institute conducting research worldwide on food security whereby in the climate change era it is concerned with the impact of climate change on food security; Overseas Development Institute (ODI) produced its framework on the gap between climate change adaptation and poverty reduction in 2008. Other international institute and organizations dealt with climate change issues and adaptive capacity includes: The Department for International Development (DFID), United Nation Development Programme (UNDP), CARE-International, Action Aid World Vision, Save the Children, and Oxfam GB.

Wall and Marzall (2006) conducted a research on Adaptive Capacity for Climate Change in Canadian Rural Communities, and developed an amoeba profile of resource levels underlying adaptive capacity for climate change (social, human, institutional, natural and economic resources). Smit and Wandel (2006) conducted a research on Adaptation,

Adaptive Capacity and Vulnerability and applied thresholds and ‘‘coping ranges’’, to define conditions that a system can deal with, accommodate, adapt to, and recover from. Smit and Wandel argued that, coping ranges are flexible and respond to changes in economic, social, political and institutional conditions over time. For instance, population pressure or resource depletion may gradually reduce a system’s coping ability and narrow its coping range, while economic growth or improvements in technology or institutions may lead to an increase in adaptive capacity. They continued by saying that, coping range can increase over time or decrease, for a variety of reasons. For example external socio-economic and political factors (e.g. war, the collapse of an institution such as a crop insurance program, loss of a key decision-maker) may lead to a narrower coping range. Furthermore, the cumulative effects of increased frequency of events near the limit of the coping range may decrease the threshold beyond which the system cannot cope/adapt/recover (Jones, 2001; Dessai *et al.*, 2003). For example, two consecutive years of high moisture deficit which are not beyond the limits of the normal coping range present little problem in the present but require drawing on stored resources, and the consumption of these resources may subsequently narrow the coping range until they can be built up again, so a third and fourth year of moisture deficit of the same magnitude may well exceed the now smaller coping range.

Similarly, conditions which are within the coping range may introduce unforeseen side effects which will narrow the coping range. For example, a warm, wet year may be an ideal year for crop production and lead to high yields. Subsequent years of warm, wet conditions can, however, encourage the development of pest and fungal outbreaks and actually decrease yields and thus the coping range is reduced. Finally, a catastrophic event beyond the limit of the coping range may permanently alter the system’s normal coping range if it is not able to recover from it. Consider a system that relies on irrigation water,

captured in a dam. A very wet year, far beyond the normal conditions, may lead to the dam's failure, and thus the previous coping range cannot be returned to in a subsequent ''average'' year.

Likewise Nelson *et al*. (2010) conducted a research on The Vulnerability of Australian Rural Communities to Climate Variability and Change: Part II-Integrating Impacts with Adaptive Capacity. Their study analyzed adaptive capacity using the rural livelihoods framework developed by Ellis (2000) as the conceptual framework underpinning deductive construction of an adaptive capacity index. This framework conceptualizes adaptive capacity as an emergent property of the diverse forms of human, social, natural, physical and financial capital from which rural livelihoods are derived, and the flexibility to substitute between them in response to external pressures (Ellis, 2000). Nelson *et al.*, (2010) also argued that farm households with a greater diversity of assets and activities are likely to have greater adaptive capacity because of a greater capacity to substitute between alternative livelihood strategies in times of stress.

Other research conducted in the world and most of developing countries in the context of vulnerability and adaptive capacity of a system include: Jones (2010) research on, Towards a Holistic Conceptualization of Adaptive Capacity at the Local Level: Insights from the Local Adaptive Capacity Framework (LAC). Vincent (2007), research on Uncertainty in adaptive capacity and the importance of scale. Yohe and Tol (2002) research on, Indicators for social and economic coping capacity moving toward a working definition of adaptive capacity. Adger *et al.* (2004), New Indicators of Vulnerability and Adaptive Capacity. Brooks, Adger and Kelly (2004) research on, determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Adger and Vincent (2005), Uncertainty in adaptive capacity. Kuriakose,

Bizikova, and Bachofen (2009), Assessing Vulnerability and Adaptive Capacity to Climate Change Risks: Methods for Investigation at Local and National Levels. Alberini, Chiabai and Muehlenbachs (2005), Using Expert Judgment to Assess Adaptive Capacity to Climate Change.

All these research have started undertaking actions to reduce the impact of climate change in their countries. In developing country a significant gap exists in terms of gendered determinants of adaptive capacity to climate change impacts.

2.4.2 Research in Africa

Several research studies based on climate change and adaptation have been conducted on the African continent. These includes the research by Riche´ *et al,*. (2009) on Climate-related vulnerability and adaptive-capacity in Ethiopia's Borana and Somali communities. Fosu-Mensah, Vlek, and Manschadi, (2010) a research on Farmers' Perception and Adaptation to Climate Change; A Case Study of Sekyedumase District in Ghana.

Other research studies based on climate change and adaptation on agriculture on African continent include the research by Lamboll, Nelson and Nathaniel (2011) on Emerging approaches for responding to climate change in African agricultural Advisory services (AFAAS): Challenges, opportunities and recommendations for an AFAAS climate change response strategy. Ngigi (2009) conducted a research on Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming System in Sub Saharan Africa. Ojwang', Agatsiva and Situma (2010) on Analysis of Climate Change and Variability Risks in the Smallholder Sector Case studies of the Laikipia and Narok Districts representing major agro-ecological zones in Kenya. Also Kalinda (2011) conducted a research on Smallholder Farmers' Perceptions of Climate Change and

Conservation Agriculture: Evidence from Zambia. Mengistu (2011) also conducted a research on Farmers' perception and knowledge of climate change and their coping strategies to the related hazards: Case study from Adiha, central Tigray, Ethiopia.

However none of all above mentioned studies none of them was a gendered research nor did analysis on determinants of adaptive capacity among smallholder farmers. Adapting to climate change effects requires resources and always resources are gendered and not engendered. Nabikolo *et al.* (2012) conducted a research on Determinants of Climate Change Adaptation among Male and Female Headed Farm Households in Eastern Uganda. However, every individual within the household face different vulnerability and have different adaptive capacity (Denton, 2002). For example in male headed household women may face time constraints resulted from their heavier burdens of household tasks. Also Blackden and Wodon (2006) found that, women in African continent have lower levels of education which also might be a factor limiting their adaptive capacity.

Several organizations also have conducted research on the African continent on climate change and adaptation among smallholder farmers. This includes IFPRI Discussion Paper. For example Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa (2007). Mapping the South African Farming Sector's Vulnerability to Climate Change and Variability: A Sub-national Assessment (2009). Micro-level Practices to Adapt to Climate Change for African Small-scale Farmers: A Review of Selected Literature (2010). Analyzing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia (2008). However many of these studies were conducted in South Africa and other countries in particular, indicating that climate change research is very elementary in other African countries.

2.4.3 Research in Tanzania

Several climate change studies have been carried out in Tanzania. Major studies include the study on Climate Change Financing and Aid Effectiveness Tanzania Case Study by (Davies and Thornton (2011), The Cost of Climate Change in Tanzania: Impacts and Adaptations by (Omambia and Gu, 2010), The Economics of Climate Change in the United Republic of Tanzania by (Okanda and Mwangoka, 2011), The dynamics of vulnerability: Locating Coping Strategies in Kenya and Tanzania by (Eriksen, Brown and Kelly, 2005), Livelihoods, Vulnerability and Adaptation to Climate Change in Morogoro Region by (Paavola, 2004).

Other studies conducted in Tanzania with focus on climate change and adaptation includes the study by Dungumaro and Hyden (2010), Challenges and opportunities to climate change adaptation and sustainable development among Tanzanian Rural Communities. Understanding Household Coping Strategies in Semi-arid areas Tanzania: Household Livelihoods Strategies in Semi-arid Tanzania (Morris *et al.,* 2009), Vulnerability and Adaptive Strategies to the Impacts of Climate Change and Variability, the Case of Rural Households in Semi-arid Tanzania (Lyimo and Kangarawe, 2010) Sustainable livelihood in the context of vulnerability and adaptation to climate change impacts in Tanzania a case of Kilimanjaro region (Meena and O‘Keefe, 2007). However these studies lack important components of gender and determinants of adaptation among gender.

Moreover another study which has incorporated gender issues includes the study by Meena and Sharif, (2008) on Gender, Poverty and Food Security in Relation to Climate Change Impact and Adaptation, a case of Kilimanjaro Region. Swai, Mbwambo and Magayane, (2012) also have conducted research on Gender and Adaptation Practices to the effects of Climate Change in Bahi District, Dodoma Region. Another research is on

Resilience, power, culture, and climate: a case study from semi-arid Tanzania, and new research directions (Nelson and Stathers 2009). Still these studies do not incorporate determinants of adaptive capacity between men and women.

Lastly the NAPA (2007) identifies immediate short-term priorities that could be addressed for adaptation to climate change effects and ranks sectors according to priority. Gender issues and determinants of adaptation to climate change effects were not analyzed.

It is visible from these and related studies that, farmers across the world and in Tanzania have developed forms of adaptation to take advantage or to endure negative effects to climate change. However, the ability to adapt varies from different communities and individuals within a given community. This implies that farmers' capacity to adapt i.e. adaptive capacity is influenced by certain factors. This study therefore looks into these factors and provides answers to research questions presented in chapter one and a theoretical framework presented in the next section.

2.5 Theoretical Framework

2.5.1 Adaptive capacity

The main component of vulnerability is adaptive capacity. Adaptive capacity is context specific and it varies between communities, individuals, age groups and gender (Adger, 2000; Adger and Vincent, 2005; Pelling and High, 2005; Berkes and Seixas, 2006; Marshall and Marshall, 2007; Vincent, 2007; Nelson *et al*., 2009a; Cinner *et al*., 2009c and Nielsen and Reenberg, 2010). Studies show that, adaptive capacity is shaped by social and cultural norms and values (Pelling, 2005; Pelling and High, 2008; Adger *et al*, 2009; Coulthard, 2008 and Deressa *et al*, 2009 Nielsen and Reenberg, 2010). In all societies

gender is an integral part of the social and cultural norms and values yet literature on how adaptive capacity influenced by gender is limited (Röhr, 2007).

In order to understand how adaptive capacity is influenced between genders and/or among different socioeconomic groups at national or local level, it is important to explain its determinants (Jones *et al.,* 2010). Unfortunately, understandings of adaptive capacity are still very much in their infancy (Vincent, 2007), and there is no agreement about its determinants at national, community or household level (Jones *et al.,* 2010). Studies identify what determines the adaptive capacity of a system particularly what types of physical or social drivers play a role (Smit and Pilifosova, 2001:895 Adger *et al.*, 2004).

The IPCC identifies economic wealth, technology, information and skills, infrastructure, institutions and equity as the principal determinants of adaptive capacity (IPCC, 2001), but as explained above by Jones *et al.* (2010) no distinction is made between determinants at national and local level. Much of the focus in assessments of adaptive capacity has been at the national level (Jones *et al.,* 2010). In addition communities with limited access to resources and entitlement, poor knowledge and skills and, unstable or weak institutions might have little capacity to adapt and are highly vulnerable (McCarthy *et al.*, 2001). In this case, adaptive capacity determines community vulnerability, and in effect serves as the link between adaptation and vulnerability. Therefore, in theory a society with high adaptive capacity experiences successful adaptation and low vulnerability to climate change which in turn will lead to better livelihood. However, the mere existence of adaptive capacity is not a guarantee that it will be used. Similarly, little empirical research has considered whether a community is able to adapt without availability of or access to resources, knowledge and skills and on institutions and what the consequences of such a situation would be for the long term sustainability of the adaptation measure in question.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

The study was conducted in two districts: Meatu and Iramba Districts in Simiyu and Singida regions. Meatu District is one of the semi-arid areas of Tanzania. It lies between latitudes 3°-4° S and longitudes 34°-35° E, south of Lake Victoria and its altitude ranges between 1000-1500 m above sea level. Based on the 2012 Tanzania National Census, the population of Meatu District was 248949, out this males were 119,721. The economy of the district depends mainly on rain-fed agricultural production. Food crops grown include maize, sorghum, paddy, sweet potatoes, cassava, pulses and groundnuts. Cotton is Meatu's major cash crop. Iramba District, the other study area is found in Singida Region in central Tanzania. It is bordered by Meatu District North, Igunga District West, Singida District South East, Hanang and Mbulu Districts East and Iringa District South. The population of the district is 367,036; out of this 178,297 are males (URT, 2013). The District has a total land area of 7,900 km^2. The main staple crops include bulrush millet, sorghum and maize. Other activities include mining (gold at Misigiri village), processing industries (sun flower oil). Generally, livelihoods in Singida, Iramba included are very dependent on the climate.

Meatu and Iramba Districts were selected because the two Districts fall within the semi-arid areas of Tanzania where there are frequent uncertainty of food shortage due to climate variability such as floods and drought. According to URT (2005), the 2000/01 household survey, the districts fell within regions with the worst assessment of food poverty. Second the area provides an opportunity to understand impacts of climate change and variability on crops and livestock. Third it is within the project area known as "A gendered analysis

of climate variability impacts and adaptation in Semi-arid area farming systems and natural resources management in Meatu and Iramba Districts, Tanzania.

3.2 Research Design

This study used a cross-sectional research design. Unlike retrospective and longitudinal research designs, cross-sectional research design allows data to be collected at one point in time (Bernard, 2006) cited by Mbwambo (2007). The design also has greater degree of accuracy in social science studies than other design (Casley and Kumar, 1998). The design employs a survey method. This can be used to establish relationship between variables for the purposes of testing hypothesis and is feasible as it uses minimum time and resources. The limited time justifies the use of the selected design.

3.3 Data Collection Methods

The study aimed to collect information from 120 respondents. It also intended to gather data from 60 men and 60 women in order to get the gender balance information concerning climate change and adaptive capacity. Qualitative and quantitative data were obtained from both men and women aged 17-86 years. Both men and women were interviewed by the researcher and research assistant was used to translate words from Kiswahili to the local language to some of the interviewee who were not very familiar with Kiswahili. This helped to obtain reliable data and it avoided loss of crucial information concerning climate change and adaptive capacity from both men and women's view. For primary data, the researcher passed through the sampled households interviewing the respondents in their homes. Secondary data were obtained by consulting different Iramba and Meatu district profile, regional profile, the internet and the TMA.

3.3.1 Qualitative data collection method

3.3.1.1 Focus group discussion

In order to capture enough information related to gendered analysis of the determinants of adaptive capacity to climate change impacts among smallholder farmers in the study area the FGDs were adopted. There were two FGDs in each village; each group comprises 8-12 participants aged 32-69 years. One group was for men and the other was for women to allow full participation.

3.3.1.2 Key informants

Several key informants participated in the research. These include two district officials in Meatu and Iramba, two village leader in Meatu and one in Iramba, two VEOs in Meatu and one in Iramba, 10 hamlet chair persons in Meatu and 6 in Iramba, two village agricultural officers in Meatu and one in Iramba, and Shinyanga and Singida Meteorological officers. Each one of these had a role to play in providing relevant information which was crucial in this study. For example, the district officials played a key role in providing introduction letter to the village leader to introduce the researcher. Village leaders and hamlet chair persons participated in FGDs and in provision of names of each household in each village and hamlet which was ultimately used in household sampling selection. Shinyanga and Singida Meteorological officials assisted the researcher in getting climate change data. All key informants were purposively selected depending on their position and profession.

3.3.1.3 Observation

Two general forms of observation were included in this study. The first was participant observation. This form of observation requires a significant investment of time and resources in a particular location. According to Meena and O'Keefe (2007), participant

observation is an attempt to ingratiate oneself within a particular society and comprehend existence from their perspective. For this to transpire, a level of reciprocal trust is necessary between the researched and the researcher. Consequentially, the focus of observation is often on the dynamics of socio-economic and cultural interaction as opposed to physical processes that can be identified (Carvalho and White, 1997). Structured observation is more suitable for fieldwork that occurs on a shorter timescale. It is usually undertaken through the creation of a pre-determined checklist of physical characteristics that require analysis. This form of observational technique was the basis for the research; a checklist was used to assemble information needed alongside notes made in the researcher's field diary.

3.3.2 Quantitative data collection methods

Questionnaire survey was employed to collect quantitative data from men and women. Specific techniques were used for each specific objective.

3.3.2.1 Data collection for objective one

Objective one focused on analyzing community perception to climate change in the study area. A five point Likert scale technique was used to measure community perception to climate change. A Likert scale comprised statements with positive and negative responses. The important question asked was how do men and women perceive climate change and adaptive capacity in the study area. The researcher met respondents in their households and asked them to number of statements formulated and respondent state whether he/she was strongly agreed, agreed undecided, disagreed and/or strongly disagreed.

3.3.2.2 Data collection for objective two

Objective two focused on analyzing adaptation practices developed and used by men and women smallholder farmers for their livelihood. The important questions asked to this

objective were what adaptation practiced was developed and used by men and women and why do they use them for their livelihood. Structured interview using close and open ended questions were applied. Questions focused on investigating how men and women respond to the effects brought about by climate change in the study area.

3.3.2.3 Data collection for objective three

Objective three focused on examining elements of adaptive capacity including institutions and knowledge of men and women in the study area. The study focused on investigating whether there was existence of institutions, governmental and non- governmental to enhance the capacity of men and women in adapting to the effects of climate change education inclusive. The important question asked to this objective was: what were the elements of adaptive capacity. A combination of structured interview and FGD was employed to capture information for objective number three.

3.3.2.4 Data collection for objective four

Objective four focused on determining factors responsible for adaptive capacity of men and women in the study area. The important question asked to this objective was: what were the factors responsible for adaptive capacity of men and women in the study area? The questions focused mainly on specific five livelihood capitals stated in the conceptual framework (Fig. 1) of this study as proxies for adaptive capacity. These capitals are human, social, natural, physical and financial capital

3.4 Unit of Data Collection and Analysis

This study used a household as a unit of data collection, in this case the selected individual were unit of sampling. A household in this study was defined as a social group which resides in the same place, share the same meal and make joint or coordinated decisions

over resources allocation and income pooling (Mbwambo, 2007). The choice of a household as a unit of data collection and analysis was based on the fact that household decisions were centered on a household under the leadership of household head. Therefore, head of household was selected for the study.

3.5 Sampling Strategy

3.5.1 Sampling strategy for FGD

In order to capture liable information related to determinants of adaptive capacity to climate change effects among smallholder farmers' men and women were selected for FGDs. The study conducted two FGDs in each village, one for men and the other for women. Each FGD had 8-12 participants selected from the village registers by the researcher by assistance of VEOs and hamlet chair persons. In order to reduce bias in selecting the participants a random sampling method was employed.

3.5.2 Sampling strategy for survey questions

In order to obtain the desired sample, multi-stage technique was employed to get the households from the villages. According to IDRC (2003) this technique is useful in large and diverse population. Two villages in Meatu District and one village in Iramba District were selected using purposive sampling. Forty households were selected from each village to make a total of 120 households from three villages. These were randomly drawn from the list of households from each village register.

3.6 Data Analysis Methods

Prior to analysis, qualitative data were processed, categorized, summarized and presented in a tabular form. Common and agreed points or views by all discussants from the FGDs were listed in point form, summarized, and coded to resemble to quantitative data to

facilitate analysis as it is stated by Hardon *et al*. (1994). Quantitative data were verified, coded and transferred to the computer code sheet for process, frequency and percentage. This involved computer data entry, using Statistical Packages for Social Science (SPSS) 16.0 programme, followed by data editing and cleaning.

3.6.1 Analysis of qualitative data

The qualitative data were recorded and summaries were made by a note taker and used in the analysis. The analysis relied much on the direct information given by the respondents according to the theme used during the discussion. It is, however, important to note that in most cases the analysis used the summaries and occasionally original statements have been included to obtain imminent of the respondent to some issues.

3.6.2 Analysis of quantitative data

Quantitative data was summarized coded and then analyzed using the Statistical Data Package for Social sciences (SPSS v.16.0). Descriptive statistics were used to analyze quantitative data and results were presented as frequencies, percentages, averages, maximum and minimum values of individual variables.

3.6.2.1 Farmers' perception on climate change

The first objective aimed to explore farmers' perception on climate change. This was analyzed using Likert scale. Likert scale was constructed consisting of seven statements. A five level scale of strongly agree, agree, undecided, disagree and strongly disagree were employed to measure perception. Descriptive statistics was used to analyze farmers' perception on climate change.

3.6.2.2 Agricultural practices and climate change

Cross tabulation and descriptive statistics was used to analyze different agricultural practices adopted by farmers in the study area. This type of analysis was used to test how community members altered their farming practices as a result of changes in rainfall and drought effects on crop production. Cross tabulation was also used to explore different IK used in the study areas and how they vary across villages. It was also aimed to capture objective two of this study.

3.7 Determination of Adaptive Capacity

In measuring adaptive capacity, this study adopts the method suggested by Nelson *et al.*, (2010), where, adaptive capacity is measured in the form of high, moderate and low. Nelson *et al* used the rural livelihoods framework developed by Ellis (2000) to conceptualize adaptive capacity as an emergent property of the diversity of assets and activities from which rural livelihoods are derived, and the flexibility to substitute between these assets and activities in response to external pressures (Ellis, 2000 in Nelson *et al.*, 2010). Human, social, natural, physical and financial capital are continuously invented, accessed and substituted in the process of generating livelihoods (Fig. 1). Reflecting its entitlements heritage, the rural livelihoods framework recognizes that the transformation of capital into livelihoods is mediated by multiple interacting of transforming structures. These can be partially incorporated into a capital substitution framework by expanding the notion of social capital used in the framework (Ibid).

Rural livelihoods analysis is based on the idea that farm households with a greater diversity of livelihood assets and activities are likely to have greater adaptive capacity because of a greater capacity to substitute between alternative livelihoods strategies in times of stress (Nelson *et al.,* 2010). The contribution of diversification and substitution to

adaptive capacity is particularly strong when non-farm sources of income less directly affected by climate are available. Livelihood diversification transcends on-farm activities, and complements economic specialization. Diversification at a household level often complements economic specialization within a household, and economic specialization in any one set of activities can facilitate investment in other forms of capital from which future livelihoods can be derived (Ellis 2000 in Nelson *at al.*, 2010). Rural livelihoods analysis provides a cross-sectional view of the potential adaptive capacity of rural households (Holling *et al.*, 2002).

As it is described by Nelson *et al.* (2010) the application of principal component analysis (PCA) was used in the construction of an adaptive capacity index based on rural livelihoods analysis. Table 2 shows assets and indicators used in measuring adaptive capacity index. Both qualitative and quantitative indicators were used in construction of the index.

Table : Measuring adaptive capacity of men and women smallholder farmers

Asset	Variable	Description	Indicator
Human	• On-farm labour • Education level	• Number of people working on farm • Years of education	• Number of household members working on farm • Years of education
Natural	• Land	• Amount of land owned by a household measured in terms of acres/plots	• Land owned in acres/plots
	• Portable water quality	• Household access to safe and clean water	• Yes/No
Financial	• Formal/informal credit	• Individuals access to formal /informal credit	• Yes/No
	• Income	• Mean total cash income of a household	• Amount in Tshs
	• Remittance	• Whether the household receives remittances from outside relatives	• Yes/No
Physical	• Health services	• Distance moved to access health services	• Distance in km
	• Transport	• Distance moved to go to the main road	• Distance in km
	• Communication	• Access to Radio/mobile phone	• Yes/No
	• Equipments for production	• Availability/access to ox-plough/oxen cart	• Yes/No • Yes/No
	• Livestock	• Individual ownership/access to livestock	
Social	• Formal/informal groups	• Individual access to formal/informal groups	• Yes/No
	• Social cohesion	• Individual participation in social events	• Yes/No
	• Decision making	• Individual participation in decision making	• Yes/No
	• Traditional rules	• Existence of traditional rules to govern equitable distribution of resources	• Yes/No

Source: Adopted and modified from Nelson *et al.*, 2010

The PCA identifies items that tap the same concept as well as creating a smaller number of factors that co-vary. The components which show a reasonable proportion of overall variance are usually extracted for subsequent use of other statistical analysis (Norusis, 2008). PCA involves several steps. The first step is to identify the variables for PCA.

The second step is extraction of components being analyzed and the first component is expected to count for a fairly large amount of the total variance. The third step is to determine number of meaningful components to retain for interpretation mostly known as the Kaiser criterion. The fourth step is the scree test of the eigenvalues associated with each component. The last step is to find the proportional of that accounts for a specified proportion (percentage) of variance in the data set. This is given by:

$$\text{Proportion} = \frac{\text{Eigenvalues for the component of interest}}{\text{Total eigenvalues of the correlation matrix}}$$

Usually the results for the percentage of variance are provided during data analysis. Below is the formula for PCA to compute scores for every indicator used in the analysis:

$$C_1 = b_{11}(X_1) + b_{12}(X_2) + \ldots b_{1p}(X_p) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where	C_1	the subject's score on principal component 1 (the first component extracted)
	b_{1p}	the regression coefficient (or weight) for observed variable p, as used in creating principal component 1
	X_p	the subject's score on observed variable p.

On the other hand PCA was also used to construct asset index for measuring household income. The steps involved in here were as follows: The first step is to identify the variables for PCA. The second step is to develop a correlation matrix in order to determine whether the variables are significantly correlated with each other. The third step is to select the variables by obtaining a factor loading index for each of the variables. The index obtained shows which items are highly correlated to the factors. Usually variables that load highly are selected while those load weakly are dropped. The fourth step involves the construction of new variables. The results of PCA are usually used to construct weighted

factor based scale. The factor loadings obtained are multiplied by the individual score for each corresponding variable (Mwageni, 1996). Below were the formula used to get the estimates

$Aj=f_1x\ (a_{ji}–a_1)/s_1+…+f_Nx(fa_{Jn}-a_N)/s_N$.....(2)

Where:	Aj	Asset index value
	f_I	Scoring factor or weights factors for the i^{th} item
	X	The variable (asset or service)
	a_{ji}	The value of the i^{th} asset (or service) the household owns or value of the i^{th} housing materials
	a_1	Mean of assets (or service) or mean of housing materials
	S_i	Standard deviation of assets (or service)

3.8 Multinomial Logit Model (MLM) Specification

Multinomial Logistic regressions model was employed in the analysis of objective four on determination of factors responsible for adaptive capacity. This model was used because it classifies subjects based on values of a set of predictor variables. This type of regression is similar to logistic regression, but it is more general because the dependent variable is not restricted to two categories (Bayaga, 2010). Thus, it has alternative data distribution assumptions, suggesting that it generates more appropriate and correct findings in terms of model fit and correctness of the analysis. A multinomial logistic regression model is a form of regression where the outcome variable dependent variable is binary or dichotomous and the independents are continuous variables, categorical variables, or both. The capacity of individual to adapt to respective climatic change option depends on various factors existing at different levels that comprise more than two categories (Manski, 1977):

$$\boldsymbol{AC_{in} = V_{in} + \varepsilon_{in}} \text{ …….....……..... (3)}$$

Where; AC_{in} is the *Adaptive Capacity* derived by the n^{th} individual from different available alternative *i*, V_{in} is the systematic (deterministic) component of all factors and *in* is the random/stochastic part of factor. The deterministic component of factors can be expressed as:

$$\boldsymbol{V_{in} = X_{in}\beta} \quad \text{..... (4)}$$

Where; *X* is a vector of observable attributes and β are unobservable parameters estimated. The probability that individual *n* chooses alternative *i* from the choice set is given by [McFadden, 1973]:

$$\boldsymbol{Pr\ [in]} = \frac{\exp(\mu V_{in})}{\sum_{j=C} \exp(\mu V_{jn})} \quad \text{..... (5)}$$

The scale factor μ is assumed to equal 1 so that the β's can be identified. As μ tends to be zero, the probability of choosing the alternative with the highest predicted utility approaches 1. With a normalised scale factor (equation 5), the MNL (conditional on alternative *i* being chosen by respondent *n*) becomes a conditional logit model:

$$\boldsymbol{Pr\ [in]} = \frac{\exp(X_{in}\beta)}{\sum_{j=C} \exp(X_{jn}\beta)} \quad \text{..... (6)}$$

The dependent variable is adaptive capacity measured in terms of high, moderate and low. The independent variables are age of household head, sex, education level, household size, household labour, household asset, household income, farm size and farm ownership.

Limitation of the study

The conclusions drawn from this study are strictly applicable to Meatu and Iramba District because of unique physical characteristics and historical background. However, the study gives clue of what could be happen during data collection. The study expected to interview 120 respondents, 60 me and 60 women from both study areas. However, it was hard to balance them because in some households women were not found as they were already gone to *shamba* or to do other household activities like fetching water and/or cleaning clothes to the river. Therefore the study interviewed 63 men and 57 women.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Main Socio-economic Characteristics

The main socio-economic characteristics and activities of respondents in Meatu and Iramba District are presented in the sub-sections below.

4.1.1 Sex of respondents

Table 3 presents sex of respondents in three villages of the study. Sex of respondents is an important parameter in determining capacity of individuals within the household to cope with the consequences of climate change. This is particularly important because all decisions within the household are centered on the head of that household. Data shows that 68.3% of the households were headed by men whereas 31.7% of households were headed by women. FGDs conducted in Mwamanimba and Mwashata villages revealed that although women were major producers, they were not allowed to decide on major farm issues and even other properties owned by the household unless they were the heads of the household.

Table : Sex of respondents (n=120)

Village of Residence	**Sex of respondents**			
	M	**%**	**F**	**%**
Mwamanimba	20	31.7	20	35.1
Mwashata	21	33.3	19	33.3
Kidaru	22	34.9	18	31.6
Total	**63**	**100.0**	**57**	**100.0**

4.1.2 Age and age categories of respondents

Results show that the overall mean age of respondents in Meatu and Iramba was 45.88 which are associated with the standard deviation of 12.6 respectively. The maximum and minimum age for both Meatu and Iramba was 86 and 17 years respectively. During discussion with respondents it was revealed that the elderly, above 50 years of age understands more changes of climate depending on years as they were capable of

mentioning the changes starting from 1970's and the way they adapted to it using their own indigenous knowledge and by getting support from the government. For example 1974/75 respondents said that they received aid from the government. From this point it was understood that age was an important parameter in determining the ability of individuals to adapt to the effects brought about by climate change. This is because adaptive capacity involves indigenous knowledge which is learnt and used with age.

Table : Age categories of respondents in Iramba and Meatu (n=120)

Age Categories	Iramba					Meatu					Grand Total
	M	%	F	%	Total	M	%	F	%	Total	
< 25 years	1	50.0	1	50.0	50.0	0	0.0	2	100.0	50.0	**4**
25-35 years	6	54.5	5	45.5	52.4	5	50.0	5	50.0	47.6	**21**
36-50 years	10	52.6	9	47.4	33.3	17	44.7	21	55.3	66.7	**57**
>50 years	5	62.5	3	37.5	21.1	19	63.3	11	36.7	78.9	**38**
Total	**22**	**55.0**	**18**	**45.0**	**33.3**	**41**	**51.3**	**39**	**48.7**	**66.7**	**120**

Note: M= Male, F = Female

Table 4 presents data on age categories in Iramba and Meatu. Data shows that the minimum age of women respondents in Iramba was 17 years of age and the maximum age was 63 years of age. The mean age was 40.67 which are associated with the standard deviation of 11.24068 respectively. The minimum age of men respondents in Iramba was 22 years of age and the maximum age was 78 years of age. The mean and standard deviation was 43.4545 and 14.3086 respectively. Table 3 above presents the percentage of age categories of respondents.

Data shows that, the minimum age for women in Meatu was 20 years old and the maximum age was 70 years old. Data also indicate that the mean age of women in Meatu was 45.1538 which are associated with the standard deviation of 11.28002 respectively. Data in Table 4 shows that the minimum age for men in Meatu was 27 years old and the

maximum age was 86 years of age. The mean age was 50.1463 which are associated with the standard deviation of 12.46908 respectively.

Data in Table 4 shows that 50% of women in Iramba aged < 25 years were interviewed during the study. This was followed by 47.4%aged 36-50years, 45.5% aged 25-35 years and above 50 years were 37.5res% respectively. Table 4 also shows that, interviewed men above 50 years were 62.5% followed by 54.5% aged 25-35 years, 52% at the age of 36-50 years, and. The study also was capable of including men below 25 years by 50%respectively.

Table 4 shows that women respondents in Meatu < 25 years were 100%, 55.3% at the age of 36-50 years followed by 50% aged 25-35 years and above 50 years were 36.7% only. Table 4 shows that men above 50 years were interviewed by 63.3% followed by 25-35 years who were 50% and 44.7% aged 36-50 years respectively. Data shows that below 25 years old of men were not included in the study.

4.1.3 Marital status of respondents

Table 5 presents data on marital status of respondents in Iramba and Meatu. Data shows that majority men in Iramba 72.4% were married and only 50% were never married. On the other only 27.6% women in Iramba were married, 100% were widow and 50% were never married. The study also found that there was no divorced woman. Although both married men and women in the study area claimed to share power and control over assets within the household, observation showed that single woman households have more power over access and control over household assets compared to married women.

Data also shows that majority men 62.9% in Meatu were married and only 12.5% were widow. On the other hand Table 5 also shows that married women in Meatu were only 37.1%, and majority women in Meatu 87.5% were widow while divorced women were 100% respectively. During household visit the study revealed that divorced women in the study area face constraints in terms of adapting to climate change. For example one of the women in the study area claimed of having no land for cultivation after being divorced while the other was depending on her family to get access to land. Concomitantly this reduced their capacity of adapting to the effects of climate change.

Table : Marital status of respondents in Iramba and Meatu (n=120)

Marital Status	**Iramba**					**Meatu**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Married	21	72.4	8	27.6	31.9	39	62.9	23	37.1	68.1	**91**
Widow	0	0.0	9	100.0	36.0	2	12.5	14	87.5	64.0	**25**
Divorced	0	0.0	0	0.0	0.0	0	0.0	2	100.0	100.0	**2**
Never Married	1	50.0	1	50.0	100.0	0	0.0	0	0.0	0.0	**2**
Total	**22**	**55.0**	**18**	**45.0**	**33.3**	**41**	**51.2**	**39**	**48.8**	**66.7**	**120**

Note: M= Male, F = Female

Marital status of respondents was an important parameter in understanding individual's capacity to cope with the effects brought about by climate change. For example a married woman gets access to land through their husband but when she gets a divorce she gets herself have no longer access to the same land in steady through hiring or buying which might reduce her capacity of adapting. This is also different from a woman who is widow. Although, Meena and Sharif (2008) argued that, households with single women as the head can potentially face even a higher risk of poverty because of the cultural and social stigmas attached to their marital status. For instance, a widow or a divorcee does not participate in many social functions and festivals because people perceive her presence as inauspicious (ibid). During household visit it was observed that, most of widow women

who also were household heads have full power on the control over household assets while during the interview with married women respondents said that they only have control over plates and chicken within the household.

The study assumed that every individual member in the community is affected differently by the impacts of climate change. Therefore Table 5 involved different respondents depending on their age and marital status in order to get their views on how adaptations are taking place among different groups of people.

4.1.4 Education of respondents

Education is an important tool in dissemination of information and diffusion of new extension innovation among farmers in general. Data shows that the mean and standard deviation of education for Meatu and Iramba were 1.833 and 0.41674 respectively. Table 6 presents data on level of education acquired by men and women in Iramba and Meatu. Data in Table 6 shows that the mean and standard deviation for men in Iramba were 2.0455 and 0.21320 respectively. On the other side the mean of women in Iramba were 2.0000 and Standard deviation were 0.00000 respectively. Data in Table 6 shows that the mean and standard deviation of men in Meatu were 1.8537 and 0.35784 respectively. On the other hand the mean and standard deviation of women in Meatu were 1.6154 and 0.54364 respectively

Table : Education of respondents in Iramba and Meatu (n=120)

Education	**Iramba**					**Meatu**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
No formal	0	0.0	0	0.0	0.0	6	27.3	16	72.7	100.0	**22**
Primary	21	53.8	18	46.2	40.6	35	61.4	22	38.6	59.4	**96**
Secondary	1	100.0	0	0.0	50.0	0	0.0	1	100.0	50.0	**2**
Total	**22**	**55.0**	**18**	**45.0**	**33.3**	**41**	**51.3**	**39**	**48.7**	**66.7**	**120**

Note: M= Male, F = Female

Data in Table 6 shows that majority men and women in Iramba 53.8% and 46.2% in the study area had primary education. Data also shows that 100% men have secondary education. Table 6 also shows that majority men 61.4% in Meatu have primary education while majority women 72.7% have not attended in school.

4.1.5 Main occupation of respondents

Main occupation of respondents is important in determining major economic activities done in the study area. Data shows that the overall mean and standard deviation for main occupation are 2.3250 and 0.96286 respectively.

Table : Main occupation of respondents in Iramba and Meatu (n=120)

Main occupation	**Iramba**					**Meatu**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Farming	16	47.1	18	52.9	32.4	32	45.1	39	54.9	67.6	**105**
Livestock Keeper	14	87.5	2	12.5	25.4	39	83.0	8	17.0	74.6	**63**
Governmen t worker	0	0.0	0	0.0	0.0	0	0.0	1	100.0	100.0	**1**
Total	**30**	**60.0**	**20**	**40.0**	**29.6**	**71**	**59.7**	**48**	**40.3**	**70.4**	**169**

NB: Multiple Responses, Note: M= Male, F = Female

Data shows that only 47.1% of men in Iramba were doing farming activities and more than half 52.9% women were also doing the same activity. On the other side 87.5% of men in Iramba were livestock keepers while the percentage of women livestock keepers were only 12.5% respectively.

Data in Table 7 also shows that 45.1% and 54.9% women were doing farming activities. Data shows that 83.0% of men were livestock keepers. On the other hand women with livestock were only17.0% comparing to men, women were more doing farming activities.

During in-depth interview with respondents in the study area, it was observed that in male headed households all livestock belong to a household head. Women within those households had no say over livestock. When asked whether they share controls women said that *"ng'ombe ni za mzee"means cows belongs to household head.* Ramaprasad (2009) argued that, Women bear the burden of household chores that result in time and mobility constraints compared to male-head. The implication of this is that majority of female headed households are poorer and have low adaptive capacity as compared to male headed households. Data also shows 2.1% women were government worker e.g. a teacher.

These results show that farming is the source of livelihood of women in rural area. With the changing climate women can find themselves at stake of low adaptive capacity during hard times of the year.

4.1.6 Household income

Table 8 gives the mean and standard deviations for assets used in measuring incomes of men and women in Meatu and Iramba Districts. Income in this study is defined by referring to assets owned and controlled by individuals within the household. URT (2006) argue that the ownership of household items may be taken as appropriate measures of household wealth. In this study asset ownership defines the wealth of men and women in the study areas for the purpose of developing the relationship between gender and adaptive capacity.

Table : Mean and Standard deviation of assets owned in the household (n=120)

Asset	Mean	Standard deviation
Land	2.22	1.42
Iron sheet house	2.23	1.35
Thatched house	2.03	0.98
Livestock	3.88	1.19
Plough	2.03	1.30

Oxen cart	3.59	1.14
Motorcycle	3.22	1.53
Bicycle	2.33	1.67
Radio	2.79	1.52
Mobile pone	2.27	1.45
Milling machine	2.65	1.39
Car	1.73	1.01
Local chicken	1.47	0.87
Plates	2.40	1.18

The study expected that respondents would be reluctant in mentioning their real annual income due to difficulty in remembering their income as a result of lack of record keeping experienced in most people. Thus, PCA method, through equation 3 clearly stated in section 3.9 of chapter three clearly states the formula used to calculate asset index. Below is the application of the formula.

$Aj=f_1x\ (aji-a_1)/s_1+\ldots+f_Nx(fa_{Jn}-a_N)/s_N$:

Aj1= 0.24 * land * (1-2.22)/1.42 + (-0.03) * iron sheet house *(2-2.23)/1.35 + (-0.30) * thatched grass house* (3-2.03)/0.98 + 0.19 * livestock * (4-3.88)/1.19 + 0.14 * plough* (5-2.03)/1.30 + 0.30 *oxen cart* (6-3.59)/1.15+ 0.55 * motorcycle * (7-3.22)/1.53 + 0.77 * bicycle * (8-2.33)/1.67 + 0.71 * radio * (9-2.79)/1.52+ 0.57 * mobile phone * (10-2.27)/1.45 + 0.21 * milling machine * (11-2.65)/1.39+ 0.20 * car * +(-0.01) * hand hoe * (12-2.63)/1.30 + 0.42 * local chicken* (13-1.47)/0.87+ 0.34 * plates * (14-2.40)/1.18 = -0.24 to 22.4

The index ranges between -0.24 to 28.5 these were categorized at three levels of income that is, high/low and moderate.

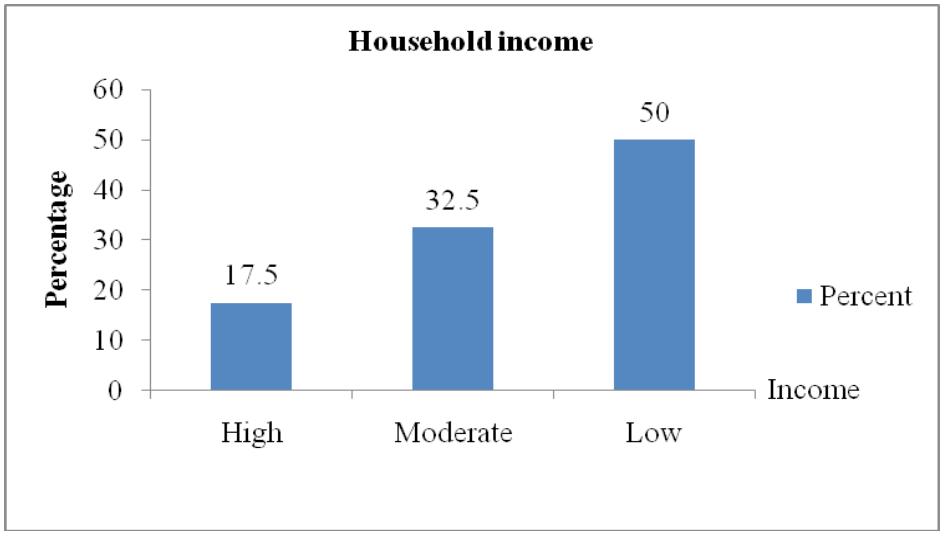

Figure : Household income

Data in Fig 2 show that 50% of respondents in Meatu and Iramba were at low level of income, 32.5% moderate and only 17.5% at high level.

4.1.7 Amount of land owned by the household

4.1.7.1 Amount of land owned by the household in Meatu district

Land is an important component in analyzing adaptive capacity of smallholder farmers to the effects brought about by climate change through observing the gender aspects of land ownership. It is also important to look into land accessibility in terms of hiring. Table 9 presents data on land ownership in Meatu in categories. Land in Meatu is owned in terms of acres. Data shows that majority respondent in Meatu own land of <5 acres whereby the minimum amount of land owned by farmers in Meatu District was 0 and the maximum amount was 1000 acres. The mean and standard deviation for land ownership was 60.6375 and 156.465 respectively.

Table : Land ownership in Meatu (n=120)

Amount of land in acres	Sex of Respondent			
	Male	**%**	**Female**	**%**
<5	21	51.2	23	59.0
6-10	3	7.3	7	17.9
11-15	0	0.0	0	0.0
16-20	1	2.4	1	2.6
21-25	1	2.4	1	2.6
>25	15	36.6	7	17.9
Total	**41**	**100.0**	**39**	**100.0**

From Table 9 data shows that there was high number of women who do not own land 30.8% as compared to men 24.4%. During FGD it was revealed that higher proportion of single women own land compared to married women. The focus groups also revealed that this was because when women get married, any former land ownership reverts to their male relatives. This was also supported by Meena and Sharif (2008) a woman move to her husband's land after marriage, and is seen as having less need for her own land since she must depend on her husband, so land reverts to male relatives since ownership must stay in the family. A similar situation exists for divorced women. When a woman is married, she gets access to her husband's land, but when she get divorced immediately she lose access to this land and have to rely on her parents if they are alive. Therefore women who gets divorcee also have very little access to land, having to rely on others to provide for them and hence have low adaptive capacity too.

Data from Table 9 also shows that 36.6 % of men own land bigger than 25 acres and only 17.9% of women own the same amount of land. Data from the Table also indicates that 28.2% of women and 26.8% of men own land ranging from 1-5 acres which is very small amount of land because having large land size in the study area was important because land is used for farming and as grazing areas (*Ngitiri*[1]). Participants in FGD said that this was due to population increase which leads to high demand of land. Field data was also

1 Indigenous natural resource management system which involves conservation of fallow and rangeland through vegetation regeneration and controlled livestock grazing for use in the dry season in response to acute animal feed shortage.

supported by Ndungumaro and Hyde (2010), who argued that population increase in developing countries Tanzania inclusive significantly impact on the ability to adapt to climate change. The population of Tanzania has continued to be primarily rural despite the fact that the proportion of urban residents has been increasing over time (URT, 2013). In Tanzania the rural population segment depend heavily on agriculture, animal husbandry, forestry and fishery to support livelihood (Ndungumaro and Hyde, 2010). All of these activities are dependent on the climate hence render the rural community at risk of climate change effects. Key informants also revealed that small land size was caused by selling during time of hunger whereby the household head can decide to sell some part of the land and use the money for buying food.

4.1.7.2 Amount of land owned by the household in Iramba District

The study found that land in Iramba was owned in terms of plots whereby the minimum land owned was 0 plots and the maximum was 30 plots. The mean for land ownership was 6.5 which is associated with the standard deviation of 6.9945 respectively. Table 10 shows that, when there were 22.2% of women who do not own land men were 9.1% only. Data also shows that half percentage of men own land which exceeded 10 plots and women who own the same amount of land was 16.7% only.

Table : Land ownership in Iramba (n=120)

	sex of respondent			
Amount of land in plots	**M**	**%**	**F**	**%**
<3 plots	4	18.2	8	44.4
4-6 plots	4	18.2	4	22.2
7-9 plots	3	13.6	3	16.7
10+ plots	11	50.0	3	16.7
Total	**22**	**100.0**	**18**	**100.0**

During FGD with women only, results indicated that both men and women have access and control to most resources and that most decisions are done jointly. However during in-depth discussion with key informants it was found that men were main controller of land and have more influences on decision made within the household especially for households headed by men. FGD and key informant discussion results indicated that, men are the ones who decide where and what to grow and women have rights to use on some plots and can make decisions on type and amount of seeds to save for future use only.

4.1.8 Type of labour working on-farm

Despite being the major activity for rural livelihood farming is very threatened by the effects brought about by climate change and variability. Increased drought, changes in seasonal calendar, unpredictable rainfalls are among of the threats faced by small-holder farmers. A smallholder farmer is an important component in adapting to these changes. The study found both Meatu and Iramba use two main household labour i.e. family labour/*ukombakomba*[2] or both to work on-farm. Survey data also showed that either the household used family labour only as a household labour or both. Table 11 indicates type of labour working on-farm for all three villages.

Table : Household's type of labour working on-farm (n=120)

Household labour	Iramba					Meatu					Grand Total
	M	%	F	%	Total	M	%	F	%	Total	
Family Labour	22	55.0	18	45.0	33.3	41	51.3	39	48.7	66.7	**120**
Ukombakomb	17	51.5	16	48.5	42.9	26	59.1	91	40.9	57.1	**77**

2 Invited people to help doing on-farm work. A household can invite a number of people depending on the capacity of that household to feed them, therefore wealth status matters.

a								8			
Total								**5**			
	39	**53.4**	**34**	**46.6**	**37.1**	**67**	**54.0**		**46.0**	**62.9**	**197**
								7			

Note: M= Male, F = Female

Data from Table 11 shows that 55% of men and 45% of women in Iramba use family labour in doing farming activities. In Meatu the percentage of men and women using family labour in working on farm were 51.3% and 48.7% respectively. On the other hand data in Table 11 shows that 51.5% of men in Iramba use ukombakomba in doing farming activities and 48.5% only of women were also using the same labour. Data also shows that when 59.1% of men in Meatu were using ukombakomba in doing farming activities women was only 40.9%. The implication of this is that majority women are poorer as compared to men, hence incapable of inviting *ukombakomba* consequently low capacity of coping with climate variability in case of short rainfall. In this study it was revealed that both Meatu and Iramba use both family labour and ukombakomba in doing farming activities.

4.1.9 Household land acquisition

The study revealed that smallholder farmer in both the study areas acquires their land using different methods and ways. Survey data in Meatu showed that farmers acquire their land through buying, inheritance, hiring and open virgin. During discussion with farmers the study revealed that big proportion of women acquires land through inheritance from their husbands. Both the widows and married women get access to land through inheritance from their husband. During in-depth interview it was observed that women in the study area get access to land through inheritance from their husband. Methods of land acquisition in Iramba and Meatu were approximately the same differences was in percentages.

Table : Methods of land acquisition in Iramba and Meatu (n=120)

Land Acquisition	IRAMBA					MEATU					Grand Total
	M	%	F	%	Total	M	%	F	%	Total	
Inherited	14	56.0	11	44.0	35.2	24	52.2	22	47.8	64.8	**71**
Hiring	2	25.0	6	75.0	19.0	20	58.8	14	41.2	81.0	**42**
Buying	0	0.0	3	100.0	15.0	13	76.5	4	23.5	85.0	**20**
Open virgin	7	87.5	1	12.5	72.7	3	100.0	0	0.0	27.3	**11**
Total	**23**	**52.3**	**21**	**47.7**	**30.6**	**60**	**60.0**	**40**	**40.0**	**69.4**	**144**

NB: Multiple responses Note: M= Male, F = Female

FGD data was supported with data from interview as shown in Table 12, 56% of men in Iramba inherit land from their families and 44% of women in Iramba get inheritance to land from their husband. This was followed by those who have access to land through hiring where 25% of men hire land while the number of women was 75% respectively. Survey data also shows that some of the women in Iramba get access to land through buying and 100% of women in Iramba buy land. Data in Iramba shows that 87.5% of men acquired their land through open virgin and only 12.5% of women used the same method to get access to land.

Data in Meatu also shows that 52.2% of men and 47.8% of women acquire land via inheritance. As discussed earlier women in the study area get access to land through inheritance from their husband. This was different from men who get access to land through inheritance from their father/clan. Table 12 shows that when the numbers of men who acquire land through hiring were 58.8% women were 41.2%. Data in Table 12 shows that those who get access to land through buying whereby men were 76.5% and women were 23.5% respectively. Data also shows that 100% men acquired their land via open virgin and none of women accessed land using the same method.

4.2 Climate Change Facts and Local Farmers Perception to Climate change

4.2.1 Men and women perception to climate change in Meatu

Women contribution to climate change is different from men. Likewise the effect goes differently and also reaction is quite different from women. This is directly linked with the way men perceive climate change is also quite different from women's perception to climate change. Table 13 presents seven statements for measuring men and women response on perception to climate change in Meatu District.

The statements were categorized into three levels of attitudes. Responses on 'Strongly Agree' and 'Agree' were summed to mean 'Agree' and were considered as favouring climate change occurrence, and responses for 'Strongly Disagree' and 'Disagree' were summed to mean 'Disagree' and were considered as favouring that there no change in climate . The 'Uncertain' responses were unchanged. Using the indices of Likert items based on Table 13 data showed that 94.9% of women in Meatu agreed that there is change in climate in their area and 66.7%, 41.0% 53.6% also agreed that climate in the area has caused by deforestation, bush fire and large number of livestock keeping. Comparing data to women, men agreed by 95.5% that climate of their area has been changed over time; this was followed by 56.1%, 43.9% and 43.9% agreement that this climate change has been caused by deforestation, bush fire and large number of livestock keeping. Results indicate that majority men and women in the study area were aware about climate change and its negative implication on crop production.

Table : Men and women perception to climate change in Meatu (n=120)

Descriptive	Sex of respondent					
	Men			Women		
	A	U	D	A	U	D
Climate of this area has been changed over time	95.2	4.8	0.0	94.9	5.1	0.0
Deforestation causes climate change	56.1	14.6	29.3	66.7	12.8	20.5

Bush fire causes climate change	43.9	34.2	21.9	41.0	30.8	28.2
Large number of livestock keeping leads to climate change	43.9	0.0	56.1	53.6	20.5	35.9
Climate change affects crop production	97.6	2.4	0.0	82.0	15.4	2.6
Heavy rain and drought are major cause of crop failure	90.2	4.8	4.8	69.3	15.4	15.4
Drought and heavy rain contribute largely to low production	87.8	4.8	7.4	53.9	17.9	28.2

Data from Table 13 shows that men and women in Meatu recognize that climate change is already happening in their area and that it has effects on crop productions. During in-depth interview with respondents it was observed that men strongly disagreed that having large number of livestock keeping leads to climate change. FGD results also proved that in the past people were owning large number of livestock but because of lack of pastures and animal diseases they have lost their livestock and remain with few but still climate is changing year after year, therefore it was also strongly disagreed in the FGD that large number of livestock keeping can lead to climate change. During discussion on whether deforestation causes climate change, men strongly disagreed by arguing that deforestation was done in the past therefore if it is issues of climate change it could have happened during that time. And therefore the question was; why is it happening now? Therefore some of them were strongly disagreed that deforestation can cause climate change. It was identified by key informants that in their area deforestation were done by header as they wanted to see all of their animals when they were grazing. Others did deforestation during land preparation.

4.2.2 Climate change in Meatu

Empirical data from Meatu District compares well with survey data as it reveals that climate change is already happened in the study area. Data in terms of change in rainfall shows that there is gradual increase and decrease in rainfall amount depending on years starting from 2000-2012. Fig. 3 presents data on total annual rainfall in (mm) in Meatu District. Data shows that there is change in years, whereby some of the years receive large

amount of rainfalls (for example 1997/98) while other years rainfall is decreasing in amount.

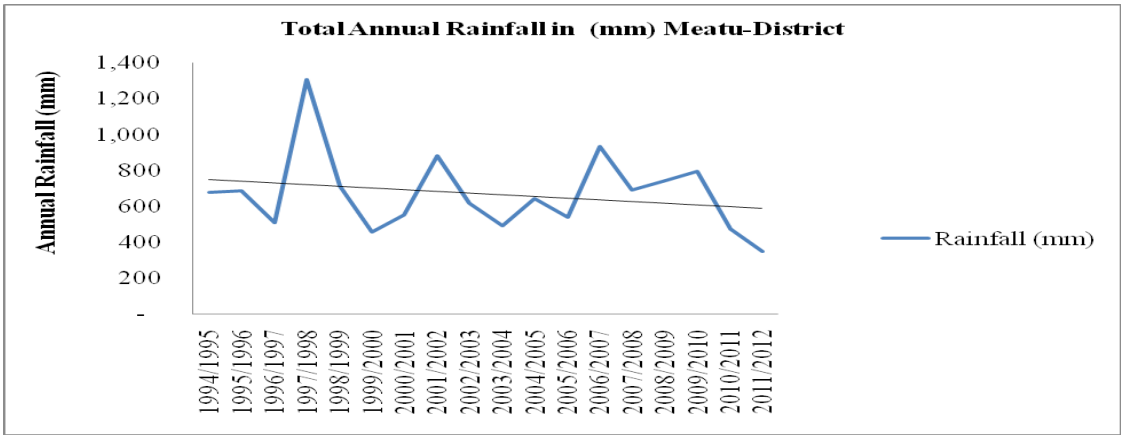

Figure : Total annual Rainfall in Meatu District

Source Meatu District Council

The analysis of empirical data was also supported by information from FGD data. Both men and women were capable of mentioning good and bad years that ever happened in their area. FGD results showed that a good year is the one which farmers were capable to produce enough food and cash crops as well as availability of pastures for animal feed and vice versa. The good years as mentioned by both men and women were 1988 and 2001 and bad years were 1974/75, 1984/85, 1997/98, 2005/06 and 2011/12. The bad years were also given names such as *Umeme for* 1974/75, *Bhuluga for* 1984/85, *Tonja for* 1997/98 and *Labhalabha for* 2005/06.

Fig. 4 also presents data on the mean annual temperature in Shinyanga. Data was obtained from Tanzania Metrological Agency (TMA) in Shinyanga station. The analysis of data shows that there is increase in temperature in Shinyanga Region.

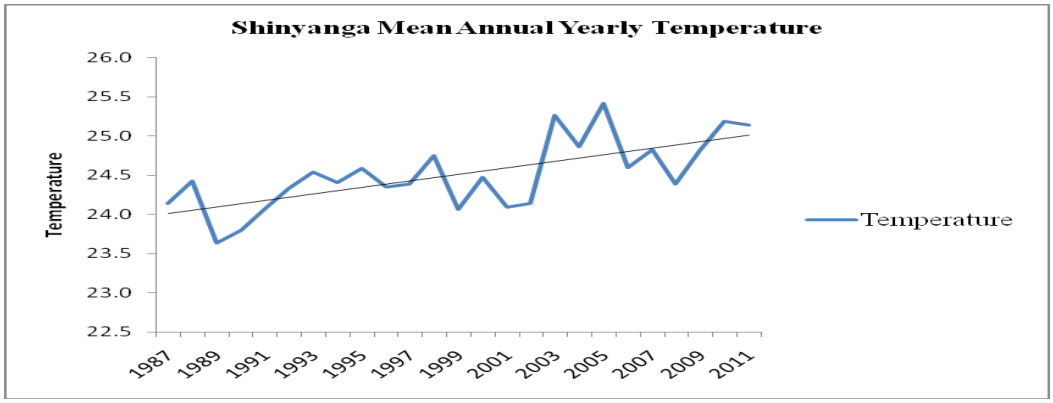

Figure : Shinyanga mean annual yearly temperature

Source: TMA 2012

These empirical data was supported by information from FGD, whereby both men and women reported that temperature in Meatu starts to increase in the midst of August to October and during May up to July it gets too cold. All these data reveales that cliamte change and variabilit is already happened in the study area and every individal have felt it. These climate change and variations have effects on crop production (Lyimo and Kangarawe, 2010).

4.2.3 Men and women perception to climate change in Iramba

Table 14 presents data on men and women perception to climate change in Iramba district. Seven statements ware constructed to measure men and women perception to climate change in Iramba District. The statements were also categorized into three levels of attitudes. Responses on ‘Strongly Agree’ and ‘Agree’ were summed to mean ‘Agree’ and were considered as favouring climate change occurrence, and responses for ‘Strongly Disagree’ and ‘Disagree’ were summed to mean ‘Disagree’ and were considered as favouring that there no change in climate . The ‘Uncertain’ responses were unchanged.

Table : Men and women perception to climate change in Iramba (n=120)

Descriptive	Sex of respondent					
	Men			Women		
	A	U	D	A	U	D
Climate of this area has been changed over time	100.0	0.0	0.0	100.0	0.0	0.0
Deforestation causes climate change	40.9	4.5	54.6	33.4	5.6	61.1
Bush fire causes climate change	18.2	4.5	77.3	16.7	5.6	77.7
Large number of livestock keeping leads to climate change	81.8	0.0	18.2	82.4	0.0	16.7
Climate change affects crop production	86.3	0.0	0.0	88.9	5.6	5.6
Heavy rain and drought are major cause of crop failure		4.5	9.1	83.3	0.0	16.7
Drought and heavy rain contribute largely to low production	86.3	4.5	9.1	83.3	0.0	16.7

Using the indices of Likert items based on Table 14 data shows that both men and women have high understanding about climate change and its impacts on crop production. Unlike men and women respondents in Meatu, majority men (54.6%) and (77.3%) in Iramba disagreed that climate change is caused by deforestation and bush fire. Majority women in Iramba also supported by (61.1%) and (77.7%) disagreeing that climate change is caused by deforestation and bush fire. Both men and women in Iramba argued that large number of livestock keeping destroys environments ultimately lead to climate change. This was also revealed in group discussion whereby respondents argued that *wasukuma na wamaasai kutoka Shinyanga na Arusha wanatuharibia mazingira na ng'ombe wao* means the Wasukuma and Maasai from Shinyanga and Arusha destroys there environment with their animals. Both men and women in the study area Wasukuma from Shinyanga take their animals to Iramba looking for pastures. It was also argued that the livestock coming from those areas are big in number hence cause environmental destruction.

4.2.4 Climate change in Iramba

The analysis of empirical data obtained from Iramba District on rainfall patterns shows significant decrease in rainfall amount starting from 1987. Fig. 5 presents quantitative data on total annual rainfall in Iramba District. Data shows gradual decrease in rainfall amount to some of the years while other year's shows high increase in rainfall which leads to floods. For example the year 1991 and 1997/98 showed to receive high amount of rainfall

while in 1993 to 1995 have low amount of rainfall. These changes showed also to have effects on the livelihood of people in the study area and on crop productions.

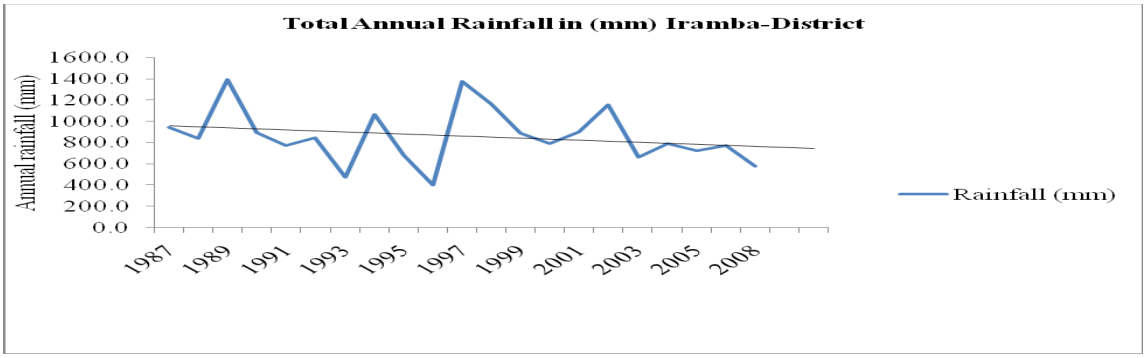

Figure : Total annual rainfall in Iramba District

Source: Iramba District Council

Data in Fig. 5 was supported by data from key informants and FGD whereby during discussion respondents reported that there is decrease in rainfall amount in the area. During FGD both men and women were able to mention years such as 1974/75, 1984/85, 2003-2005 and 2011/12 years with very prolonged drought which caused hunger, and also the year 1998 there was heavy rain (El Nino) which caused floods. The impact was loss of property and grain. Key informants explained that heavy rain come with green grasshoppers which destroyed on-farm products such as sorghum and finger millet.

Fig. 6 also presents data on mean annual yearly temeperature in Iramba District. Data on temperature was obtained from TMA in Singida station. TMA data showed a significant increase in both minimum and maximum temperature in the region. These data gives support to FGD data, whereby both men and women said that temperature in Iramba starts to increase in July to October and during May up to end of June it gets too cold.

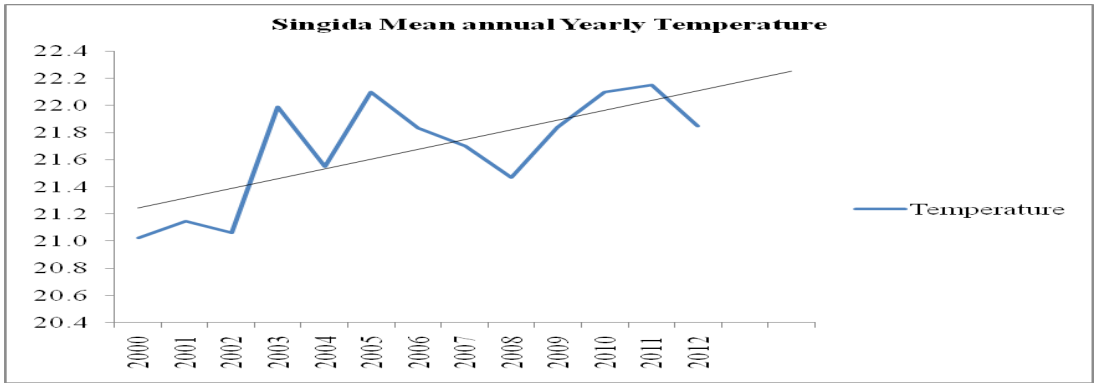

Figure : Singida mean annual yearly temperature

Source TMA 2012

These results also confirmed findings by (Lyimo and Kangalawe, 2010) conducted in Shinyanga. Also other studies conducted in the western part of Tanzania (cf. Tilya & Mhita, 2006; Mongi *et al.*, 2010) that there has been increase in temperature. IPCC (2007) has also reported that over the western Tanzania there has been an increase in temperature of between 1°C and 2°C from 1974 to 2005 (Lyimo and Kangarawe, 2010).

4.3 Most Vulnerable Groups to Climate Change in Meatu

This section shows the percentage Likert scale of men and women's view on vulnerability towards climate change impacts. Majority of the respondents strongly agreed that children, pregnant and nursing women, old women and men were the groups which suffer mostly from climate change effects. Women said that children were getting malnutrition due to lack of complete diet, elderly women suffers from many diseases that are caused by climate change and pregnant and nursing women also suffers, some deliver under weight babies. Women also said that the boys do not know what to do instead *wanakaa vijiweni tu (jobless corner).* On the other side men said that the negative effects of climate change were disproportionately distributed among them (Table 15). Men complained that their

daughters were not getting married because young men now do not afford to pay for bride prices.

Table : Men and women's view on main vulnerable groups in Meatu (n=120)

Descriptive	Sex of respondents					
	Men			Women		
	A	U	D	A	U	D
Children	97.6	0.0	2.4	97.4	0.0	2.6
Pregnant and nursing women	97.6	0.0	2.4	97.4	0.0	2.6
Old women	97.6	0.0	2.4	92.4	0.0	7.6
Men	22.0	0.0	78.0	25.6	0.0	74.4
Old men	100.0	0.0	0.0	89.8	2.6	7.6
All suffer equally	4.9	0.0	95.1	2.6	0.0	97.4

Women also complained that their husbands were running away from families during hard times. These findings was also supported by Nelson and Stathers (2009) who indicates that children, women, elders, widows and widowers, orphans, and the long-term sick people were the poorest and most vulnerable to climate change, because of their increasing inability to secure food in times of drought. On the other hand men added that climate change has forced their wives to use contraceptives in order to reduce family size but it has negative effects on labour because household activities depend on family labour. Both men and women concluded by saying that climate change has been completely affected their lives and the distribution of the effects differ from one social group to another.

4.3.1 Most vulnerable groups to climate change in Iramba

Table 16 presents data on men and women's view to main vulnerable groups to climate change in Iramba. Majority respondents in Iramba agreed children, pregnant women and nursing mother, the elderly men and women were the one who suffer the most with climate change. Through FGD Women said that climate change has brought pain in their husband's because a man is a household head, therefore if there is no food within the house he is the one who critically think how to find food for the family. During FGD

discussion both men and women concluded that the effects of climate change goes disproportionately from one social group to another.

Table : Men and women response on main vulnerable groups in Iramba (n=120)

Descriptive	Sex of respondents					
	Men			Women		
	A	U	D	A	U	D
Children	81.8	9.1	9.1	88.9	0.0	11.1
Pregnant and nursing women	72.7	9.1	18.2	88.9	11.1	0.0
Old women	86.4	9.1	4.5	77.8	16.7	5.5
Men	63.6	4.5	31.8	72.2	5.5	22.3
Old men	86.4	9.1	4.5	83.4	11.1	5.5
All suffer equally	9.1	4.5	86.3	5.5	0.0	94.5

4.3.2 Farmer's indicators of climate change

Farmers have their own indicators to climate change. In the three village surveyed by the researcher, small-holder farmers used words like *jangwa*, *ukame*, *na njaa* respectively meaning desert, drought and hunger as their main indicators to climate change as expressed below in the sub-sections.

4.3.2.1 Indicators to climate change in Meatu

Table 17 shows main indicators to climate change used by farmers in Meatu District. Data shows 16.7% of men and 16.9% of women in Meatu expressed climate change drought. This was followed by 15.4% of men and 16.5% of women who used the word *mabadiliko ya miaka* means change in years as their indicator to climate change. Both men and women said that there is a big change in terms of years. They argued that, in 1960s farmers used to cultivate small amount of land like 1-3 acres and produce enough food to eat throughout of the year but now they cultivate up to 20 acres of land still they very grow low produce. Few respondents also used words like wind, increase in temperature, pests animal disease and others as their indicator to climate change.

Table : Farmers on indicators to climate change in Meatu (n=120)

Indicator	Sex of Respondent			
	M	**%**	**F**	**%**
Drought	41	16.7	39	16.9
Change in years	38	15.4	38	16.5
Low production of crops	31	12.6	35	15.2
Hunger	30	12.2	39	16.9
Decrease in rainfall amount	28	11.4	30	13.0
Unavailability of pastures	21	8.5	12	5.2
Human diseases	12	4.9	6	2.6
Pests	12	4.9	6	2.6
Animal diseases	12	4.9	6	2.6
Wind	8	3.3	1	0.4
Increased temperature	7	2.8	18	7.8
Others	6	2.4	1	0.4
Total	**246**	**100.0**	**231**	**100.0**

NB: Multiple Responses

Observation showed that drought was the major problem in the study areas hindering agricultural productions of food and cash crops as well as livestock due to unavailability of water and pastures.

During discussions conducted in the study area with FGDs and key informants participants were capable of mentioned human diseases such HIV, malaria, and diarrhoea to be increased in recent years and was associated with climate change. Other diseases mentioned was pain in the back born and legs for elderly and *ndigana*[3] *and ugonjwa wa kuzunguka ng'ombe (kifafa cha ng'ombe*[4]*)* for animals. These diseases have been a major obstacle for both men and women to adapt to the effects of climate change. FGD done by women alone revealed that women spend a lot of time to look after the sick at home which also minimizes their time to perform other activities which can enable them adapt to climate change effects. Key informants also argued that since changes in climate started in their environment such diseases also happened. The IPCC (2001) also argue that, because of climate change length of growing seasons, extreme weather events and prevalence of human diseases are prevalent.

3 East cost fever. Animal diseases carried by ticks

4 Cycling diseases

4.3.2.2 Indicators to climate change in Iramba

Table 18 shows indicators of climate change used by men and women in Iramba District. Data shows that both men and women used the word drought as their main indicator to climate change whereby men represent 30.9% and women were 36.0% respectively. Data also shows that both men and women used the word, floods as indicator to climate change. During in depth interviews with men and women small-holder farmers in the study area, respondents said that during the period of raining floods come from the mountains and wash away all grains in their fields as the area is low land. These floods come from river *ndurumo* and *jerumani* as mentioned by men and women themselves during discussions. Both men and women said that floods in their area minimize their adaptive capacity to the effects brought about by climate change as there is no way of controlling by themselves.

Table : Farmers indicators to climate change in Iramba (n=120)

Indicator	Sex of respondents			
	M	**%**	**F**	**%**
Drought	17	30.9	18	36.0
Floods	14	25.5	10	20.0
Increased temperature	7	12.7	9	18.0
Few produce	5	9.1	6	12.0
Human disease	4	7.3	4	8.0
Hunger	4	7.3	2	4.0
Change in years	2	3.6	1	2.0
Others	2	3.6	0	0.0
Total	**55**	**100.0**	**50**	**100.0**

Data in Table 18 shows that 12.7% of men and 18.0% of women said that increased temperature is also an indicator of climate change in the study area. According to Hulme *et al*. (2001) and IPCC, (2001) these local observations about climate change are consistent with scientific projections which suggest that Tanzania will warm by between 28C and 48C by 2100. According to FGDs conducted in the study area temperature starts to increase in August-October while during May-July it decreases and gets cold. These data on temperature also supports TMA data which shows increased temperature in the

study area. Changes in temperature affect crop production and reduce adaptive capacity of men and women hence continuing to worsen people's livelihood. The IPCC, (2001) supports that changes in temperature and rainfall are likely to prolong dry seasons, and to worsen periodic droughts, particularly inland.

4.4 Adaptation Practices Mentioned and used by Farmer

4.4.1 Adaptation Strategies

Analysis of adaptation practices based on livelihood strategies between men and women smallholder farmers in the study area has shown that both men and women use multiple adaptation strategies to cope with the impacts of climate change and variability. Sub-sections below identifies adaptation strategies and practices developed by men and women in Meatu and Iramba district

4.4.1.1 Adaptation practices based on livelihood strategies in Meatu

Table 19 presents data on adaptation practice based on livelihood strategies of men and women in Meatu District. Survey data revealed that both men and women in the study area use different adaptation practices as their response to climate change and variations. Data shows that majority (12.5%) of men and (17.9%) of women in Meatu plant drought tolerant crops such as sorghum, maize, sweet potatoes, green peas, cow peas, pigeon peas, beans, ground nut and cotton as one of the mechanism of coping with climatic variations. Men and women in Meatu also showed to respond on climate change by using sliced and dried sweet potatoes after harvesting which was used it as food during hard times of the year.

Table : Adaptation practice based on livelihood strategies in Meatu (n=120)

Adaptation practice	Sex of respondents

	M	%	F	%
Drought tolerant crops	41	12.5	39	17.9
Drying sweet potatoes	41	12.5	39	17.9
Early timing of farm operations	39	11.9	35	16.1
Temporal migration of livestock keepers	38	11.6	12	5.5
Mixed crops	36	10.9	22	10.1
Fast maturing varieties	35	10.6	18	8.2
Farm fallowing	30	9.1	14	6.4
Cultivation in wetlands	28	8.5	20	9.1
High yielding varieties	18	5.5	11	5.0
Buying more land	15	4.6	8	3.7
Permanent migration of livestock keepers	8	2.4	0	0.0
Total	**329**	**100.0**	**218**	**100.0**

NB: Multiple responses

During FGD conducted in the study area participants said that the sliced and dried sweet potatoes are sometimes sold and get income which is used to purchase other household needs. Other adaptation practices showed by men and women in the study area was early timing of different farming activities, temporal migration of livestock keepers, mixed crops, planting fast maturing varieties, farm fallowing cultivation in wetland, plating high yielding varieties and buying more land for cultivation and grazing purposes. Data in Table 19 also showed that there was permanent migration of livestock keepers whereby 2.4% of men showed to migrate to other places.

These data was also supported by FGD data conducted in the study area whereby participants said that there was early preparation of land for planting locally known as *kupugha* which starts at the end of September and during the didst of August was when they start planting. Temporal migration of livestock keepers was also discussed during FGD and it was reported that herders use to take their livestock to the game (Serengeti national park) were they can find pastures for animals feed as a way of adapting to climate change. However participants reported that it was a risk for them to feed their animals in reserved areas. This was also supported by information obtained from key informants who said that one of his village member was punished to pay TZS 1,000,000/= after being

caught grazing in the game reserve. The situation sometime force smallholder farmers to sale their cattle in order to pay for the requested amount of money.

Observation showed that grazing away from home reduces the capacity of a household in adapting to climate change and variations in the study area because during that period animal products i.e. milk were not available. Observation also showed that selling cattle in order to pay for a punishment after being caught grazing in the game also reduce the capacity of a household in adapting to the effects of climate change. The IPCC (2001) argue that once the rural households lose their houses, livestock, food reserves and other household's possessions, due to impacts of climate change it impossible for them to recover. Another observation showed to reduce the capacity of individual in adapting to the effects brought about by climate change and its variability was on permanent migration of livestock keepers to other area search pastures for their animals. During in-depth interview one of the respondent said that his parents sold all farms and migrated to Morogoro to search for fertile area where they can get pastures for their cattles. The situation become worse for the person who remained home as all the lad was sold.

FGD data also showed that both men and women in the study area have started to use inputs i.e. SEEDCO and PANNAR provided by the council and other were given from the NGO as means of coping with climatic variability. Village extension officers in the study area said that now they provide extension services to farmers on the use of fast maturing varieties i.e. red sorghum that are high yielding.

4.4.1.2 Adaptation practices based on livelihood strategies in Iramba

Table 20 presents the main adaptation practices that were developed and used by farmers as their response to climate change and variability and other changing socio-economic

based on data survey in Iramba District. A lot of practices were mentioned by both men and women smallholder planting of drought tolerant such as maize, sorghum, finger millet green peas, cow peas, ground nut and sunflowers.

Table : Adaptation practices based on livelihood strategies in Iramba (n=120)

Adaptation practice	Sex of respondents			
	Male	%	Female	%
Drought tolerant crops	22	25.9	18	26.9
Early timing of farm operation	17	20.0	18	26.9
Fast maturing varieties	15	17.6	9	13.4
Buying more land	11	12.9	9	13.4
Mixed crops	9	10.6	11	16.4
Cultivation in wetlands	9	10.6	1	1.5
Migration	2	2.4	1	1.5
Total	**85**	**100.0**	**67**	**100.0**

Early timing of farm operation locally known as *kunjipilia mgunda* also was one of the practices used by men and women in Iramba. Men and women small-holder farmers in Iramba ensure proper timing of farming preparation of land for planting which starts early October.

A growing number of mixture crops were also mentioned as adaptation practice that has been used by farmers in order to reduce the risk of losing crops completely as different crops are affected differently by climatic events (Nhemachena and Hassan, 2007). Table 20 also shows that men and women small-holder farmers plant fast maturing varieties of maize and sunflower that can cope with unpredictable rainfalls. According to Below *et al.* (2010) these traditional and newly introduced adaptation practices can help farmers to cope with both current climate variability and future climate change. Buying more farm-land for the purpose of enlarging farming area was also identified as one of the adaptation practice used by men and women in the study area. Respondents said that in the past they were cultivating small area of land and produce enough food to eat throughout

the year but now it is different, therefore they need to have big farming areas. Data in Table 20 shows that men and women cultivate in wetland areas that is alongside rivers *ndurumo* and *jerumani*. Quantitative data in Table 20 found that there was out-migration between men and women. Although out-migration an important element in adaptation it has negative impacts to others which also limits their capacity of adaptation. This was revealed during in depth interview with both men and women where it was found that the migrants run away and leave their children to their grand father and mother if it was a man or step mothers if it was a woman.

4.4.3 On-farm adaptation practice during dry season

Table 21 presents on-farm adaptation practices done during dry season between men and women in Meatu and Iramba districts. As one of the adaptation practices developed and used by farmers, data shows that on-farm adaptation practice for women was grazing, cutting firewood and irrigation. Men were also grazing, clearing of cotton residues, gardening and mining and irrigation locally known as *kuyusila* in Iramba. Survey found that women were using water for irrigation of sweet potatoes and men for gardens. Irrigation activities were done alongside river *Simiyu* in Meatu and river *ndurumo* and *jerumani* in Iramba.

Table : On-farm adaptation practice of men and women during dry season (n=120)

	IRAMBA					MEATU					Grand Total
Activities	**M**	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Grazing	17	89.5	2	11.5	19.2	41	51.3	39	48.7	80.8	99
Irrigation	12	75.0	4	25.0	25.4	8	17.0	39	83.0	74.6	63
Gardens	12	100.0	0	0.0	54.5	8	80.0	2	20.0	45.5	22
Clearing cotton remains	0	0.0	0	0.0	0.0	32	58.2	23	41.8	100.0	55
Mining	0	0.0	0	0.0	0.0	3	100.0	0	0.0	100.0	3
Cutting fire wood	0	0.0	22	100.0	36.1	0	0.0	39	100.0	63.9	61
None	7	100.0	0	0.0	77.8	2	100.0	0	0.0	22.2	9
Total	**48**	**63.2**	**28**	**36.8**	**24.4**	**94**	**39.8**	**142**	**60.2**	**75.6**	**312**

NB: Multiple Responses

During in-depth interview in the two study areas both men and women said that there was lack of instruments e.g. irrigation machine for irrigation activities only few own. Those who do not own machines for irrigation were to work first to those who own in order to get the machine. This reduces the capacity of both men and women in terms of adaptation because of pending time by working into others farm first which means you come to work into your own farms in very little time that climatic variation also starts to occur. Quantitative data shows that men in both Iramba and Meatu were engaged in none of the activities during dry season.

4.4.4 Adaptation by finding alternative during food shortage

Table 22 presents alternative way done by men and women during food shortage. During study visit in both Meatu and Iramba it was revealed that both men and women use different methods of getting food during hard time of food shortage. The methods used were by selling livestock, buying from off-farm money, sale of family labour and eat less preferred food. A less preferred food in Meatu was *ugali wa mtama and matobholwa*[5].

5 Sliced and dried sweet potatoes

During household survey in Meatu it was observed in one of the household a child crying wanting ugali and his mother was prepared *matobholwa*.

Table : Alternative way doing by men and women during food shortage (n=120)

Alternative	Iramba					Meatu					Grand Total
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
buying after sell of livestock	17	56.7	13	43.3	31.9	38	59.4	26	40.6	68.1	94
buying from off-farm money	15	57.7	11	42.3	33.3	29	55.8	23	44.2	66.7	78
sale of family labour	11	45.8	13	54.2	37.5	17	42.5	23	57.5	62.5	64
Eat less preferred food	1	25.0	3	75.0	25.0	3	25.0	9	75.0	75.0	16
Total	**44**	**52.4**	**40**	**47.6**	**33.3**	**87**	**51.8**	**81**	**48.2**	**66.7**	**252**

NB: Multiple Responses

Quantitative data More than half men in Meatu and Iramba 56.7% and 59.4% sell their livestock as alternative way of responding to climate change during hard times of food shortage of the year. Men also can use off-farm income to buy food during food shortage. During study survey it was observed that men were capable of getting off farm money from different sources of investments like small shops, Bodaboda, and saloon because they were owners. Comparing to men majority women in the study area showed not to have control over livestock and hence cannot decide on it. Table 22 shows that more than half women in Iramba and Meatu 54.2% and 57.5% sale family labour during hard times of the year for them to respond to the effects brought about by climate change. Majority women (75%) in Meatu and Iramba said that they eat less preferred food during food shortage. The less preferred food was mentioned as *matobholwa* and *ugali wa mtama.*[6] During study visit in one of the households the researcher found children crying after their mother being cooked *matobholwa*.

6 Sorghum

4.4.5 Adaptation by diversifying to non-farm activities

The survey also found that there were an increased number of diversifications in both Meatu and Iramba. The study found that both men and women in both the study area were engaging into non-farm activities as their ways of responding to climate change. Although the activities might be much more profit-driven, the study assumes that it was response for the changing climate.

Table : Off-farm activities done by men and women (n=120)

Off-Farm activity	**Iramba**					**Meatu**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Petty trade	9	47.4	10	52.6	32.2	21	52.5	19	47.5	67.8	59
Hand craft	12	100.0	0	0.0	36.4	21	100.0	0	0.0	63.6	33
Bodaboda (Motorcycle drivers)	3	100.0	0	0.0	37.5	5	100.0	0	0.0	62.5	8
Milling	1	100.0	0	0.0	100.0	0	0.0	0	0.0	0.0	1
selling fire wood	0	0.0	12	100.0	57.1	0	0.0	9	100.0	42.9	21
Making local brew	0	0.0	5	100.0	26.3	1	7.1	13	92.9	73.7	19
charcoal Production	0	0.0	2	100.0	100.0	0	0.0	0	0.0	0.0	2
Non	9	52.9	8	47.1	40.5	14	56.0	11	44.0	59.5	42
Total	**34**	**47.9**	**37**	**52.1**	**38.4**	**62**	**54.4**	**52**	**45.6**	**61.6**	**185**

NB: Multiple Responses

Data shows both men and women in Meatu and Iramba were engaged into non-farm activities. The study in Iramba found that more women (47.5%) in Meatu and (52.6%) in Iramba were doing business activities such as running small hotels (*mama lishe*); *selling vitenge* and prettying hair (*kusuka nywele)*. In Meatu the study found that 52.5% of men were also doing business activities like running small shops, saloon and selling livestock. Very few women in Meatu found doing petty trade activities such as selling vitenge. Data shows that majority women in both Iramba and Meatu were selling fire wood, charcoal production and making local brew in sukuma known as *chimpumu*, *mapuya* and *moshi* while in *Nyiramba* it was known as *mangai ya tulu*.

Off-farm activities were important in gaining off-income in both Meatu and Iramba. However in Meatu some women said that their husband restricts them to carry out these

off-farm activities. Eriksen *et al.* (2005) show how women in Kenya and Tanzania were excluded from carrying out certain coping strategies. They show how many of the most profitable sources of off-farm income, such as stonemasonry or running a shop, require a sustained period of time to be committed regularly. Women had to perform other household chore assigned to her by the community, they were unable to spare such continuous periods of time and were therefore excluded from many favourable coping strategies.

4.5 Elements of Adaptive Capacity

4.5.1 Access to extension services by sex

Data in Table 24 shows how men and women have access to extension services. Data shows that majority of the responses were not accessible to extension services which may hinder farmers capacity to adapt to the impacts of climate change. Farmers accessibility to extension services helps them cope with new technologies but also can make them be aware of the important information regarding change in climate. During group discussion, farmers said most of the extension received in both Meatu and Iramba were home visit and farm field school, however very few farmers were accessible to the service.

Table : Access to extension services (n=120)

Extension service	Iramba					Meatu					Grand Total
	M	%	F	%	Total	M	%	F	%	Total	
Access	15	62.5	9	37.5	66.7	9	75.0	3	25.0	33.3	36
No access	7	43.8	9	56.2	19.0	32	47.1	36	52.9	81.0	84
Total	**22**	**55.0**	**18**	**45.0**	**33.3**	**41**	**51.3**	**39**	**48.7**	**66.7**	**120**

Data in Table 24 indicates that majority men (62.5%) in Iramba were receiving extension services and only 37.5% of women were receiving the same service in the area. more than

half 56.2% women in Iramba were not receiving extension services. Data also shows in Meatu three quarter (75%) of men were receiving extension services and only 25% of women were receiving the same service. More than half 52.9% of women in Meatu were not receiving extension services.

4.5.2 Access to information regarding rainfall forecast by sex

Data on access to information regarding rainfall forecast in Iramba and Meatu are presented in Table 25. Information on rainfall forecast of short term events and long term changes in climate are important in planning land use activities and also coping to the impacts of climate change.

Table : Access to information regarding rainfall forecast (n=120)

Access to information	**Iramba**					**Meatu**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Access	4	100.0	0	0.0	13.8	23	92.0	2	8.0	86.2	29
No access	18	50.0	18	50.0	39.6	18	32.7	37	67.3	60.4	91
Total	**22**	**55.0**	**18**	**45.0**	**33.3**	**41**	**51.3**	**39**	**48.7**	**66.7**	**120**

Data shows very few farmers in both Meatu and Iramba were up-date with information regarding rainfall forecast. Most of those who were up-date with the information regarding rainfall forecast received it via radio. The study done by Archer (2003) found that gender is a determinant of farmers' ability to accept climate forecasts in South Africa. Data shows that only 8% of women in Meatu were able to listen to radio broadcast and be able to get information on seasonal forecast. According to Archer (2003), while men were flexible enough to listen to a radio broadcast at a regular time, women prefer for the provision of seasonal forecasts by an agricultural extension officer, because their time is not flexible enough to allow them to listen to a radio program at a fixed time. Furthermore, women like to ask questions rather than receive one-way information.

In group discussion conducted in Meatu, both men and women argued that although some of them have access to information regarding rainfall forecast majority of them do not trust the information because it might be forecasted that rain will start early instead it starts late or end with dry periods throughout the year. Therefore majority men and women even those who have access to information regarding rainfall forecast do not apply that knowledge in planning on land use activities.

4.6 Factors Responsible for Adaptive Capacity

In the conceptual framework it is already indicated that, ability or inability of individuals or social groups to respond to, cope with, recover from or adapt to, any external stress placed on their livelihoods and wellbeing will depend on availability of resources (e.g. social, economic, ecological and human) to reduce or eliminate vulnerability. Results generated from focus groups discussions and individual interviews (including key informants) revealed the following findings regarding men and women's capacity to cope with, recover from or adapt to climate change including climate variability.

In group discussions conducted in all three study areas with farmers land ownership, availability of credit, market, transportation, safe and clean and accessibility to health services were mentioned as major factors responsible for adaptive capacity among them. Studies also indicate that market availability, access to land, water, knowledge to adaptation, inputs and credit are important factors responsible to adaptive capacity at individual level (Babugura, 2010; Nhemachena and Hassan, 2007; Nelson *et al.*, 2010; Wall and Marzall, 2006). Other factors mentioned were irrigation facilities, availability of hired tractors, seeds, ownership of livestock, and control over private properties within the household was also important. The study found that all member in the community were accessible to land, water and health services, however while others use drilled water some member within the community still use water flows from rivers (i.e. river Ndurumo, Msua,

Jerumani and Simiyu). The result indicated that at least a rich household can own private properties (i.e. ox-plough, oxen cart, bicycle, mobile phone, radio etc) as compared to a poorer household which can only have one and/or two hand hoes.

Although there is no restriction on the use of some of the resources women found to be majority with limed control over resources. This was revealed on ownership of private properties resources within the household. Interviews with respondents both men and women in Mwamanimba and Mwashata found that in male headed households women control over resources was low as compared to female headed households. While in female headed households a woman has full power on private properties in male headed household a woman has only control over plates. The study done by Babugura (2010) also revealed that in female headed households women have full power and control over the resources. During in-depth interview in Mwamanimba village some respondents said that according to their culture a woman is like an asset or child. However the issue was quite different from Kidaru were both the husband and wife share controls over resource.

4.6.1 Gender access and control over resources

During study survey it was found that gender was an important factor in adapting to climate change effects. As discussed earlier control over land depends on many factors. In Meatu the study found within female headed households a woman have full power and control over sources as a household head. But in male headed households husband is the one who makes decision on the use of land. However in Iramba majority of respondents said that the husband and wife share controls over resources. Resource controls such as land and others within the household are important to the survival of many rural communities (Babugura, 2010). The study revealed that at least every individual in the household had an access to land. In spite of how men and women had access to land, both explained that the major challenge was lack of production facilities such as inputs e.g.

seeds which can withstand different climatic conditions experienced, credit and improve use of technology to simplify their work e.g. use of tractor during cultivation.

In terms of land ownership, higher proportion of single women own land compared to married women. The focus groups revealed that this was because when women get married, any former land ownership reverts to their male relatives. Women move to their husband's land after marriage, and are seen as having less need for their own land since they must depend on their husband, so land reverts to male relatives since ownership must stay in the family. A similar situation exists for divorced or separated women. When they are married, they have access to their husband's land, but when they get divorced or separated, they immediately lose access to this land and have to rely on their parents if they are alive. These women therefore have very little access to land, having to rely on others to provide for them (Meena and Sharif, 2008).

Quantitative data in Table 26 shows that smallholder farmers in the study area use animal powers for ploughing. Ploughing land using oxen is much faster than by hand, and this speed allows maximum use of the shortened, often intermittent rainy period for crop production. However, the poorest households can rarely afford to plough using oxen, and the wealthier owners prepare their own fields first.

Table : Access and ownership of resources (n=120)

Asset Ownership	**IRAMBA**					**MEATU**					**Grand Total**
	M	**%**	**F**	**%**	**Total**	**M**	**%**	**F**	**%**	**Total**	
Land	21	60.0	14	40.0	36.1	36	58.1	26	41.9	63.9	**97**
Iron sheet house	14	63.6	8	36.4	38.6	21	60.0	14	40.0	61.4	**57**
Thatched house	8	44.4	10	55.6	28.6	20	44.4	25	55.6	71.4	**63**
Livestock	14	58.3	10	41.7	34.8	33	73.3	12	26.7	65.2	**69**
Ox plough	14	58.3	10	41.7	38.7	31	81.6	7	18.4	61.2	**62**
Oxen cart	3	75.0	1	25.0	10.5	29	85.3	5	24.7	89.5	**38**
Motorcycle	4	100.0	0	0.0	15.4	17	77.3	5	23.7	84.6	**26**

Bicycle	9	69.2	4	31.8	22.0	32	69.6	14	30.4	78.0	**59**
Radio	6	75.0	2	25.0	17.4	38	100.0	0	0.0	82.6	**46**
Mobile phone	22	64.7	12	35.3	34.7	36	56.3	28	43.7	65.3	**98**
Milling machine	2	100.0	0	0.0	100.0	0	0.0	0	0.0	0.0	**2**
Car	1	100.0	0	0.0	100.0	0	0.0	0	0.0	0.0	**1**
Local chicken	0	0.0	18	100.0	31.6	0	0.0	39	100.0	68.4	**57**
Plates	0	0.0	18	100.0	31.6	0	0.0	39	100.0	68.4	**57**
Hand hoe	22	62.9	13	37.1	32.4	41	56.2	32	43.8	67.6	**108**
Total	**140**	**53.8**	**120**	**46.2**	**31.0**	**334**	**57.6**	**246**	**42.4**	**69.0**	**840**

NB: Multiple Responses

O'Brien *et al.* 2000; Phillips, Makaudze, and Unganai 2001; Valdivia, Gilles, and Materer 2000; Valdivia *et al.*, 2001; Vogel 2000; Patt and Gwata 2002; Ziervogel 2004). Vogel (2000), for example, argues that access to resources such as credit is the decisive determinant for the ability to implement appropriate adaptation practices. Boko *et al.* (2007) also emphasize the point that access to credit is an important determinant in farmers' use of climate forecast practices. For resource-poor farmers access to land is another key factor (Vogel, 2000). Phillips, Makaudze, and Unganai (2001) found in a case study in Zimbabwe that inadequate access to draft animals constrains a farmer's ability to vary planting times in response to seasonal climate forecast information.

4.6.2 Adaptive capacity index

Table 27 presents the principal component weights for the first component extracted and variations for every indicator. The PCA method, through equation 2 clearly stated in section 3.8 of chapter three was employed to determine the weights. The weight ranges from -1 to 1 indicating positive negative relationship between variables. Out of 16 variables used in the analysis only one variable such that education had negative weights

of 0.08% respectively. This is because majority men and women in both two study areas had low level of education contributing to low level of farm management skills.

Most of the indicators in Table 27 appears to have high principle component weights except road infrastructure (weights = 0.24), health services (weights = 0.06), participation in decision making (weights = 0.06), traditional rules (weights = 0.25), water (weights = 0.01). This is because in both two study areas community members were not accessible to tarmac road infrastructure. For example in Iramba, in-depth discussion with interviewee showed that means of transport to nearby market in town were by the use of oxen cart. This was because there was no car from town to the village because the road was bad.

Table : Principal component weights

Asset	**Indicator**	**Weight** (*first component extracted*)	**Variation explained** (%)
Human	Ukombakomba/groups	0.45	18
	Education	-0.08	
Physical	Road infrastructure	0.24	
	Radio/mobile phone	0.55	
	Livestock	0.80	27
	Ox plough/oxen cart	0.72	
	Health services	0.06	
Social	Formal/informal groups	0.57	
	Occasional events	0.57	9
	Participation in decision making	0.06	
	Traditional rules	0.25	
Natural	Land	0.62	15
	Water	0.01	
Financial	formal/informal credit	0.18	
	Mean total cash of a household	0.76	25
	Remittance	0.18	

Source: Adopted and Modified from Nelson *et al.* (2010)

Nelson *et al.* (2010) categorized adaptive capacity into three levels of 0-10% low adaptor, 10-25% moderate and 25-100% high. This study also uses the same categories to identify high, lower and moderate adaptors to climate change effects. Data in Meatu shows that the percentage of men and women high adaptors were only 14.6% and 8%, moderate were 34.1% and 33.3% and lower adaptors were 51.2% and 58.7% respectively. On the other hand data in Iramba shows the percentage of men and women high adaptors to the effects caused by climate change were 10% and 5.6%, moderate were 35% and 44.4% and low were 55% and 50% respectively.

Data in Table 27 shows that low level of human capital caused by low level of education of respondents in the study areas. Data in Meatu shows that 14.6% and 40% of men and women had no formal education 85.4% and 56.4% of men and women had primary education and only 2.6% of women had secondary education. On the other side data in Iramba show that the percentage of men and women with primary education were 95.5 and 100 and only 4.5% of men had secondary education. According to Nelson *et al.*, (2010) low levels of human capital, contributed by low levels of formal education for farm operators leads management of corporate farms, poor farm management skills and also poor self-assessed health. Low levels of self-assessed health are not just an issue for remote communities. Poor health also contributes to low human capital across scattered areas.

Table 27 shows that in both study area there was low level of physical capitals caused by poor road infrastructures, poor communication network and poor health services. This was mainly caused by remoteness of some areas in both of the two study areas. Data also shows that in both of the two study area there was low level of social capital because of low interaction among them. For example during study visit in Meatu it was observed

that there was high turnover of land holdings causing low connectivity of community members hence low interaction among them.

4.6.3 Relationship between dependent and independent variables

4.6.3.1 Regression model

Chapter 3 clearly elaborates the Multinomial Logit Model (MLM) used to analyze the relationship between dependent and independent variables. A number of factors were modeled against adaptive capacity. These factors included household factors and farm factors. In the section the measures of adaptive capacity were analyzed together with factors for adaptive capacity in order to verify its strengths and weaknesses on the contribution of adaptive capacity. Table 28 defines and provides the descriptive statistics of the variables used in the regression model.

Table : Variable definition

Variable	Description	Mean	SD
Dependent variable			
- adaptive capacity	Ability of individual to adjust from climate change effects	1.7119	.68064
Independent variables			
➢ **Household factor**			
- household size	Household currently residents	2.3167	.85978
- Household labour	Type of labour working on-farm	2.2250	.94791
- Age of household head	Years since one was born	3.0750	.79030
- Sex	Sex of respondent		
- Education level	Number of years one spent in schooling	1.8333	.41674
➢ **Farm factors**			
- farm size	Amount of land cultivated by the household per year	5.3500	4.00346
- land owned	Amount of land owned by the household	5.1167	3.66492
- household Asset	Type of assets owned within the household	3.5462	1.64032
- Household Income	Mean total cash of the household per year	2.3833	1.49049

4.6.3.2 Results in the regression model

The MLM was carried out to determine factors responsible for adaptive capacity in Meatu and Iramba Districts study areas. These include household labour, sex of respondents, age of respondents, education level, household land size, land ownership, household asset and household income.

Table : Multinomial Logit model for levels of adaptive capacity

Adaptive Capacity	Variables	B	Std. Error	Wald	df	Sig.	Odds Ratio
Moderate	Intercept	-3.769	2312.012	.000	1	0.999	
	Household labour [1= fewer labour]	3.294	0.769	.002	1	0.000***	3.687
	Sex of respondents[0= female]	-2.215	1.081	4.198	1	0.040**	.109
	Age of household head [1=younger]	1.065	1.584	.452	1	0.501	2.901
	Age of household head[2=older]	1.346	1.484	.822	1	0.365	3.840
	Education of respondents[1=uneducated]	-19.238	2312.011	.000	1	0.993	4.417
	Education of respondents[2=educated]	-19.931	2312.010	.000	1	0.993	2.209
	Household size[1=small hhs]	-20.123	1.019	389.900	1	0.000***	5.48
	Household size[2=big hhs]	18.205	.000	.	1	.	8.062
	Household farm size[1=small farm size]	2.748	1.484	3.429	1	0.064*	.064
	Household land ownership[1=small land]	4.022	1.441	7.790	1	0.005***	55.807
	Household asset[1=fewer asset]	15.092	325.709	.002	1	0.963	3.585
	Household asset [2=high asset]	-4.307	1.995	4.661	1	0.031**	74.212
	Household income [2=high income]	-2.800	1.148	5.947	1	0.015**	.061
Low	Intercept	-34.953	4809.220	.000	1	0.994	
	Household labour [1= fewer labour]	16.817	297.374	.003	1	0.955	2.012
	Sex of respondents[0= female]	-1.478	1.199	1.521	1	0.217	.228
	Age of household head [1=younger]	17.440	672.329	.001	1	0.979	3.749
	Age of household head[2=older]	17.377	672.328	.001	1	0.979	3.522
	Education of respondents[1=uneducated]	5.399	.000		1		.005
	Education of respondents[2=educated]	-5.477	1.628	10.990.	1	0.001***.	.004
	Household size[1=small hhs]	15.879	4761.992	.000	1	0.997	7.875
	Household size[2=big hhs]	4.322	1.211	12.745	1	0.000***	75.328
	Household farm size[1=small farm size]	2.165	1.523	2.019	1	0.155	.115
	Household land ownership[1=small land]	3.636	1.677	4.698	1	0.030**	37.923
	Household asset[1=fewer asset]	16.525	325.716	.003	1	0.960	1.502
	Household asset [2=high asset]	-5.832	2.999	3.781	1	0.052**	341.114
	Household income [2=high income]	1.834	1.644	1.244	1	0.265	6.257

a. The reference category is: High.
b. This parameter is set to zero because it is redundant.

Statistically =***, **, and * Significant at ($p<0.01$), ($p<0.05$) and ($p<0.1$)

Pseudo-R^2 = Cox and Snell = 0.691; Nagelkerke = 0.795 and McFadden = 0.577

LR chi-square =140.842; Probability sig. = 0.000; -2Log likelihood = 75.585

Findings in Table 29 shows that the probability of the model chi-square 140.842 was 0.000, less than the level of significant at 0.05 (i.e. $p< 0.05$) suggesting that there was statistically significant relationship between the dependent variable and the independent variable.

Strength of the model was tested using Pseudo R^2 Cox and Snell 0.691 and Nagelkerke 0.795 suggesting that between 69.1% and 79.5% is explained by the set of variables used in the model.

4.6.3.2.1 Household labour

The likelihood ratio test check shows that household labour significantly contributed to the model at 0.000 (i.e. $p<0.05$). The positive sign in Table 29 indicates that households in the study area adapt low/moderately to the effects of climate change because of limiting labour capacity within the household. Household characteristics (Table 11) indicate that majority of respondents in both Meatu and Iramba Districts use either family labour/ukombakomba or both to work on farm. However inviting ukombakomba depends largely with the capacity of the household to feed the group. The implication of this therefore is that there is shortage of household labour for poorer people especially to women own few resources within the household. Section 4.1.6 indicates that most of women in both Meatu and Iramba have low income suggesting low capacity of inviting ukombakomba for farming activities. These results are supported by Grepperud (2003) who observed that inadequate labour is a significant factor hindering implementation of soil conservation practices. This implies that households with adequate labour force are more likely to adapt highly to the effect of climate change.

4.6.3.2.2 Sex of Respondents

The likelihood ratio test check shows that sex of respondents significantly contributed to the model at 0.059 (i.e. $p>0.05$). Table 29 shows that fewer women adapt moderately/low to the effects of climate change than men by -2.215 and -1.478 with probability of $p<0.040$ respectively. The study found that women in both Meatu and Iramba are doing multi-activities such as fetching water, collecting and selling fire wood, preparing sweet potato seeds, irrigation activities, grazing and constructing terraces for collecting water for home use and animal drink during drought periods. Therefore these diversifications of activities have enabled more women in Meatu and Iramba to adapt highly to climate change effects than men.

4.6.3.2.3 Age of household head

The likelihood ratio test check shows that age of household head significantly contributed to the model at 0.097 (i.e. $p>0.05$) factor that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. This probability significant indicates that most of the respondents in the study area were adult enough to understand changes of climatic happening in their area and ways of adapting to it. The likelihood ratio test therefore suggests that age has a bearing effect on adaptive capacity in the study areas. FAO, (2005) noted that an adult farmer with experience in farming activities were able to adapt to climate change using different interventions than younger farmers with less experience.

4.6.3.2.4 Education of respondents

The likelihood ratio test check shows that education of respondents significantly contributed to the model at 0.339 factors that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. Data in Table 29 shows that

educated respondents in the study areas were positively adapting moderately by 1.346 and non-educated were also positively adapting to the effect of climate change by1.065 respectively. Data also shows that respondents very few educated respondents adapt low by -5.447 with probability significant at p<0.001and majority respondents adapt highly.

4.6.3.2.5 Household size

The likelihood ratio test check shows that household size significantly contributed to the model at 0.062 (i.e. p>0.05) factor that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. Data shows that majority of households with small number of household members adapt highly than moderately to climate change. Table 29 shows that households with small proportions of household members were negatively moderately adapting to climate change by 20.123 with probability significant at p<0.000 than households with large proportion of household members. This was mainly because the study found that majority respondents in the study areas do not rely on household member as labour for working on farm instead they use ukombakomba (Table 11). Data also shows that households with big proportions of household member were positively low adapting to climate change effects by 4.322 with probability significant at p<0.000 respectively.

4.6.3.2.6 Land size and ownership

The likelihood ratio test check shows that land size and ownership significantly contributed to the model with probability significant at 0.003 (i.e. p<0.05) factor that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. The positive sign means that households which cultivate small land size adapts moderately/low to climate change. Data shows that those who adapts moderately adapt at probability significant at p<0.064 respectively. Data also shows that farmers who owns small land size were positively adapting moderately/low to climate change effects at probability significant at p<0.005 and p<0.030 respectively.

Data in section 4.1.7.1 indicates that land in Meatu was owned in terms of acres. The maximum land owned in Meatu was 1000 acres per household and the minimum was 0 acres. Land in Meatu was used for cultivation, grazing and for Ngitiri purposes. Therefore having large size of land in Meatu was important in adaptation processes because it was also used for farm fallowing. Section 4.1.7.2 shows how land was owned in Iramba. The maximum land ownership in Iramba was found to be 30 plots and the minimum was found to be 0 plots. Study survey in Iramba also showed that those who owned a big proportion of land were highly adapting to climate change since land ownership in Iramba defined land cultivated land size.

4.6.3.2.7 Household asset

The likelihood ratio test check shows that land size significantly contributed to the model at $p<0.034$ factor that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. Table 29 shows that majority farmers with enough asset within the household were negatively moderately/low adapting to climate change at $p<0.052$ and $p<0.015$ respectively. Section 4.1.6 shows the mean and standard deviations for asset ownership. Asset ownership defines the wealth of men and women in the study areas for the purpose of developing the relationship between adaptive capacity and gender.

4.6.3.2.8 Household income

The likelihood ratio test check shows that household income significantly contributed to the model at $p<0.017$ factor that influenced adaptive capacity of men and women small holder farmers in Meatu and Iramba District. Data in Table 29 shows that households with high income was negatively moderately adapting to climate change with a probability significant at $p<0.015$ respectively.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

This chapter presents summary of major findings of the study. The main objective of this study was to examine determinants of adaptive capacity to climate change among men, women and other vulnerable groups of smallholder farmers in Meatu and Iramba Districts, Tanzania. The purpose was to provide empirical data on determinants of adaptive capacity of men and women in relation to adaptation strategies and practices developed and used for livelihood and transforming structures used to govern resource use in the study area. This information will assist programme and policy maker to design relevant intervention programmes and policies concerning the gendered determinants of adaptive capacity to climate change. In the previous chapter, the presentation and discussion of the major findings of this information have been covered.

5.1 Conclusions

5.1.1 General characteristics

Demographic characteristics used in this study include age, sex, marital status and household labour. The variables have positive significance to the dependent variable implying that they have much contribution in studying adaptive capacity to climate change of men and women in the study area. The study obtained data from both men and women with age ranging from 17-86 years of age. The study found that respondent from both Meatu and Iramba use two main household labour i.e. family labour and ukombakomba for on-farm farming. Survey data showed that majority men and women in both Meatu and Iramba had primary education. Field data on main occupation of respondents showed that in both Meatu and Iramba main occupation of men and women were farming and livestock keeping. Survey data also showed that land in Meatu was owned in terms of acres and in

Iramba was land was owned in terms of plots. Land in Meatu was used for three purposes first for residential area, second for farming areas and third for *Ngitiri.* The methods used to acquire land in both the study areas include: inheritance, hiring, buying and open virgin land. Data shows that majority of men and women in both Meatu and Iramba acquire land through inheritance.

5.1.2 Community perception to climate change

The research results show that majority of respondents in both Meatu and Iramba Districts were aware about climate change and its negative implications on their lives. Respondents well understood the causes of climate change in their area. FGD results in Meatu proven that having large number of livestock keeping leads to climate change. Survey data were well supported by empirical data obtained from Meatu District, which showed that there is gradual increase and decrease in rainfall amount depending on years starting from 2000-2012. Empirical data obtained from TMA also showed that there is increase in temperature in Shinyanga region. Data in Iramba showed that both men and women were strongly agreed that climate of their area has been changed since 1974. Survey data were supported by empirical data obtained from Iramba District on rainfall patterns, which showed significant decrease in rainfall amount starting from 1987-2008. Empirical data obtained from TMA also showed significant increase in both minimum and maximum temperature.

5.1.3 Adaptation practices developed and used by famers

Another notable observation in this study is that both men and women use different adaptation practices based on their livelihood strategies. In Meatu the study found that men the most popular coping strategies used by men was permanent and temporal migration of livestock keepers and women use to plant drought tolerant crops such as sorghum, maize, sweet potatoes, green peas, cow peas, pigeon peas, beans, ground nut

and cotton as one of the mechanism of coping with climatic variations. During period of food shortage the study found that women prefer to eat less preferred food while men sale their livestock and buy food. The study also revealed that more women were doing other on-farm adaptation practices such as grazing, irrigation and cutting fire wood. The study found that men in Meatu were doing petty trade, hand craft, motorcycle driving and mining activities to enable them earn off-farm income and women were also more popular in doing making local brew, selling fire wood and petty trade for enabling themselves earn off-farm income.

In Iramba the study found that both men and women plant drought tolerant crops such as maize, sorghum, finger millet green peas, cow peas, ground nut and sunflowers. Other adaptation practices were planting fast maturing varieties, mixed crops, and cultivation in wetlands. The study revealed that the most popular on-farm adaptation practice for men in Iramba were grazing, irrigation and gardening and women were cutting fire wood, irrigation and grazing. The study also found that during food shortage men preferred to sale their livestock and to use off-farm money in order to buy food and women preferred to sale family labour and also use their off-farm income to buy food. The study also revealed that men in Iramba were doing off-farm activities such as hand craft, petty trade and motorcycle drivers to enable them earn off-farm income women also were selling fire wood, petty trade, making local brew and charcoal production for earning off-farm income.

5.1.4 Elements of adaptive Capacity

The study survey found that the main elements of adaptive capacity in the study areas was gender, access to extension services and access to information on rainfall forecast. Study findings in previous chapter show that the most popular extension type received by both

men and women in Meatu and Iramba Districts was home visit. FGD results also showed that some respondents in the study areas were in farm field school. Survey data also showed that men were flexible enough to listen to a radio broadcast at a regular time, while women prefer for the provision of seasonal forecasts by an agricultural extension officer, because their time is not flexible enough to allow them to listen to a radio program at a fixed time.

5.1.5 Factors responsible for adaptive capacity

Objective four of this study requires determination of factors responsible for adaptive capacity of men and women smallholder farmers in the study area. Section 4.6.2 provides measures of the determinants of adaptive capacity using adaptive capacity index whereby adaptive capacity is measured at three levels of high, low and moderate. The PCA method was employed to determine the weights. The weight ranged from -1 to 1 indicating positive negative relationship between variables.

The Multinomial Logit Model (MLM) was used to analyze factors responsible for adaptive capacity. The study found that factors such as age of household head, sex, education, household labour, household size, household farm size, household land ownership, household asset and household income were important for predicting the capacity of a household to adapt to climate change effects. Statistically the variables were significant at ($p<0.05$, $p<0.01$ and $p<0.1$) showing high contributions to the model. Findings shows that the probability of the model chi-square 140.842 was 0.000, less than the level of significant at 0.05 (i.e. $p< 0.05$) suggesting that there was statistically significant relationship between the dependent variable and the independent variable.

5.2 Recommendations

i. According to the findings presented in chapter four of this study adaptive capacity is gendered and multiplicity, meaning that adaptive capacity of men and women varies depending on access and control over resources. Findings in this study showed different adaptation practices used by men and women in both study areas which are ultimately defining the adaptive capacity of every individual within the household.

ii. Study findings showed that access to resources were major determinants of gendered adaptive capacity to climate change effects. The resources included were access to and control over livestock, ox plough, oxen cart, radio, mobile phone, land, trees/forest, formal/informal credit, household cash and remittance. Other assets included education, ukombakomba, formal/informal groups, participation in occasional events, participation in decision making, traditional rules, road infrastructure and health services. Therefore different NGOs, stakeholders and other Government institutions operating in the study areas need to take initiatives in addressing the issues of equal gender access to resources within the households in order to promote a gendered adaptive capacity to climate change impacts and its variability. Promoting equal gender access to resources at local level will help increase of gender sensitivity among people and at government level.

iii. The main lesson for policy implication of the results presented in this study is that adaptive capacity of men and women in rural areas is mainly low. In this study the percentage of men and women high adaptor in Meatu and Iramba were 14.3 and 12.3, moderate were 50.8 and 383.6 and low were 34.9 and 49.1 respectively. At least half men (50.8%) were at moderate level of adaptive capacity to climate

change but about half women (49.1%) were at low level of adaptive capacity to climate change. However it is difficult to compare adaptive capacity of men and women in the study area and at National level because of unavailability of gendered disaggregated data on cc and adaptive capacity. According to MDG lack of gender disaggregated data leads to lack of comprehensive reporting and monitoring on gender issues. The Government of Tanzania and other institutions should take initiative to address the gendered empowerment on determinants of adaptive capacity to effects brought about by climate change among smallholder farmers in order to increase the capacity of men and women in adapting for the betterment of their lives, hence for the national wellbeing.

iv. The Government of Tanzania needs to understand, promote and address what determines the adaptive capacity of men and women smallholder farmers. Understanding determinants of adaptive capacity of men and women affects their system ultimately their behavours in general. Both men and women will be aware of what can make their lives less vulnerable to the effects of climate change hence will have great opportunity of equal access and control over assets important for adaptation. Therefore the Government of Tanzania through its policy documents e.g. (NAPA) should ensure that climate change response is focusing on gendered empowerment through effective climate change adaptation, for example by targeting on economic empowerment of both men and women to endow them with financial assets e.g. credit important for adaptation.

v. Governments like Tanzania that promote greater equality between men and women may also tend to promote and susceptible gendered determinants of adaptive capacity to the effects of climate change for smallholder farmers. Smallholder

famers, through their community development sector, cooperatives and civil society organisations, should be educated, sensitized, and mobilized for a change from discriminating one gender on important issues related to climate change and adaptive capacity empowerment also on gendered access and ownership of assets important for adaptation.

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APPENDICES

Appendix : Operational definition

Concept	Operational definition	Measurement level	Units
Age	Number of years since one was born	Ratio	Net years
Sex	Being male or female biologically	Nominal	1. Male 2. Female
Education level	Number of years one went to school	Ratio	Net years
Family size	Number of members in a household	Ratio	Number of members
Vulnerability context	Ability of individual to respond to climate change impacts	Ordinal	1.Rich 3. Not so rich 2. poor
Climate Change	Change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for extended periods, typically decades or longer	Ratio	Periods
Climate Data	Data obtained from secondary sources	Ratio	Number of data
Assets/Capital	Stores, resources, claims and access	Nominal	1. Stores 2. resources 3. claims 4. Access
Human capital	Individual level of education,	Ratio	Number of

	knowledge and skills,		years
Social capita	Individuals interaction into formal or informal groups	Nominal	1. Yes 2. No
Physical capital	Availability of road access nearest to the market and time used	Ratio	Km/hr
Financial capital	Ability of individual to belong to a certain credit organization or gets remittances.	Ratio	Tshs
Natural capital	Access and entitlement to land resource.	Ratio	Hectares
Transforming structures	Policies, institutions and processes that influence livelihood resources	Nominal	1.Policies 2. Institutions 3.Processes
Institution	Rules and regulations that govern access, control and distribution of resources	Nominal	1. Rules 2. Regul ations
Resources	Assets that are transformed to produce benefit and in the process may be consumed or made unavailable	Ratio	Number of Assets
Knowledge	Individual understandings on climate change	Nominal	1. Yes 2. No
Skills	Ability to transform knowledge into practice	Nominal	1. Yes 2. No
Gender	The biological difference between men and women that is socially constructed	Nominal	1. Male 2. female
Adaptive capacity	A livelihood outcome that is influenced by vulnerability context, livelihood resources and transforming structures.	Ratio	Number of variables that have influence on

			adaptive capacity

Appendix : Questionnaire for respondents

SECTION A: HOUSEHOLD INFORMATION

Part 1: Basic respondent's information

Interview date		
Village name		**Ward name**
Name of respondents		**Ethnicity**
Marital status (Tick whichever applicable) [1] Married [2] Divorced [3] Widowed [4] Single/not ever married		
Age of Respondent [ ]	**Sex of Respondent** [1] Male [2] Female	**Age of household head** [ ]
Sex of household head [1] Male [2] Female (Tick whichever applicable)		
Origin of household head (Tick whichever applicable) [1] Native [2] Immigrant If immigrant show year of residence [ ]		

Part 2: Members of household currently resident

No	**Age**	**Sex**	**Relationship**	**Education**	**Occupation**
1		1 = Male	1 = Father	1 = None	1=Child
2		2=	2 = Mother	2 = Primary	2=Student
3		Female	3 = Husband	3 = Secondary	3=Farmer
4			4 = Son	4= Higher	4=Civil servant
5			5 = Daughter		5=Livestock keeper
6			6 = Other relative		
7			7 = Non relative		
8			8 = Father in law		
9			9 = Mother in law		
10					
11					
12					
Total					

1. Do you own land? Yes ( ) No ( )

2. If YES how many Acres
3. How do you use your land
    a) Grazing
    b) Cultivating
    c) Both

SECTION B: PERCEPTION

Part 1: Understanding of climate change

1. Have you noticed any changes in your planting season from the period of 10-30 years?

   Yes ( ) No ( )

2. If Yes, how? (1) Earlier ( ) (2) Later ( )
3. How long have you noticed changes? Explain (Years)
4. How do you describe the climate during the past 10-30 years?
5. Give reason _____
6. Has the vegetation changed over time? Yes ( )No ( )
7. If yes, has it increased or decreased than 10 or 20 years back? Increased Decreased

Part 2: Causes of climate change

S/N	STATEMENT	SA	A	U	D	SD
1	Climate of this area has been changed over time	1	2	3	4	5
2	Deforestation causes climate change	1	2	3	4	5
3	Bush fire causes climate change	1	2	3	4	5
4	Large number of livestock keeping leads to climate change	1	2	3	4	5
5	Climate change affects crop production	1	2	3	4	5
6	Heavy rain and drought are major cause of crop failure	1	2	3	4	5

7	Drought and heavy rain contribute largely to low production	1	2	3	4	5

Key:

1. Strongly Agree
2. Agree
3. Undecided
4. Disagree
5. Strongly Disagree

Part 3: Vulnerability

1. Climate change affects the livelihood of men and women. Yes( ) No ( )
2. What causes differences in vulnerability between men and women?
    a) Lack of access to resources
    b) Lack of control over resources
    c) Many tasks at home
    d) Many dependants

S/ N	**STATEMENT**	**SA**	**A**	**U**	**D**	**SD**
1	Children	1	2	3	4	5
2	Pregnant and nursing women	1	2	3	4	5
3	Old women	1	2	3	4	5
4	Men	1	2	3	4	5
5	Old men	1	2	3	4	5
6	All suffer equally	1	2	3	4	5

Key:

1. Strongly Agree
2. Agree
3. Undecided
4. Disagree
5. Strongly Disagree

SECTION C: ADAPTATION PRACTICES

1. Indicate whether you perform the following practices to cope with climate change

    (a) Planting drought tolerant crops

    (b) Early timing of farm operations

    (c) Migration

    (d) Mixed crops

    (e) Fast maturing varieties

    (f) Farm fallowing

    (g) Cultivation in wetlands

    (h) High yielding varieties

    (i) Others (please mention)……

2. What do women do during dry season?

    Patty trade, (b) selling fire wood, (c) charcoal production, (d) artisanal mining

3. What do men do during dry season?

    (a) Construction (b) Brick making (c)artisanal mining (d) seasonal Migration

    (b) Charcoal production

4. What do men and women do when there is food shortage

    (a) Eat less preferred food (b) sale family labour

    (c) Buy from off-farm income (d) buys after sell of livestock

    (e) Migrate to other places

5. What other activities do men and women do to cope with climate change

    (a) Irrigation (b) Gardening (c) Grazing (d) Making local brew

    (e) Selling fire wood (f) hand craft (g) motorcycle driver

    (h) Milling (i) cutting fire wood

6. Indicate main crops cultivated

Cereals	**Acres**	**Bags**
Maize		
Sorghum		
Finger millet		
Rice		
Sweet potatoes		
Legumes	**Acres**	**Bags**
Beans		
Pigeon peas		
Groundnut		

SECTION D: ELEMENTS OF ADAPTIVE

1. In your opinion, has weather of this area changed in the last 10-30 years? Yes( ) No( )
2. Do you have any understanding of rainfall forecast? Yes ( ) No ( )
3. From what source do you get weather related information?
    (a) Radio
    (b) community meeting
    (c) community leaders
    (d) Others (specify)……..
4. Do you trust the source of information? (Yes ( ) No ( ))----------
   Explain----------
5. Does the information help you in planning your land use activities? Yes ( ) No ( )
   (How/why)----------
6. Do all men and women have access to information regarding rainfall forecast? Yes ( )
   No( ) Explain
   ----
7. Do you have access to extension services? Yes( ) No( )
8. What type of extension service do you receive?
    (a) Home visit

(b) Farm field school

(c) Others----------

9. Are there any traditional institutional arrangements in your community for the right of and control over productive resources?
10. If yes, how do men and women participate in these traditional institutions? Explain

_____

11. How are decisions taken within these traditional institutions?

_____

____

12. Explain how do these traditional institutions ensure equal distribution of resources between men and women_____

SECTION E: FACTORS RESPONSIBLE FOR ADAPTIVE CAPACITY

1. In the table bellow you are asked to write the assets that you access, own and have control of them in this household. Please estimate the values of both assets

	Asset	**Access**	**Ownership**	**Control**	**Quantity (If answer is Yes)**
1	Land (in acreage)/plots				
2	Iron roofed house				
3	Grass roofed house				
4	Ox cart				
5	Ox plough				
6	Hand hoe(s)				
7	Livestock				
8	Motorcycle				
9	Chicken				
10	Bicycle				
11	Milling machine				
12	Radio				
13	Car				
14	Other				

Appendix : Checklist/Guide for group and key informants

Place & date of discussion: ……

Number of people participating: ----------

1. Please let us discuss on the general view of climate trend in this area over the past 10 – 20 years
2. General view of the state of the land in terms of vegetative cover, plant and wildlife composition (natural biodiversity) and soil fertility/productivity over the past 10 - 20 years.
3. So now let us look on how people adapted to adverse climatic conditions over the past 10 - 20 years.
4. Please let us discuss on the way men/women adapt to these climatic changes happening in your area now.
5. Groups which suffer the most in the community.

   Plants and animals those are most vulnerable to adverse changes