SMALL HOLDER FARMERS' PERCEPTION ON CLIMATE CHANGE AND ITS ADAPTATION STRATEGIES AT NACHINGWEA DISTRICT-LINDI REGION

JOB NSEMWA

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE OF THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

The undersigned certify that he has read, and recommends to the Senate, for acceptance of a Dissertation titled, Community Perception on Climate change and its adaptation Strategies at Nachingwea District – Lindi Region in Partial Fulfillments of the requirements for the degree of Master of Science in Environmental Science

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Dr. Josephat Saria

.....

Date

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DECLARATION

I, **Job Nsemwa,** do hereby declare that this dissertation is my own work and that it has not submitted for a degree to any other university

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Signature

.....

Date

DEDICATION

In recognition of importance of Environmental Conservation and Organic farming, this work is dedicated to those who sincerely devote their time and money in making the world safe place to live.

ACKNOWLEDGEMENT

I have many debts of gratitude to acknowledge. First of all, I humbly submit my grateful prayer to almighty God who taught human being what he knew not.

I express a deep sense of gratitude to Dr. Joseph Saria who supervised my Dissertation right from the crude stage to the final copy. Without his special attention and willful heart to tirelessly assist me, this work would not have been accomplished.

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My family my wife Nolasca Mtega who with great perseverance suffered my absence both physical and mental absence. Her passionate tolerance created such a positive environment that kept me in line with my course. My three sons and one daughter, who frequently missed my hug and kisses despite the deep filial love that ever growing between us.

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ABSTRACT

The study assessed farmer's perception on impact of climate change and its adaptation strategies at Nachingwea District in five divisions Namambo, Ruponda, Lionja, Naipanga and Mbondo. Data were collected by using structured interview schedule administered on 260 Households randomly selected from five divisions in the study area. Description and analysis of data were carried out using frequency counts, percentages means and tables, while multiple regression was used to test the hypothesis. Majority of farmers are much aware of climate change, about 91.5% were aware of the climate change and their impacts, only 8.5% do not; though they emphasize on the bad events of flood that happen in some years back that 54.2% of respondents have long years of experiencing climate change. Farmers indicate problems associated to effect of climate change whereby about 39.3% reported to have low yield of crops, 17.2% stunted growth, 15.2% drying of seedling after germination, 13.1% ease spread of pest and diseases attack on crops and 15.2% ineffectiveness of agricultural chemicals used due to delay in rainfall. Extension services were reported as inadequate and under capacitated to provide education on better agricultural practices, climate change, and environmental conservation. Educational programme tailored to meet the climatic information needs of farmers to enable them cope with the emerging challenges to enhance their production. Support on micro financing was found critical to with the establishment of credit facilities non-restrictive agricultural loans from banks. It is therefore, recommended that government and stakeholders should put up educational programme tailored to meet the climatic information needs of farmers to enable them cope with the emerging challenges to enhance their production. .

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Climate consists of the statistics of temperature, rainfall, wind, humidity, atmospheric pressure, and other meteorological elemental measurements in a given region over decade or more. This is unlike weather, which is the present condition of these elements and their variations over shorter periods. According to Trenberth, *et al*., (2000). climates can be classified as the average and the typical ranges of different variables, most commonly precipitation and temperature.

In Sub-Saharan Africa (SSA). agriculture is the most important sector and it is set to be hit the hardest by climate change and Tanzania is not exceptional. However, it is clear that climate change will bring about substantial welfare losses especially for smallholders whose main source of livelihood derives from agriculture. Climate change will affect the agricultural sectors of different countries differently. Tanzania is among countries in Africa affected by climate change as most of their people depend on agriculture as main source of their livelihood. Most of the people live in villages dealing with agriculture, keeping of livestock, fishing and other social-economic activities which almost depend on rainfall (NAPA., 2006). According to Agrawala, *et al.,* (2003) the sectors potentially impacted by climate change in Tanzania include, agriculture, forests, water resources, coastal resources, health, energy, industry and transport. In approaching the issues of climate change appropriately, one must take into account local communities on the understanding of climate change, since they perceive climate as having a strong spiritual, emotional and

physical dimension. It is therefore assumed that, these communities have an inborn adaptive knowledge from which to draw and survive in high-stress ecological and socio-economic conditions. Thus, the human responses are critical to understand and estimate its effects on production and food supply for ease of adaptation. Accounting these adaptations and adjustments is necessary for to estimating climate change mitigations and responses (Apata, *et al*,. 2009; SPORE, 2008; BNRCC 2008). In combating environmental climate change related issues, the Government of Tanzania has rectified to a number of Multilateral Environmental Agreement (MEA). thus Government develop Tanzania National Adaptation Program of Action (NAPA., 2006) in order to counteract environmental related issues on climate change.

NAPA preparation has been a timely opportunity to look at the country's climate change related to vulnerabilities in various sectors which are important for the economy. NAPA has identified the agriculture sector as the most vulnerable sector to climate change amongst others in the country. Tanzania's economic base depends much on agriculture sector which contributes about 44.7% to the national GDP. The sector is highly vulnerable to the adverse impacts of climate change and to extreme weather events. The impacts are already vivid through the attributed severe drought that affects most parts of the country, triggering food shortage. An economic survey conducted in 2005 showed that the agricultural sector (which is the main economic stay of the country) grew by only 5.2% compared to 5.8% in 2004 and this was again attributed to the prolonged drought in 2005/2006 (URT, 2007). Data from aerial surveys supplement the team's field studies, which show that Mount Kilimanjaro melting has dramatically accelerated in recent decades. (Thompson., 2009). From

1912 to 1953, ice coverage declined by 1.1% per year. Between 1953 and 1989 figure 1, the annual rate of ice loss jumped to 1.4 percent. From 1989 to the most recent survey in 2007 figure 2, the ice-covered area dropped, on average, a whopping 2.4 percent per year.

Figure 1.1 Mount Kilimanjaro as it Observed in 1984

Figure 1.2: Mount Kilimanjaro as it was Observed in 2007

Source: wikipedia.org 2012

Developed countries are regarded as the big causative of climate changes due to different economic activies like Industrial and factories activities which contribute much in air pollution, there is a need to take serious attention to reduce the amount of pollution or by paying the covering cost (Kate, 2007). Kikula, *et al.,* (2003). argued that, the forest resources not only reduce the heat in atmosphere and preserve water and soil, but also they provide the considerable part of export and local revenue. The majority of the adverse effects of climate change are experienced by poor and low-income farmers around the world, who have much higher levels of vulnerability to environmental determinants of health, wealth and other factors, and much lower levels of capacity available for adapting with environmental change (WHO, 2007). Adaptation is widely recognized as a vital component of any policy response to climate change.

Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced (Easterling, *et al.*, 1993; Rosenzweig and Parry 1994; Smith 1996; Mendelsohn, 1998; Reilly and Schimmelpfennig 1999; Smit and Skinner, 2002). The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Indeed, adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001). Thus, the adaptive capacity of a system or society describes its ability to modify characteristics or behavior so as to cope better with changes in external conditions. Adaptation to climate change requires farmers to take note of the fact that the climate has changed,

then identify useful adaptations and implement them (Maddison, 2006). Many agricultural adaptation options have been suggested in the literature. They encompass a wide range of scales (local, regional, global). actors (farmers, firms, government). and types: (a) micro-level options, such as crop diversification and altering the timing of operations; (b) market responses, such as income diversification and credit schemes; (c) institutional changes, mainly government responses, such as removal-preserve subsidies and improvement in agricultural markets; and (d) technological developments the development and promotion of new crop varieties and advances in water management techniques (Smith and Lenhart., 1996); Mendelsohn., 2001); Smit and Skinner., 2002); Kurukulasuriya and Rosenthal., 2003). Most of these represent possible or potential adaptation measures rather than those actually adopted. Therefore, there is no evidence that these adaptation options are feasible, realistic, or even likely to occur. Furthermore, they would only be possible with complete and accurate knowledge of future climate conditions, which is why these were aptly named “clairvoyant farmer” scenarios (Risbey, *et al*. 1999, cited by Belliveau, *et al,*. 2006).

Thus, climate change impact studies often assume certain adaptations and little explicit examination of how, when, why, and under what conditions adaptation actually occurs in economic and social systems. The study aimed at providing the understanding of small holder farmers’ knowledge level about climate change at Nachingwea District (i.e. cause and its impact, water and land conservational stretegies). The findings are expected to give appropriate interventions to the policy

makers on the sustainable strategies to address the problems in those areas prone to the effects of climate change and scaled up to the rest of the country.

1.2. Statement of the Problem

Climate change has brought about severe and possibly permanent alterations to the planet, The Intergovernmental Panel on Climate Change (IPCC) now contends that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities"(IPCC, 2001). These changes have led to the emergence of large-scale environmental hazards to human health, such as ozone depletion, loss of biodiversity, stresses to food-producing systems and the global spread of infectious diseases. There are identification of production systems which are most resilient to climate variability, that is production systems with the ability to adjust or recover from negative impacts and take advantage of positive impacts of the current climate variability. One of the factors that contribute to increasing resiliency of agricultural systems is the identification of appropriate mixes of production activities. For example, establishing crop/livestock mixed systems, using a mix of crop species, cultivar types and sowing dates, combining less productive drought - resistant cultivars and high yield but water sensitive crops. In other words, modifying the production systems by introducing four strategies:

a) Increased diversification including activities that are less sensitive to drought and/or temperature stresses.

b) Compatibility: activities that take full advantage of beneficial climate conditions.

c) Escaping sensitive growth stages: This is by establishing crop practices that avoid the concentration of sensitive growth stages in the same period of the year (e.g different season lengths, sowing dates etc)

d) Elimination: another pathway for increasing resiliency is by eliminating climate related factor which is most limiting to crop productivity (e.g. introducing irrigation in water-limited summer crops)(IPCC., 2001).

Nevertheless rural communities in Tanzania have always managed their resources and livelihoods in the face of challenging environmental and socio-economic conditions (Mortimore and Adams., 2001, and Ole, *et al.,* 2009). They have to a large extent been able to develop their livelihood strategies in a way which enables them to constantly cope with and adapt to an erratic climate change, severe pest attack, changing agricultural policies at local, national, global levels and other natural factors (BNRCC,2008 Apata *et al,*. 2009;IPCC, 2001; ODI, 2007and Molua, 2008). There is a need to gain as much information as possible, and learn the positions of rural farmers and their needs, about what they know on climate change, in order to offer adaptation practices that meet these needs. (Royal Society, 2005 and Apata, *et al,*. 2009 Lobell, *et al*., 2008 Hassan and Nhemachem, 2008).

The Farmers' perception on Climate change and their adaptations at Nachingwea District has not been studied and documented, hence researcher aimed at assesing small holder farmers' perception on Climate change and how they adapt. This gave a chance to explore community based integrated strategies, knowledge and opinions from the past experiences and current ones to be incorporated in the adaptation

process to reduce adverse impacts for sustainable development, on the environment, food security and human health.

1.3 Study Gap

Farmers' perception can fundamentally compel or constrain political, economic and social action to address particular climate risks. For example, public support or opposition to climate policies (e.g., treaties, regulations,taxes, subsidies, etc.) will be greatly influenced by public perceptions of the risks and dangers of climate change. Further, successfully mitigating or adapting to global warming will require changes in the behavior of billions of human beings, who each day make individual choices that collectively have enormous impacts on the Earth's climate. Despite there being a lot of information on the impacts of climate change in Nachingwea District, little is known about how different sections of the community in the district perceive climate change and related drought events. It is this knowledge gap that necessitated this study to be carried out so as to have a better understanding on how sections of the small holder farmers have perceived the drought conditions. This would help relevant government agencies to formulate suitable policy interventions for the farmers whose livelihoods have been undermined by the adverse effects of recurring droughts caused by climate change.

1.4 Significance of the Study

The impacts of climate change results into climate risks such as drought, intense rainfall and heat waves, but can also trigger secondary stresses such as the spread of pests, increased competition for resources, the collapse of financial institutions,

human and species migration and biodiversity losses. Some Farm based adaptations options to these effects have taken place in study areas including Nachingwea district. The study findings will provide appropriate interventions to the policy makers on the sustainable strategies to address the problems in those areas prone to the effects of climate change. Also be scaled up to the rest of the country upon successful outcome of the targeted areas.

1.5 Objectives of the Study

1.6 General Objective

The general objective of the study is to assess the Small holder farmers' perception on climate change and their adaptation.

1.7 Specific Objectives

1. To asses the farmers' perception on climate changes and its induced risks.
2. To evaluate best farmers' adaptation strategies that could be enhanced.

1.8 Research Questions

- How small farmers understand and identify climate change?
- How small farmers identify impacts of climate change?
- To what extend has the climate change affected both production and productivity of small farmers?
- What socio-economic effects do small farmers face due to climate change?
- Which type of agricultural sub-sector has been more prone to climate changes?
- Which population groups have been more prone to climate changes?

- What traditional adaptation and mitigation measures small farmers use to cope with climate changes?
- What modern adaptation and mitigation measures small farmers use to cope with climate changes?
- What adaptation measures and policies could be implemented by the government?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Climate Change Impacts on Agriculture

The climate of Tanzania is mainly influenced by its location close to the equator, the impact of the Indian Ocean and the physiographic in general. As a consequence, Tanzania experiences a variety of climatic conditions ranging from humid coastal to alpine deserts. The coastal area and all of the islands in the Indian Ocean experience a tropical climate, and most of the country is sub-tropical except for the areas at higher altitudes. Average temperatures range between 17°C and 27°C, depending on location. Temperature variations have significant impact on the agro-ecological zones and the adaptation strategies in the agriculture sector. Rainfall in about 75% of the country is erratic and only 21% of the country can expect an annual rainfall of more than 750 mm with a 90% probability.

As a result, crop and livestock production under such conditions remains vulnerable to the adequacy, reliability and timeliness of rainfall. The mean annual rainfall varies considerably, ranging from less than 400 mm to over 2,500 mm per annum (TMA report, 2007). Agriculture constitutes the backbone of most African economies, Tanzania included. It is largely contributor to GDP; the biggest source of foreign exchange, accounting for about 40% of the continent's forex; and the main generator of saving and tax revenues. In addition, about two-thirds of manufacturing value-added is based on agricultural raw materials. Agriculture remains crucial for pro-poor economic growth in most African countries, as rural areas support 70-80% of total

population. More than in any sector, improvements in agricultural performance have potential to increased rural incomes and purchasing power for large number of people to lift them out of poverty (NEPAD, 2002; Wiggings, 2006). The Tanzania economy depends heavily on agriculture, which accounts for more than 25% of GDP, provides 80% of exports, and employs 80% of work force (URT., 2007). Sale of agricultural products accounts for about 70 percent of rural household incomes (Figure 2.1).

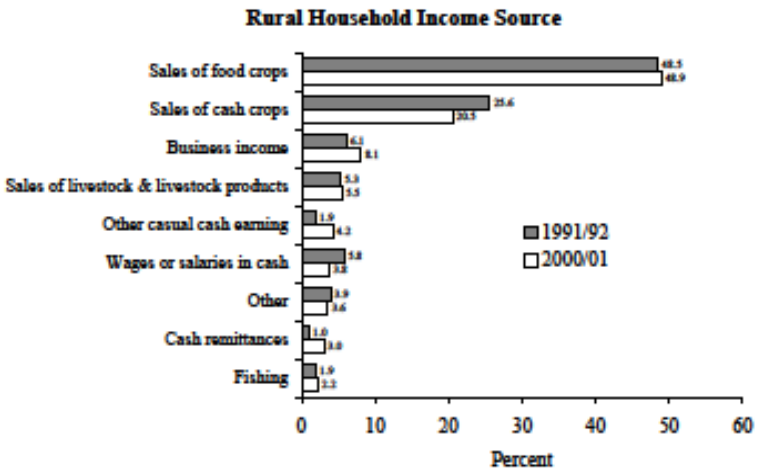


Fig. 2.1 Rural Household Income Source

Over the 1990s, average agricultural growth was 3.6 percent, which was higher than in the 1970s and 1980s when annual agricultural growth averaged 2.9 and 2.1 percent respectively. It grew by 6.0% in 2004. Over the 1990s, agricultural exports grew at an annual rate of over 7 percent per year, although this rate has slowed in recent years due to many factors, including climate (URT, 2007). Topography and Climate change however, is considered as posing the greatest threat to agriculture and food security in the 21st century, particularly in many of the poor, agriculture-based countries of sub-Saharan Africa like Tanzania with their low capacity to effectively cope (Shara, *et al.*,2009). African agriculture is already under stress as a result of population increase,

industrialization and urbanization, competition over resource use, degradation of resources, and insufficient public spending for rural infrastructure and services. The impact of climate change is likely to exacerbate these stresses even further (Ludi, 2009). Climate change has drastically reduced agricultural production through extreme weather events, such as recurrent droughts and floods (Hassan and Nhemachena, 2008; Deressa, *et al.,* 2008). Smallholder farmers (including herders and fishers) make up the majority of the world's poor people. International Fund for Agricultural Development (IFAD) (IFAD, 2009) estimates that there are 1.2 billion people who cannot meet their most basic needs for sufficient food every day. Of these, the largest segment are the 800 million poor women, men and children, often belonging to indigeneous populations, whose life is in rural environments and try to make a living as subsistence farmers. They often occupy marginal lands and depend heavily on rain fed production systems that are particularly susceptible to climate change.

Climate change will have wide-ranging effects on the environment, socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever. Temperature increases will potentially severely increase rates of extinction for many habitats and species (up to 30% with a 2°C rise in temperature). Particularly the effect

will be on coral reefs, boreal forests, Mediterranean and mountain habitats. Increased evaporation and evapotransipiration with associated soil moisture deficits will impact rainfed agriculture (Bates, *et al.,* 2008). Increasing sea levels mean greater risk of storm surge inundation and wave damage to coastlines, particularly in small island States and countries with low lying deltas. A rise in extreme events will have effects on health and lives as well as associated environmental and economic impacts. Recent estimates shows that for each 1^0C rise in average temperature dryland farm profits in Africa will drop by nearly 10% (FAO, 2008).

2.2 Climate Change Vulnerability

Africa is already a continent under pressure from climate stresses and is highly vulnerable to the impacts of climate change. They are vulnerable to a number of climate sensitive diseases including malaria, tuberculosis and diarrhea (Guernier, *et al.,* 2004). Under climate change, rising temperatures resulting in changing the geographical distribution of disease vectors which are migrating to new areas and higher altitudes, for example, migration of the malaria mosquito to higher altitudes will expose large numbers of previously unexposed people to infection in the densely populated east African highlands (Boko, *et al,*. 2007). Future climate variability will also interact with other stresses and vulnerabilities such as HIV/AIDS (which is already reducing life expectancy in many African countries). conflict and war (Harrus and Baneth, 2005). resulting in increased susceptibility and risk to infectious diseases (e.g. cholera and diahrrhoea) and malnutrition for adults and children (WHO, 2004).

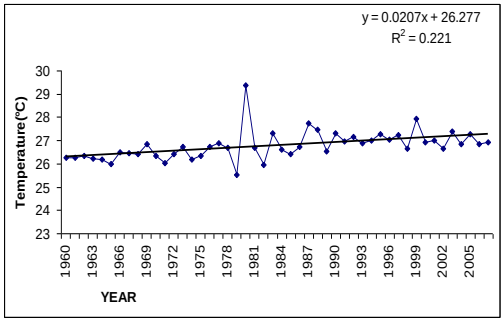
Many areas in Africa are recognized as having climates that are among the most variable in the world on seasonal and decadal time scales. Floods and droughts can

occur in the same area within months of each other. These events can lead to famine and widespread disruption of socio-economic well-being. Many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent's ability to cope with climate change. These include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. The overexploitation of land resources including forests, increase in population, desertification and land degradation pose additional threats of persistance drought, extreme temeperature and disease outbreaks in most underdeveloped countries like Tanzania (UNDP, 2006).

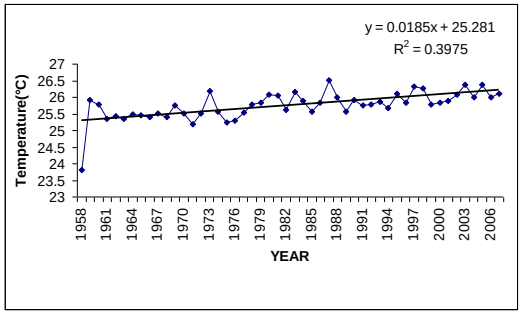
Africa faces increasing water scarcity and stress with a subsequent potential increase of water conflicts as almost all of the 50 river basins in Africa are transboundary (Ashton 2002, De Wit and Jacek, 2006). Agricultural production relies mainly on rainfall for irrigation and will be severely compromised in many African countries, particularly for subsistence farmers in sub-Saharan Africa. Under climate change much agricultural land will be lost, with shorter growing seasons and lower yields. National communication report that, climate change will cause a general decline in most of the subsistence crops, e.g. sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; Millet in Sudan; and groundnuts in Gambia (Fischer *et al,*. 2002). Climate change is an added stress to already threatened habitats, ecosystems and species in Africa, and is likely to trigger species migration and lead to habitat reduction. Up to 50 per cent of Africa's total biodiversity is at risk due to reduced

habitat and other human-induced pressures (Boko, *et al,*. 2007). The latter include land-use conversion due to agricultural expansion and subsequent destruction of habitat; pollution; poaching; civil war; high rates of land use change; population growth and the introduction of exotic species. For example, the habitat of the great apes, including the western lowland gorilla – identified as critically endangered on the World Conservation Union's (IUCN) red list of threatened species, is likely to seriously decline between 2002 and 2032. Future sea level rise has the potential to cause huge impacts on the African coastlines including the already degraded coral reefs on the Eastern coast. National communications indicate that the coastal infrastructure in 30 percent of Africa's coastal countries, including the Gulf of Guinea, Senegal, Gambia, Egypt, and along the East-Southern African coast, is at risk of partial or complete inundation due to accelerated sea level rise.

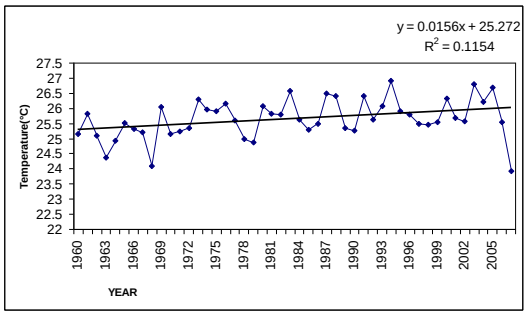
In Tanzania, a sea level rise of 50 cm would inundate over 2,000 km^2 of land, costing around USD 51 million (UNEP 2002a). Future sea level rise also threatens lagoons and mangrove forests of both eastern and western Africa, and is likely to impact urban centres and ports, such as Cape Town, Maputo, and Dar Es-Salaam. Analysis of monthly minimum and maximum temperatures over years for meteorological stations located in regions of Arusha, Bukoba, Dodoma, Iringa, Kilimanjaro, Mbeya, Morogoro, Mwanza, Songea, Tanga, Zanzibar and Shinyanga showed an upward trend (figure 2.2)



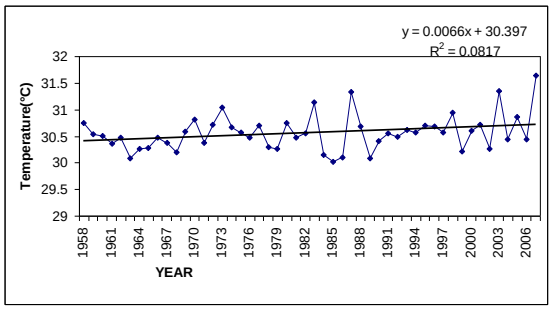
a) Songea station



b) Bukoba station



c) Arusha station



d) Zanzibar station

Figure 2.2: Mean Annual Maximum Temperature Time Series for Songea, Bukoba, Arusha And Zanzibar Stations (1958 – 2005)

Source: TMA, 2007

The increasing trend was mostly associated with the months of January, July and December. The retreat of the glaciers of Mt. Kilimanjaro., the submersion of Maziwe Island in the Indian Ocean near the coast of Tanga, and decrease in water levels of Lake Victoria and increasing malaria endemicity in highland areas of the country could be linked to the observed temperature trend (NAPA, 2005).

2.3 Indicators of Climate Change

The effects of climate change and variability are undeniably clear with impacts already affecting ecosystems, biodiversity and people. Large-scale events, such as the

1997/98 El Niño, illustrate ways in which many communities are already suffering from less predictable and more extreme weather patterns. The 1997/98 El Niño, for example, resulted in cereal deficit at 916,000 metric tons in Tanzania. As a consequence, the President of the United Republic of Tanzania declared a national food crisis and appealed for additional food aid (Karen O'Brien, *et. al*., 2000). The livestock sector also underwent severe losses due to increased disease infection (especially Rift Valley Fever). drowning, damaged water facilities (dams, boreholes, water troughs). and disruptions in market infrastructure and road systems (Kandji, *et. al.,* 2006). Despite the massive losses, the abundant rainfall was beneficial in some areas. In some agriculturally marginal areas, production of crops was above average and there were improved fodder and water stocks, leading to an improvement in livestock performance in those areas. The La-Niña event of 1996/97 was responsible for the severe drought that occurred in most parts of Tanzania, Nachingwea inclusively leading to insufficient rainfall for hydroelectric power generation and urban water supplies. Crop failure was widespread and rangelands could not support livestock resulting in massive production shortfalls. Recently, farmers in Dodoma region have reported an 80% fall in expected yields due to late and poor rains.

Food Assessment Reports conducted by Food Situation Investigation Team in 2005 showed that poor rains during the short rainy season (locally called "*vuli*") resulted in food relief distribution in over half of the districts in the north-east and coastal regions (Karen O'Brien *et. el.,* 2000). In 2005 the agricultural sector grew by only 5.2% compared to 5.8% growth in 2004 and the GDP was targeted to grow by 6.9% but it grew by 6.8%. This was attributed to severe drought that affected most parts of the

country, triggering food shortage and power crisis (NAPA, 2005). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) dispelled many uncertainties about climate change. Warming of the climate system is now unequivocal. It is now clear that global warming is mostly due to man-made emissions of greenhouse gases (mostly CO_2). Over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 parts per million to 379 parts per million in 2005, and the average global temperature rose by 0.74° C. According to United Nations Framework Convention on Climate Change (UNFCCC, 2007). this is the largest and fastest warming trend that they have been able to discern in the history of the Earth. Tanzania is also prone to droughts and flooding. According to Hatibu and Mahoo, (2000). historically, floods have caused about 38% of all declared disasters, while droughts caused 33%. Over the last four decades, the country has been hit by a string of severe droughts and flooding, the most recent droughts occurring in 1971, 1975-76, 1983, 1985, 1987, 1992, 1996-97, 1999-2000. On the other hand, some of the most severe flooding episodes in recent years occurred in 1993, 1997/98 (El Niño) and 2000/01 (Kandji *et. al.* (2006). Climate variability and trend depicted by Enforsand Gordon, (2007). reveal that there is gradual reduced rainfall and long period of dry spell in part of Tanzania especially in highlands such as Same and Kilimanjaro (figure 2.3).

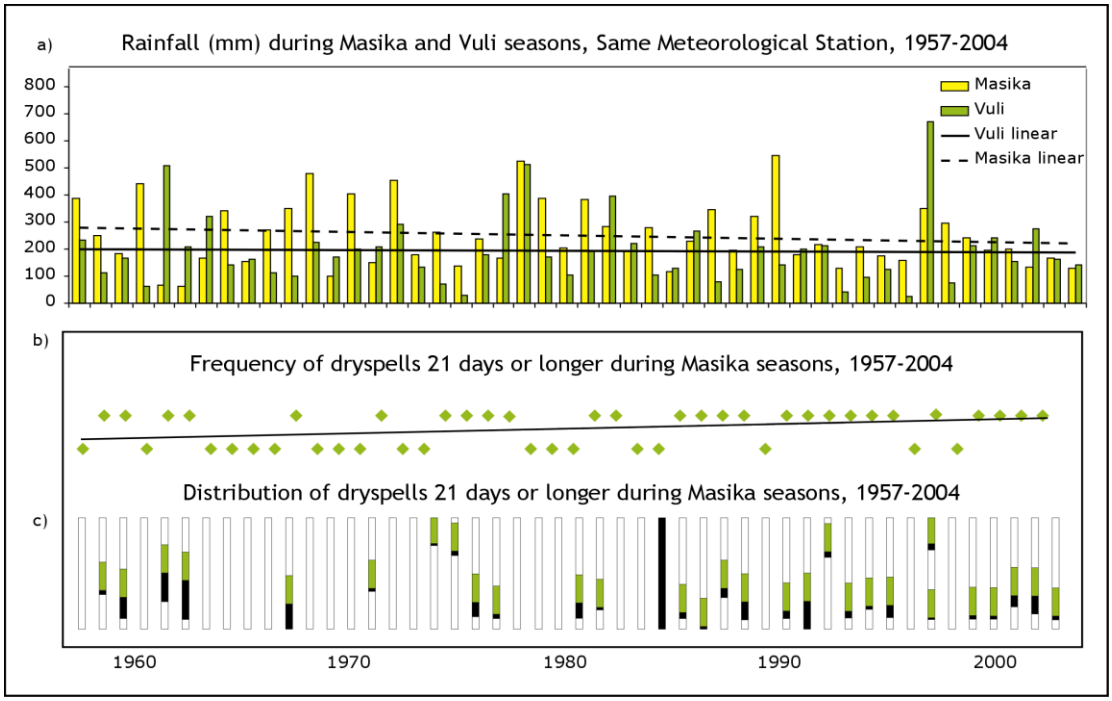


Figure 2.3: Rainfall Variations and Dryspells Distribution for Same Station, Kilimanjaro Region

Source: Enfors, and Gordon (2007)

An increasing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years. The IPCC Report gives detailed projections for the 21st century and these show that global warming will continue and accelerate. The best estimates indicate that the Earth could warm by 3°C by 2100. Even if countries reduce their greenhouse gas emissions, the Earth will continue to warm. Predictions by 2100 range from a minimum of 1.8°C to as much as 4°C rise in global average temperatures. Human beings have been adapting to the variable climate around them for centuries. Worldwide local climate variability can influence peoples' decisions with consequences for their social, economic, political and personal conditions, and effects on their lives and livelihoods. The effects of climate change imply that the local climate variability that people have

previously experienced and have adapted to its changing and changing at relatively great speed.

Increasing ocean temperatures cause thermal expansion of the oceans and in combination with melt water from land-based ice this is causing sea level rise. Sea levels rose during the 20th century by 0.17 metres; By 2100, sea level is expected to rise between 0.18 and 0.59 metres. There are uncertainties in this estimate mostly due to uncertainty about how much water will be lost from ice sheets (Bindoff, *et al*., 2007). for example Greenland is showing rising loss of mass in recent years (UNEP, 2007). Increased melting of sea ice and freshwater influx from melting glaciers and ice sheets also has the potential to influence global patterns of ocean circulation.

As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons). floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events (Meehl, *et al*., 2007). Increasing intensity and frequency of storms, drought, and flooding alter the hydrological circle and precipitation variance have implication on the future food availability. The potential impacts on rain fed agriculture against irrigated systems are still not well understood. The developing world already contends with chronic food problems. Climate change presents yet another significant challenge to be met. While overall food production may yet be threatened, those least to cope will likely bear additional adverse impacts (WRI, 2005). The estimate for Africa that 25 - 42 percent of species habitant could be lost,

affecting both food and non food crops. Habitant change is already underway in some areas, leading to species range shifts, changes in plant diversity which includes indigenous foods and plant-based medicine (McLean, Colin, *et al.,* 2005).

In developed countries 11 percent of arable land will be affected by climate change including reducing cereals production in 65 to countries, about 16 percent of the agriculture GDP (FAO, 2005). Agriculture-base system and livelihood systems that are already vulnerable to climate change face immediate risk of increased crop failure, loss of livestock and fish stocks, increased water scarcities and destruction of productive asserts. These systems include small-scale rainfed farming, pastoralism, in land and coastal fishing /aquaculture Farmers and forest-based systems. Rural people inhabiting coasts, flood plains, mountains, dry lands, and Arctic are most at risk. The urban poor, particularly in coastal cities and floodplain settlements, also face increasing risks (Ellis, & Sunberg 1998). Climate change is altering the distribution of animal and plant pests and diseases, the full effects are difficult to predict. Changes in temperature, moisture and atmospheric gases can fuel growth and generation rates of plants, fungi and insects, altering the interactions between pests, their natural enemies and their hosts. Changes in land cover, such as deforestation or desertification, can make remaining plants and animals increasingly vulnerable to pests and diseases. While new pests and diseases have regularly emerged throughout history, climate change is now throwing any number of unknowns into the equation. Some of the most dramatic effects of climate change on animal pests and diseases are likely to be seen among arthropod insects, like mosquitoes, midges, ticks, fleas sand flies, foot-and-mouth disease, bovine spongiform encephalopathy, classical swine fever disease and,

most recently, bird flu disease, are estimated to have caused economic losses and the viruses they carry. With changes in temperatures and humidity levels, the populations of these insects may expand their geographic range, and expose animals and humans to diseases to which they have no natural immunity.

Other climate changes can create more opportunities for vector-borne diseases. In pastoral areas, for instance, drier conditions may mean fewer watering holes, which will increase the interaction between domesticated livestock and wildlife. Increased interaction between cattle and wildebeest in East Africa could lead to a serious outbreak of malignant catarrhal fever, a highly fatal disease for cattle, since all wildebeest carry the fever virus. Aquatic animals are also vulnerable to emerging climate-related diseases, particularly since their ecosystems are so fragile and water is such an effective disease carrier. A fungal disease called the epizootic ulcerative syndrome recently expanded to infect fish in southern Africa due in large part to increases in temperature and rainfall levels.

2.4 Farmers' Perception on Climate Changes

Despite the scientific warnings of earlier decades, global warming did not become a significant public issue until 1988 - at that time the hottest year since the middle of the nineteenth century (Douglas, *et al.,* 2007). To date, there have been only a few indepth studies of public climate change risk perceptions (Craig, *et al.,* 2007). The most recent report of the Intergovernmental Panel on Climate Change (IPCC., 2007) confirmed that there is overwhelming evidence that humans are affecting the global climate, and highlighted a wide range of implications for human health. Climate variability and change cause death and disease through natural disasters, such as heat

waves, floods and droughts. In addition, many important diseases are highly sensitive to changing temperatures and precipitation (PHE, 2005). These include common vector- borne diseases such as malaria, tropical fever (dengue) as well as other major killers such as malnutrition and diarrhea. Climate change already contributes to the global burden of disease, and this contribution is expected to grow in the future.

The impacts of climate on human health will not be evenly distributed around the world. Developing country populations, particularly in Small Island States, arid and high mountain zones, and in densely populated coastal areas, are considered to be particularly vulnerable. WHO, (2001) estimated thirteen million deaths annually are due to preventable environmental causes. Preventing environmental risk could save as many as four million lives a year, in children alone, mostly in developing countries. Fortunately, much of the health risk is avoidable through existing health programmes and interventions. Concerted action to strengthen key features of health systems, and to promote healthy development choices, can enhance public health now as well as reduce vulnerability to future climate change. Proper environmental management is the key to avoiding the quarter of all preventable illnesses which are directly caused by environmental factors. The environment influences the health in many ways through exposures to physical, chemical and biological risk factors, and through related changes in our behaviors in response to those factors (IPCC, 2005). There is an urgent need to develop sustainable adaptive strategies and early warning systems that will address future climate change challenges. Combined efforts that improve adaptation to current climate variability and future climate change, early warning systems, knowledge of disease, medical health infrastructure and provision of

services, and improved socio-economic status would reduce the existing vulnerable situation. Future adaptation programs should take into account the diversity of factors that influence a society's capacity to cope with the changes.

Such programs should take into consideration the demographic trends and socio-economic factors, as these have an effect on land use, which may, in turn, accelerate or compound the effect of climate change. Trends in demographic, socio-economic development would definitely have a dampening effect on the potential consequences of climate change. The programs dealing with the other diseases that may increase the stress factors should be factored into the analysis of the future effects of climate change on the vulnerable systems (Yanda, *et al*., 2005).

2.5 Farmers' Adaptations to Climate change

Adaptation is widely recognized as a vital component of any policy response to climate change. Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced (Easterling, *et al.* 1993; Rosenzweig and Parry 1994; Smith 1996; Mendelsohn, 1998; Reilly and Schimmelpfennig, 1999; Smit and Skinner, 2002). The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Indeed, adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001). Thus, the adaptive capacity of a system or society describes its ability to modify its characteristics or behavior so as to cope better with changes in external conditions. Adaptation to climate change requires that farmers first notice that the

climate has changed, and then identify useful adaptations and implement them (Maddison, 2006).

Many agricultural adaptation options have been suggested in the literature. They encompass a wide range of scales (local, regional, global). actors (farmers, firms, government). and types: (a) micro-level options, such as crop diversification and altering the timing of operations; (b) market responses, such as income diversification and credit schemes; (c) institutional changes, mainly government responses, such as removal-preserve subsidies and improvement in agricultural markets; and (d) technological developments—the development and promotion of new crop varieties and advances in water management techniques (Smith and Lenhart, 1996; Mendelsohn 2001; Smit and Skinner, 2002; Kurukulasuriya and Rosenthal, 2003). Most of these represent possible or potential adaptation measures rather than ones actually adopted. Accoding to UNFCC, there are different approaches in responding to climate change in different sectors, the effectiveness of a practice depend on location and socio-economic situation. The practice does not prevent being shared, replicated and improved. Therefore, there is no evidence that these adaptation options are feasible, realistic, or even likely to occur. Furthermore, they would only be possible with complete and accurate knowledge of future climate conditions, that is why these were aptly named “clairvoyant farmer” scenarios (Risbey, *et al.*, 1999, cited by Belliveau, *et al,.* 2006). Thus, climate change impact studies often assume certain adaptations and little explicit examination of how, when, why, and under what conditions adaptation actually occurs in economic and social systems. Farm level analysis has shown that large reductions in adverse impacts from climate change are

possible when adaptation is fully implemented (Mendelsohn and Dinar, 1999). Short-term adjustments are seen as autonomous in the sense that no other sectors (e.g. policy, research etc.) are needed in their development and implementation.

Long-term adaptations are major structural changes to overcome adversity such as changes in land-use to maximize yield under new conditions; application of new technologies; new land management techniques; and water-use efficiency related techniques. With changes in precipitation and hydrology, temperature, length of growing season and frequency of extreme weather events, considerable efforts would be required to prepare developing countries to deal with climate-related impacts in agriculture (Mendelsohn, *et al.,* 1999). Among the key challenges will be to assist countries that are constrained by limited economic resources and infrastructure, low levels of technology, poor access to information and knowledge, inefficient institutions, and limited empowerment and access to resources. Managed carefully, climate adaptation strategies could have environmental benefits for some countries (Adams, *et al.,* 1999). The agricultural sector should adapt appropriate measures, to reduce the impact of change climate that include; use of artificial systems to improve water use/availability and protect against soil erosion, change farming systems, change timing of farm operations, use of different crop varieties, change governmental and institutional policies and programmes, and research into new technologies (FAO, 2008). Many of these involve improved resource management – an option with benefits that extend beyond adaptation. Climate change and variability are among the most important challenges facing Least Developed Countries because of their strong economic reliance on natural resources and rain-fed agriculture. People

living in marginal areas such as dry lands or mountains face additional challenges with limited management options to reduce impacts (Darwin, 1999). Climate adaptation strategies should reflect such circumstances in terms of the speed of the response and the choice of options. Also Wisner, *et al.*, 2004 argued that situation differ between Farmers and among individuals of how and which coping and adaptation strategies eventually take place; moreover the aspects of change compels analysis to integrate multiple scales as positions and situations over time.

In view of the above, a framework for climate change adaptation needs to be directed simultaneously along several interrelated lines which involve legal and institutional elements decision making, institutional mechanisms, legislation, implementing human right norms, tenure and ownership, regulatory tools, legal principles, governance and coordination arrangements, resource allocation and networking civil society (Easterling, 1996). The first important issue in agricultural adaptation to climate change is the manner in which farmers update their expectations of the climate in response to unusual weather patterns. Referring to Kolstad, *et al*,. (1999). Maddison, (2006) discussed what he calls “the transitional cost” of adapting to climate change. The transitional cost is the difference between the maximum value of net revenues per acre following perfect adaptation and the net revenues actually experienced by farmers given that their expectations of (and therefore response to) climate change lag behind actual climate change. A farmer may perceive several hot summers but rationally attribute them to random variation in a stationary climate. One could argue that farmers engage in simple Bayesian updating of their prior beliefs according to the standard formula. If so, the process of updating is likely to be slow, and therefore one

should not expect decades of information to be thrown out overnight. However, there is evidence that farmers did not update their priors in this way. Indeed, farmers place more weight on recent information than its efficiency. Another important issue related to adaptation in agriculture pointed out by Bryant, *et al.,* (2000) is how perceptions of climate change are translated into agricultural decisions. If farmers learn gradually about the change in climate, Maddison, (2006) argued that they will also learn gradually about the best techniques and adaptation options available.

According to him, farmers learn about the best adaptation options through three ways: (1) learning by doing, (2) learning by copying, and (3) learning from instruction. There is recognition that farmers' responses vary when faced with the same stimuli. Such varied responses, even within the same geographic area, are partly related to the variety of agricultural systems involved and the different market systems in which farmers operate (Bryant, *et al.,* 2000). A more important factor of varied farmers' responses is the differences between farmers in terms of personal managerial and entrepreneurial capacities and family circumstances. Also, farmers can be influenced by their peers' perceptions and by values present in their Farmers as well as their professional associations. A review of literature on adoption of new technologies identified farm size, tenure status, education, access to extension services, market access and credit availability, Agroclimatic conditions, topographical features, and the availability of water as the major determinants of the speed of adoption (Maddison, 2006).

2.6 Importance of Environmental Management on Adaptation Strategy

Muthoka (1998) defined environmental management as the measure and controls undertaken at individual, farmers', National and International levels and directed at environmental conservation so as to ensure that natural resources are allocated and utilized in a manner that will improve the quality of life for present and future generation. The aim of environmental management is to ensure long term productivity of the environmental resources so as to sustain development. In addition to that environmental management should ensure that in the process of development the interrelationships and interdependence within nature are maintained.

Environmental management involves the management of all components of the bio-physical environment, both living (Biotic) and non-living (Abiotic). The practices to be promoted are cropland management, restoration of degraded lands, use of Bio-energy and livestock management because they are interconnected and network of relationships of the human environment, such as the social, cultural and economic environment with the bio-physical environment (Muthoka, 1998).

2.6.1 Agriculture Sector

Environmental management aimed at utilizing the land resource in agricultural production through good agricultural practices (like mixed croping, organic farming, crop roation etc) which maintain and conserve the soil and biotic component.

2.6.2 Water Sector

Utilization of water resource for mankind without disprupting hydrological cycle through maintaining natural water cycle.

2.6.3 Education Sector

Education is one of the tool for tackling environmental issues through awareness. By utilizing extension officers, cummunity becomes aware and knows on how to manage and maintain natural environment and use the resources susstainably.

2.6.4 Health Sector

Proper medical waste diposal system is a key aspect in Environmental management in health sector. It involve taking care of community health while managing the environment.

2.7 Local Coping Strategies

In Africa rural farmers have been practicing a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events (UNFCCC, 2007c). These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes, such as the introduction of sheep in place of goats in the Bara province in Western Sudan, pruning and fertilizing to double tree densities and prevent soil erosion in semi-arid areas, e.g. Senegal, Burkina Faso, Madagascar and Zimbabwe; manipulation of land use leading to land use conversion, e.g. a shift from livestock farming to game farming in Southern Africa; water conservation techniques to cope with arid conditions such as the Zaï technique in Burkina Faso: farmers dig pits in the soil to collect organic material carried by the wind during the dry season, at the start of the rainy season farmers add organic matter from animals which attracts termite activity resulting in termite tunnels that can collect rain deep enough that it doesn’t evaporate, and thus increasing soil fertility. In many locations tribal and individual movements and migration are also identified as adaptation options. Despite there being a lot of

information on the impacts of climate change in Nachingwea District, little is known about how different sections of the community in the district perceive climate change and related drought events. It is this knowledge gap that necessitated this study to be carried out so as to have a better understanding on how sections of the small holder farmers have perceived the drought conditions. This would help relevant government agencies to formulate suitable policy interventions for the farmers whose livelihoods have been undermined by the adverse effects of recurring droughts caused by climate change.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This section describes the characteristics of area of study, the target population, sampling procedures, the sample size, data collection techniques, instruments and the data analysis plan.

3.1 Study Area

The study was conducted at Nachingwea District in Lindi Region. Nachingwea is one of the six districts in Lindi region. The district borders with Ruangwa district in the North-East, Masasi district to the south-east, Tunduru district to the South-West, and Liwale district to North-West (figure 3.1). Administratively, the district has five (5) divisions, which in turn are sub divided into 27 wards and a total of 104 villages with 41,580 households. The district has a population of 161,473 people of which 78,494 were males and 82,979 were females (NBS, 2002). The district experiences tropical climate where the warmest month of the year is December with an average temperature of 27^{o}C while in July the average temperature is 21.9 ^{o}C in which it is the lowest average temperature of the whole year, the average variation of temperature during the whole year is 5.1 ^{o}C. Driest month is August with 4 millmetre of precipitation while most precipitation falls in January with an average of 180 millmetre. The main ethnic groups are Mwera, Ngido, Yao, Makonde and Makua and their major activity is Agriculture. The main crops grown in the district include cassava, sorghum, legumes, maize, cashew, millet, sesame, bambara-nuts and groundnuts, paddy fruits and Irish potatoes; few of them practice small scale livestock keeping.

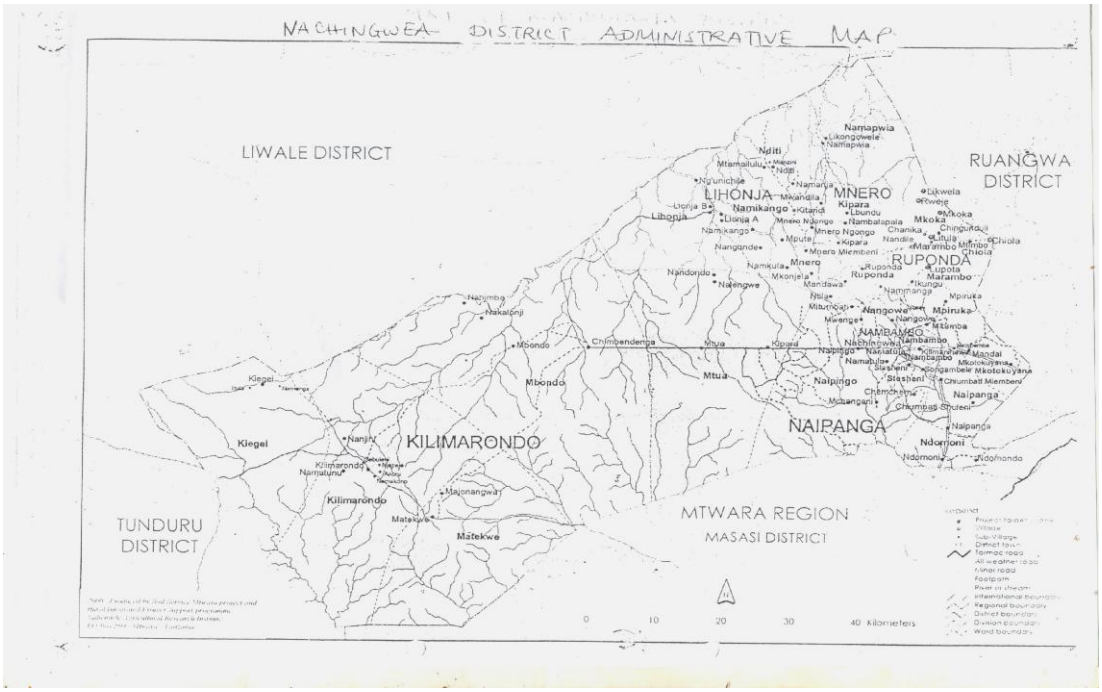


Figure 3.1 Nachingwea District Administrative Map

3.2 Population and Sampling Procedures

Multistage sampling technique was used to select, two hundred and sixty (260) respondents from five divisions (Small holder farmers) for the study (Table 3.1).

Table 3.1. Sampling Plan

ATRIBUTES NUMBER OF	NAMES OF DIVISIONS					TOTAL
	NAMBAMBO	RUPONDA	LIONJA	NAIPANGA	MBONDO	
Wards	6	5	5	6	5	27
Village	23	20	20	21	20	104
Respondent on each ward	60	50	50	50	50	260

Ten household were randomly selected from each ward out of them one were Executive wards another is village leader. The rest of respondents were systematically randomly selected for interview. Structured interview schedule was administered on respondents through Personal contact also open handed and closed questionnaires was

used so as to obtain information on the climate changes perception and their induced risks from respondents.

3.3 Data Collection Methods

Data has been collected through field surveys where personal interviews and Participatory Rural Appraisal (PRA). a technique that emphasizes local knowledge and enables local people to make their own appraisal or assessments, analysis, and plans. Together with semi-structured questionnaires (flexible checklists). focused group discussions (FGD) were used to enable information sharing, analysis, and action among stakeholders. An assessment was done to see how farmers have been affected by climate change, their coping mechanisms, adaptation measures, and how government supports them.

3.4 Analysis of Data

Research finding are presented using different themes. Tables, charts and diagrams have been used to analyse and present different themes from the data collected. The data collected has been processed using the Statistical Package for Social Sciences (SPSS) and analysed according to the study objectives.

CHAPTER FOUR

This chapter presents the data and findings for the study and it is organized into three main sections: The first section presents the demographic data which were obtained by the asking the participants to provide personal information. The second theme is Agricultural production trends and lastly Community perceiption and their adaptive strategies.

4.1 Social Economic Context

Socioeconomic status is an economic and sociological combined total measure of a person's work experience and of an individual's or family's economic and social position relative to others, based on income and education, and occupation (Marmot, 2004). indicates when analyzing a family's social economic status, the household income, earners' education and occupation are examined, as well as combined income, versus with an individual, when their own attributes are assessed.

In social sciences study, personal characteristics of respondents have very considerable role to play in expressing and giving the responses about the problem. Keeping this in mind, in this study a set of personal characteristics namely, age, sex, education, occupation of the 260 respondents have been examined and presented in this chapter.

4.1.1 Age of Respondents

Age of the respondents is one of the most important characteristics in understanding their views about the particular problems; by and large age indicates level of maturity of individuals in that sense age becomes more important to examine the response. The household analysis has shown that most of the households interviewed have mature

age above 51 years. These situations suggest that they have enough experience on climatic related events in their area (Fig 4.1).

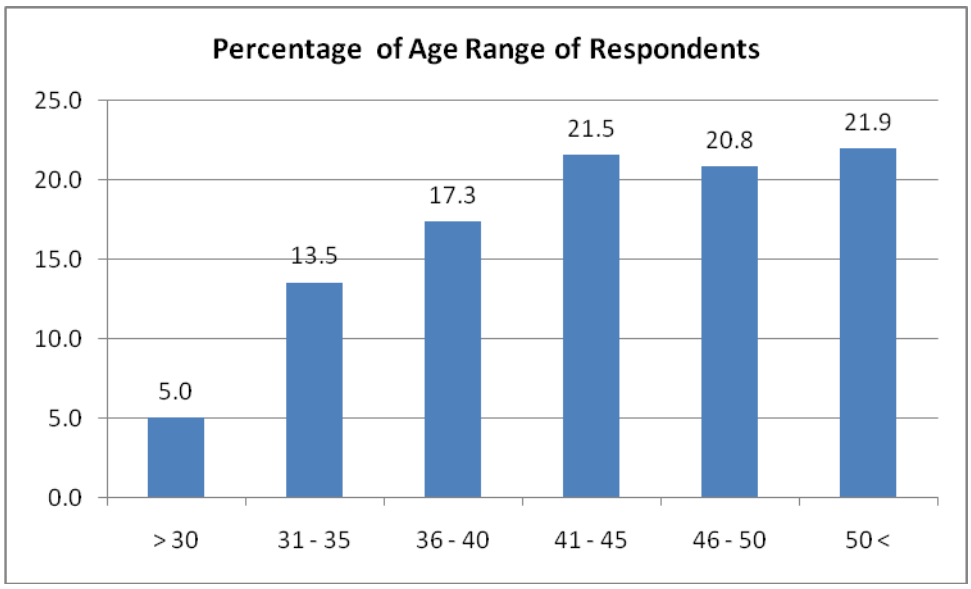


Figure 4.1: Percentage Age Range Distribution of Respondents

Figure 4.1 reveals that 21.9% of the respondents interviewed were the age of above 50 while 21.5% fell between 41-45 years of age while 20.8% and 17.3% were between 46-50 and 36-40 years respectively, and 5.0% fell between the ages of less than 30 years. This implies the majority of respondent interviewed have enough information on climate change and its characteristic impacts on livelihood.

4.1.2 Gender of Respondents

Gender is an important variable in a given African social situation which is variably affected by any social or economic phenomenon and globalization is not an exception to it. Hence the variable gender was investigated for this study. Even though excellent work on gender and climate change is beginning to emerge. However, experts from different disciplines are rarely working together on these issues, so opportunities to pool resources for more creative, effective solutions are being lost. In addition, much

of this work does not take into account complex realities. For example, women are often treated as a homogeneous group, rather than as highly differentiated according to their age, social class, level of access to resources, and many other factors. Significantly, existing work rarely takes into consideration women's relationships with men, through which particular gender roles and expectations are often reinforced for example, if women are not involved in important decision-making at the household level, it follows that they are unlikely to be consulted on climate change adaptation strategies. Existing work also tends to reinforce the assumption that women are only victims of climate change, rather than also being agents of positive change. Furthermore, it assumes that men cannot be victims and ignores their particular experiences of climate change that are compounded by poverty or other forms of disadvantage.

In this study about 47.3% of the respondents were males and 52.7% were female. This was done firmly so as to attain the balance in assessing variation in vulnerability and climate change impacts on both males and females in the community. However, this shows women who are more responsible to feed the family therefore, they will give appropriate answers in accordance to what they have been experiencing. Marriage is one of the most important social institutions. In a developing country like Tanzania, it has undergone many changes. The perceptions and attitudes of the person can also differ by the marital status of the persons because the marriage might make more responsible and mature in understanding and giving the responses to the questions asked. Out of the female population, 32.7% were single, 30.8% were married while 17.7%, 10.8% and 8.0% were separated, divorced and widowed respectively (Fig 4.2).

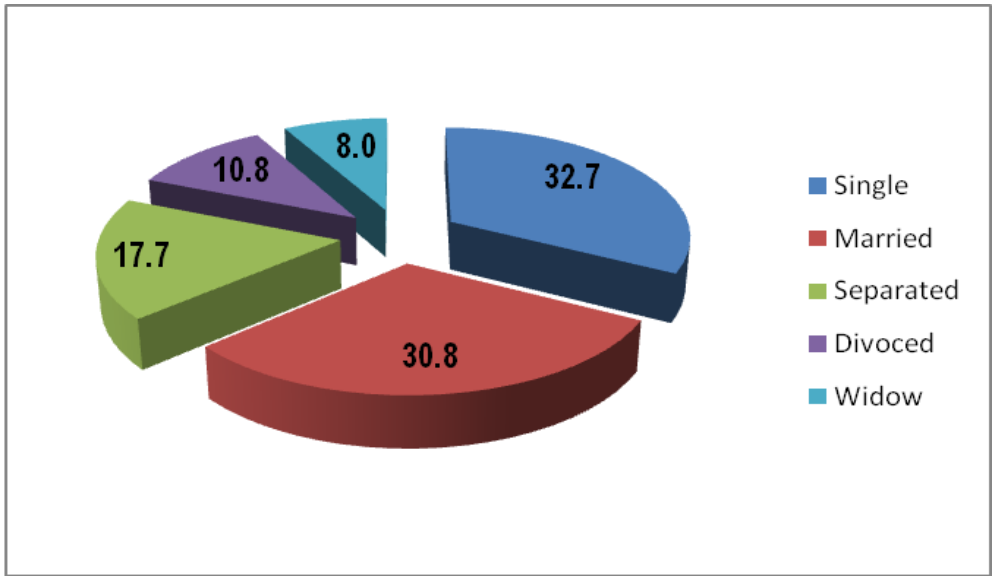


Figure 4.2 Percentage of Female with Different Status

This implies, a total of 36.5% were leaving with their families out of marriage for various reasons. This was higher than what was reported in Tanzania statistics of the district (Census, 2002) that orphanhood in the district stood at 14.34 percent, 0.80 percent of whom were child orphans.

4.1.3 Education Level of Respondents

Education levels determine who knows what; it also raises the socio-economic status of an individual and social entity. Education level also has impacts on understanding of climate change related issues and associated adaptation strategies (Mwanga, 2012). According to Tanzania statistics (Census, 2012). the literacy in the district is more than 58 percent among the population aged 5 years and above. Literacy in Kiswahili stood at 54 percent while 4 percent were literate in both Kiswahili and English. Furthermore, literacy rate was highest among those aged between 10 and 19 years. Literacy was also higher among the urban population than the rural. According to TenMet (2011). the district showed a net enrolment rate of 60 percent. The enrolment

rate for the rural population was 59 percent compared to 68 percent in the urban areas. The enrolment rate for males was 59 percent compared to that of females at 68 percent. Field data shows that, about 71.2% of respondent were literate at different levels of education from Primary level to tertiary level (Fig 4.3). This implies that, majority of respondents interviewed have necessary information on their surroundings.

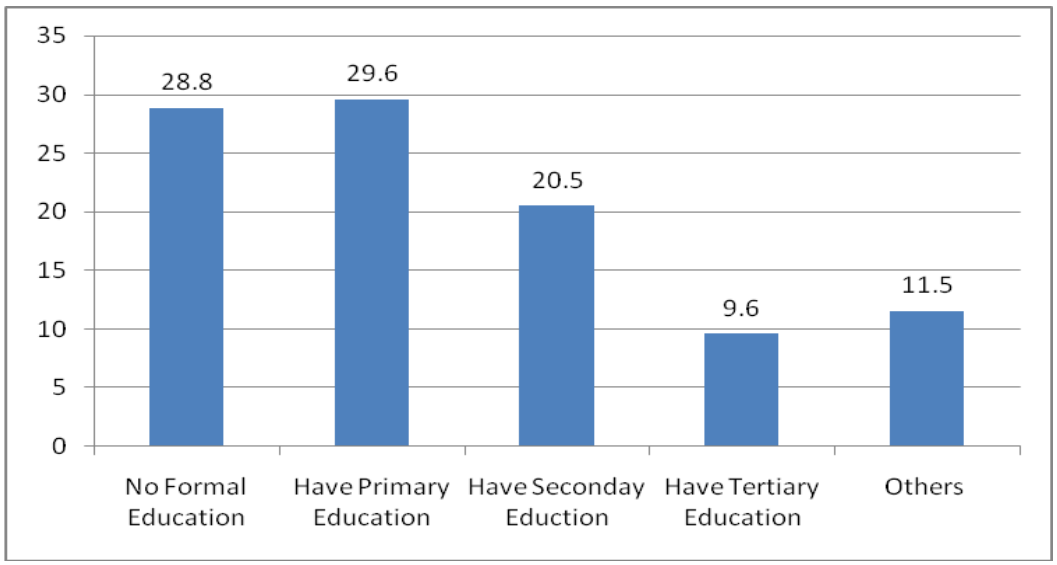


Figure 4.3 Education Level of Respondent

The number of people having secondary school education is lower than that got primary school. This also have been indicated by PEDP (2003) in which they disclosed that in 1998, almost 3,000 primary school girls were expelled from school due to pregnancy. This is equivalent to closing down about 67 classrooms with 45 pupils each, per year. Dropout rates for girls appear to be high because of pregnancy. Pregnancy makes a larger proportion of reasons from girls dropping out of school than any other reason in both Lindi and Mtwara Regions. About of 60% girls who dropped out of school in Lindi in 2005 and 86% of those in Mtwara, did so after getting pregnant (TenMet, 2011). Pregnancy is becoming increasingly a major concern in

many districts in Tanzania because of its ultimate consequences, that of permanently terminating girls' education.

4.1.4 Places of Origin and Reasons for Settling in the Study Areas

Some respondents were found to have limited understanding on climatic conditions that have prevailed over generations in those villages. The reality that some of the villagers originated from other places than they currently settle may be the factor limiting their in-depth knowledge of local environment. However, it was found that those who migrated to those villages before 1980 have acquired considerable understanding of the local climatic patterns, changes and climate indicators through oral history and personal experience. About 47% of the respondents have lived for more than 11 years in the village while 52.7% resided for the period between 1-10 years (Figure 4.4).

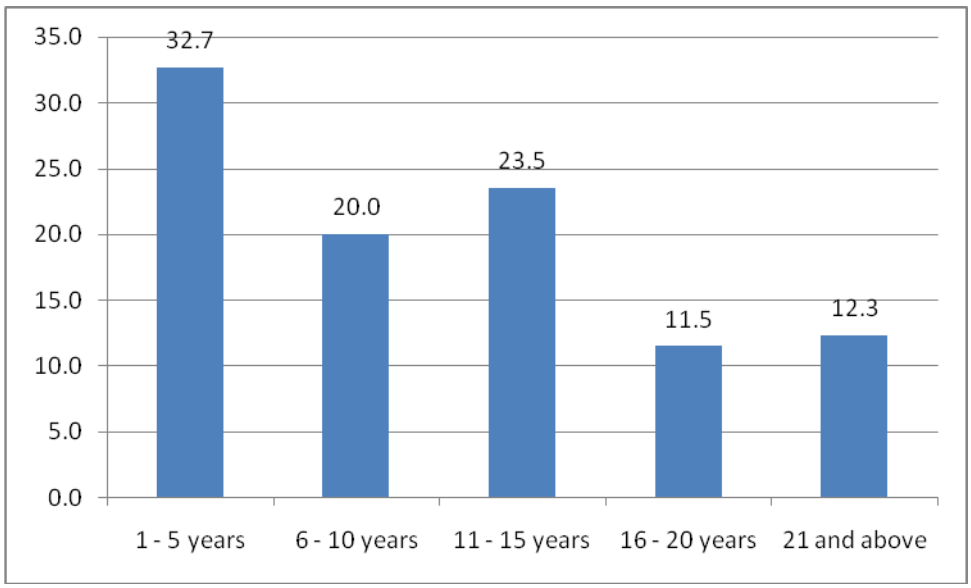


Figure 4.4 Number of Years Respondents have Stayed in the Study Area

Figure 4.4 shows that some of respondents moved to the area in search for business opportunities. This suggests that such activity is not much important in supporting livelihood in the study area. On the other hand, others indicated that they moved in searching for agricultural land, this also shows the importance of agricultural activities in supporting livelihood of the people in the study area. It is not surprising because moving from one location to another looking on good area for cultivation is one of prominent indicator for the climate change (Majule, *et al.,* 2013). This is well noted as the high rate of respondents about 53% have just moved to the place recently.

4.1.5 House Hold Income for the Respondents

Household income shows that, 52.3% fells on average of a less than Tanzania shillings 250,000 per year while 36.2% fell on the average between Tanzania shillings 250,000 – 500,000 per year and 11.5% fell on income above 500,000 Tanzania shillings (Figure 4.5).

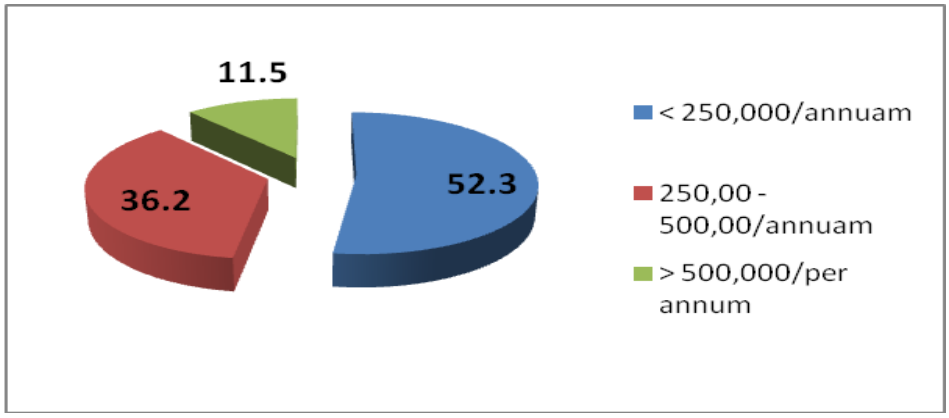


Figure 4.5 Percentage Household Income

Figure 4.5 shows that majority of residents got less than 250,000/= Tshs per annum which is equivalent to be less than 20,000/= Tshs per month which is somehow equivalent to 10 USD per month. That shows level of poverty in the study area is high because majority of residents leave in less than a dollar in a day. This suggests that

when such sources of income are impacted by climate change it may have serious consequence on household livelihoods of the concerned communities.

4.1.6 Householder Head

When they were requested to indicate the head of the house it learnt that majority of house head was Mothers (53.1%) while 41.9% headed by Fathers and 5.0% are headed by others like grandfather/mother or children themselves (Figure 4.6).

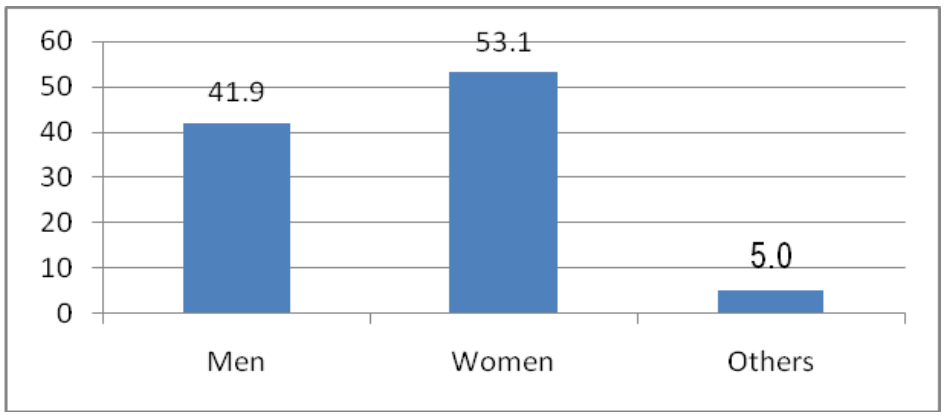


Figure 4.6 Percentage Household Head

This confirms what was observed in 4.1.3 that the majority of young teenager in the study area droped out of school because of early pregnancy. All these got early pregnancy ended heading a household. The Government of Tanzania inforce bylaws to fight against the teenage pregnancies in this area (Lindi Region) on the understanding that the livelihood of young girls requires immediete action. However a mixture of poor tradition, customs and norms and poverty among the majority of study area societies make the young girls the most vulnerable group. Otherwise this indicates women are the one who bear the burden for taking care of the families therefore most affected by climate change.

4.2 Farm Asset ownership

The economic status of Smallholders farmers depends solely on ownership of farm assets like farm plots. Plot size, plot location and fertility are the key determinants on the kind of crops to be produced as well as livestock production utilities. A combination of livestock and crop production is very important in climate change adaptation strategies.

4.2.1 Farm Plots

Field data (Table:4.2) revealed that, about 53.1% of respondents interviewed own small plots of farms between 1-5 acre, 36.1% ranging between 6 – 10 acre and 10.8% own more than 11 acres. This implies the majority of respondents have enough land for agricultural activities of which 37.7% have acquired through inheritance from their ancestor, 21.5% and 40.8% own through purchasing and given from village council recovered from village farms.

4.2.2 Livestock Ownership

In Tanzania there are three types of livestock husbandry systems in a form of pastoralism and commercialized intensive systems; (1) Pure Pastoralists – "*Ufugaji asili";* (2) Agro-pastoralist "Ukulima na ufugaji" and 3) Intensive livestock keepers "*Ufugaji shadidi"* (Mashingo, 2010). In the surveyed areas, farmer practice agro-pastoralist and households keep the following animals' cattle, chicken, pig, goat, and ship; while chicken and goat are most raised animals. Field data Table 4.2 revealed that, 45.4% of respondents own chicken, 41.9% own mixed stocks like shoats, cattle and chicken while 7.7% own goats and 5.0% own cattle. This implies that, household have diversified their income on farm get income and livestock keeping.

When interviewed on the reason why they keep these type of animals (Fig.4.2). more than a half (54.3%) said that livestock increases their income after sell of the animals and its products, while the other (13.7%) reasons included nutrition factors (for milk, meat, eggs etc). 32.0% said that livestock is used as safety net during crisis; this has to be encouraged given the current price instability for cash and food crops in the markets, livestock helps to cushion income changes due market instabilities. Establishment for livestock raising projects at family level such as traditional chicken, goats, pork could be one way of getting out of poverty for many households.

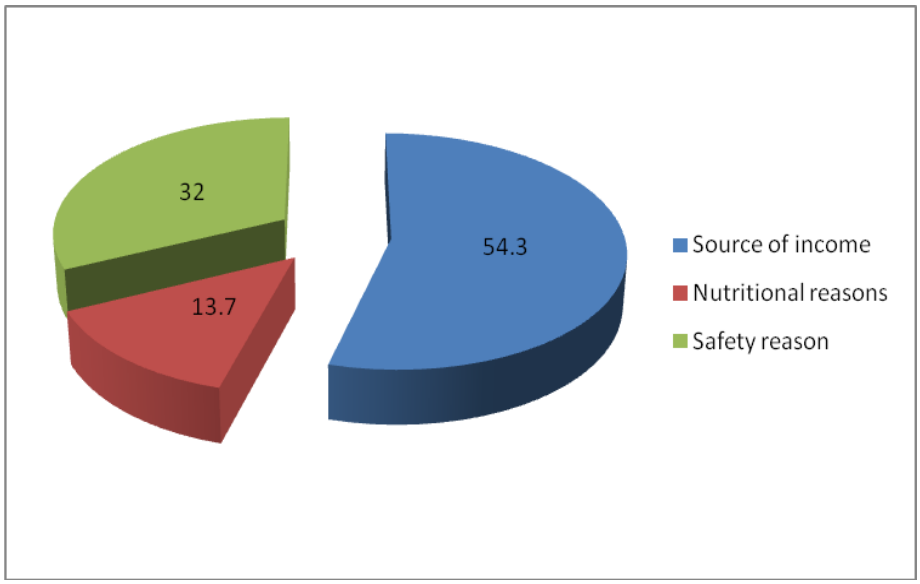


Figure 4.2 Percentage Reasons for Keeping Livestock

4.3. Agriculture Production Trends

Agricultural activities are affected by a number of factors including reduction of soil fertility and climate change of which may results into low agricultural produce.

4.3.1 Reduction in Soil Fertility and Crop Yields

Some of the impacts of climate changes noted by farmers include reduction in soil fertility. In addition to the changes observed above that directly affect agricultural production in a negative way; soil fertility seemed to negatively affect crop

production to a large extent. Most farmers agreed that soil fertility has been reducing over the years. This has resulted in reduced crop production. Examples were given by farmers that compare to the past maize harvest has drastically declined, due to reduced soil fertility; hence, if they do not use fertilizer the harvest becomes so low. One can argue that soil fertility is not only influenced by climate change. There are various reasons for the decline of soil fertility. Farming system may also contribute; Some common farming practices, including burning crop residues and leaving soil bare and unprotected from the sun and wind, are part of the problem. Excessive or insufficient use of fertilizers and improper crop rotations also lead to declining soil fertility. As noted in the discussions above, most farmers have mainly primary school education and live in rural areas. Livelihood choices for these farmers is limited, therefore decreasing crop yields is a serious challenge to their survival.

4.3.2 Crop Categories Grown

Farmers have observed some changes in the type of crops used to grow, Some crops are no longer grown or if grown its yields have declined such that farmers don't get equitable return. For instance sunflower, cassava, sorghum, legumes, maize, millet, bambara-nuts, groundnuts, paddy fruits and Irish potatoes are the crops that are mostly grown because these are short term crops that mature within a short period and give good return to farmers. Others said that old types of seeds for crops have disappeared (maize, beans, banana, millet, mangoes, oranges, cashew, groundnuts). One old man in Namatula village during the discussion said that the "maize and potatoes we used to grow in the past was sweat but are not grown now…things have changed at the moment ...the old crops are not the current crops, and even the farming

ways have also changed, in the sixties we were not using chemicals or fertilizer but now if you don't use you will not get the better yields". Field data in Table: 4.3 revealed that food crops and cash crops are the main categories of crops grown in Nachingwea District, 70.4% of responded grew both cash crops and food crops while 15.4% and 14.2% grew cash crops only and food crops only respectively. This implies that, most of the household have alternative crops to grow in case they experience adverse weather conditions. In addition to the disappearance of major crops, there have also been changes in what is considered as major crops. Farmers interviewed noted that there have been changes over the past ten years on what is considered as a major crop (Figure.4.3.2)

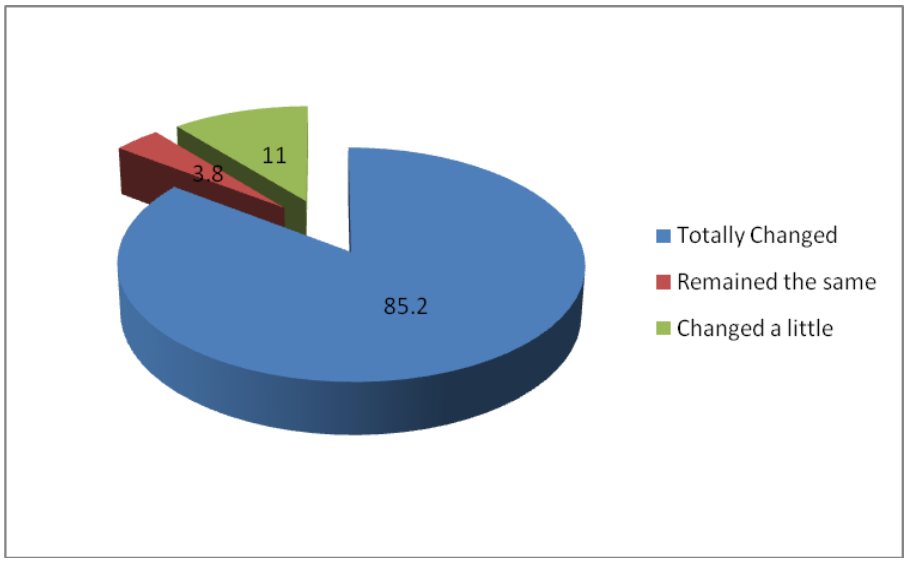


Figure. 4.3 Percentage Major Crops Change Over Past Ten Years

About 85. 2% of farmers interviewed indicated that there are changes in the type of crops they farm over the past ten years and 56.8% noted that these changes are frequent depending on the availability of rain. Although climate/weather changes have

been contributing significantly in farmers shift into new crops species, prices changes, world demand for new crops have been contributing into crop/livestock changes.

4.3.2 Production Pattern

The historical pattern of crop productivities per acre varies between years, these variation are caused by multiple factors, including soil factors, climatic factors and farm operations; 50.8% of respondents reported decline annual yield during last 30 years while 4.6%, 30.0% and 14.6% reported to increase, fluctuate and constant yield respectively. This implies, there is general decline in Agricultural production trends yearly.

4.3.3 Average Crop Yield per Hectare

Also the average crop yield per hectare reveals the same (fig. 4.3). 33.8% harvest less than 1000kgs per hectare, 30.0% lies between 1000-2000kgs, 24.6% and 11.5% fells between 2001-3000kgs and above 3000 kgs of the yield.

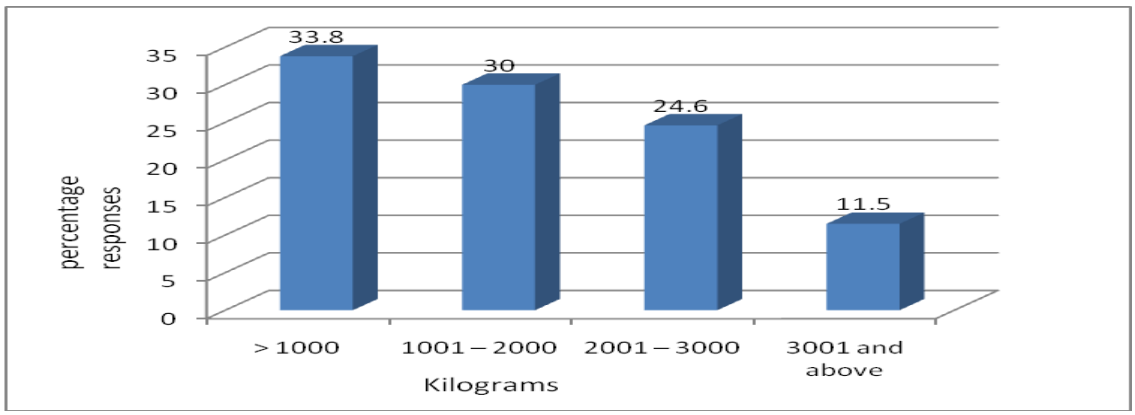


Figure. 4.3 Crop Yield per Hectare

Interview with respondents showed that more yield have been reported by those smallholder farmers who have access to Extension services and have household income of above 500,000 Tanzania shillings, because they have ability to buy farm

inputs. The argument supported by Deresa, *et al.,(2009)* who reported that, extension services is very important in analyzing the adoption decision of the adaptive measures of climate change.

4.4 Access to Meteorological Data/Information

Field data in Table 4.4 revealed that, about 68.5% of the respondents have access to weather forecast information while 31.5% do not. Also data shows that, out of 68.4% of those who access the information (Fig. 4.4). about 4.6% obtain information from Meteorological station, 35.8% from Media such as radio and news papers, 39.2% from Extension Officers, 3.5% from Researchers, 3.8% from indigenous local forecasting, 9.6% and 3.5% from Village meeting and NGO working in the Village.

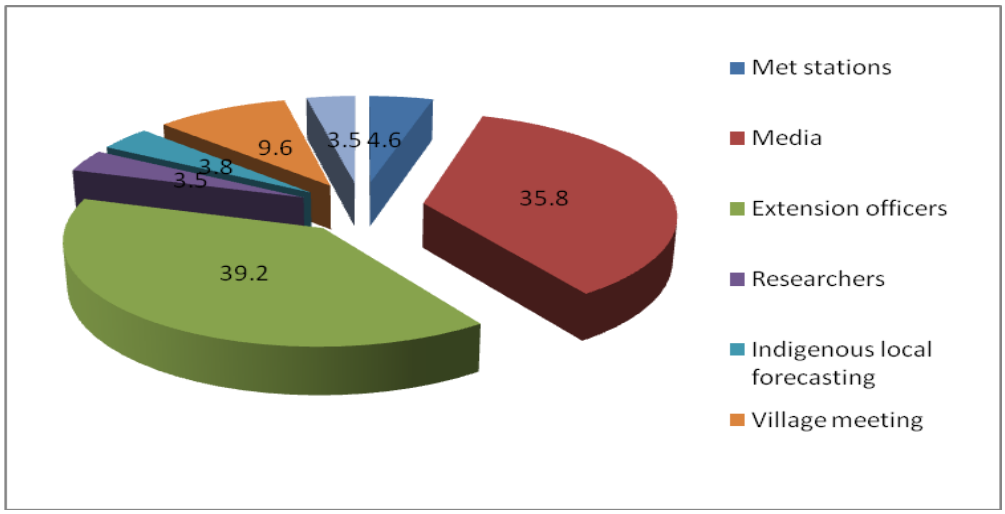


Figure. 4.4. Sources of weather information

Information such as starting and ending of rains, amount of rain, drought spell, temperature and strong winds are available to smallholder farmers. This implies, erratic climate change and mitigation measures can possibly be taken care. This finding is in line with Daresa *et al., (2009)* findings which reported; among many sources of information, Agricultural extension services is the most important for analyzing the adoption decision of the adaptive measure. It is hypothesized that,

farmers who have significant contact extension services have better chance of being aware of changing climate conditions as well as adaptation measures in respond to change of these conditions.

4.5 Community Awareness and their Adaptations to Climate Change

Awareness is very important for adaptation to climate variations. Farm level analysis has shown that large reductions in adverse impacts from climate change are possible when adaptation is fully implemented (Mendelsohn and Dinar, 1999).

4.5.1 Community Awareness on Climate Change/Perceptions

Awareness refers to ability of an individual to protect change that would happen if measures were not taken (Maddison, 2006). Field data in Table 5 revealed that, 91.5% of the respondents interviewed are aware of the Climate change and their impacts, only 8.5% are not. Although majority of respondent emphasize that, the bad events of flood that happen in some years back was God's punishment of misconduct on environment. When farmers were asked what was the cause of all the said environmental changes, farmers listed a number of factors such as: increase of population that also increases economic activities, destruction of water sources, deforestation that has resulted in reduced rain and drought.

Other contributing forces included increased farming and urbanization taking up land and forests which were initially used for grazing, though some of reasons mention was not applied in their villages. Out of 91.5% of respondents on climate change awareness (Fig.4.5). about 29.6% is from own respondents observations, 24.6% is through Media, 7.7% is through extension officers, 11.5% through researchers, 11.5%,

7.7% and 7.3% through indigenous local forecasting, village meeting and NGO working in the village respectively.

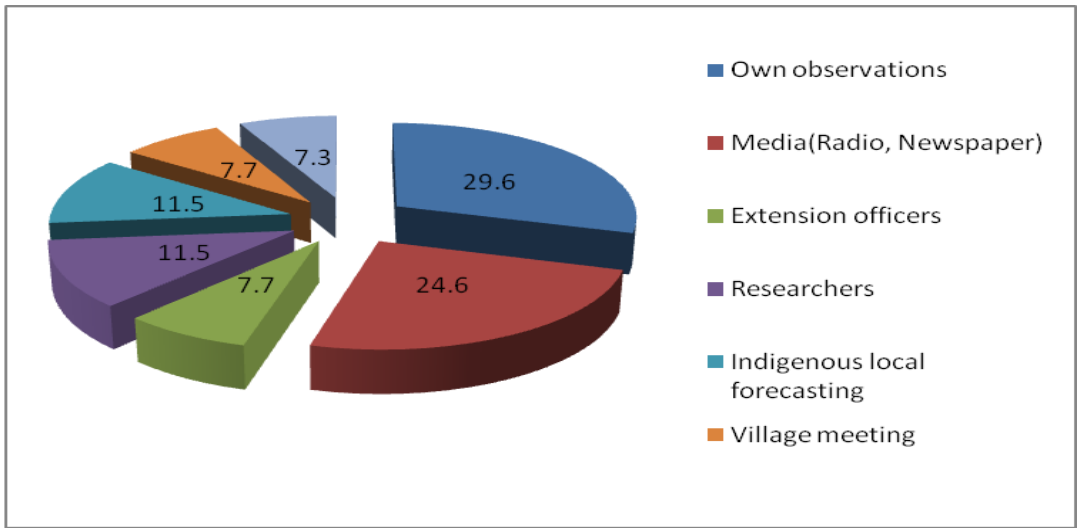


Figure. 4.5 Sources of Climate Change Awareness

This implies, the majority of respondents are in the position to mitigate and adapt these changes. The finding agree with the finding of Kurukusuriya and Mandelson, 2006; Juana, *et al.,(2013)* which says majority of farmers in Africa are aware of changes in temperature and precipitation but have limited capacity to cope with adverse consequences of climate change and have barrier to adopt different adaptation strategies.

Also data revealed that 54.2% of respondents have long years of experiencing Climate change of between 6 – 30 years while only 45.8% have recent experience of year ranging from 1- 5. This implies the more exposure to extreme weather conditions the more adaptive techniques to reduce the impact. These finding agree with those of Ayanwuyi, *et al., (2010).* The responses of sampled farmers perception on climate change in Nachingwea district indicates 31.1% delayed rainfall, 24.7% indicated

higher temperature 11.7% indicated unusual heavy rainfall, 9.4% indicated fast water evaporation and undefined season while 5.0%, 4.4% and 4.2% indicated more longer days than night, flood with serious consequence and late fruiting of tree crops respectively as the determinant of climate change in their environment. This result conform with Lobell,(2008) Apata, *et al*., (2009) who reported that 89.0%, 72.0% and 65.0% of the respondents respectively indicated higher temperature, water evaporation from the ground is fast and delayed rainfall as the determinants of climate change. Responses from sampled farmers on impact of climate change on crop production (Fig. 4.5.2). revealed that about 39.3% reported to have low yield of crops, 17.2% stunted growth, 15.2% drying of seedling after germination, 13.1% ease spread of pest and diseases attack on crops and 15.2% ineffectiveness of agricultural chemicals used due to delay in rainfall.

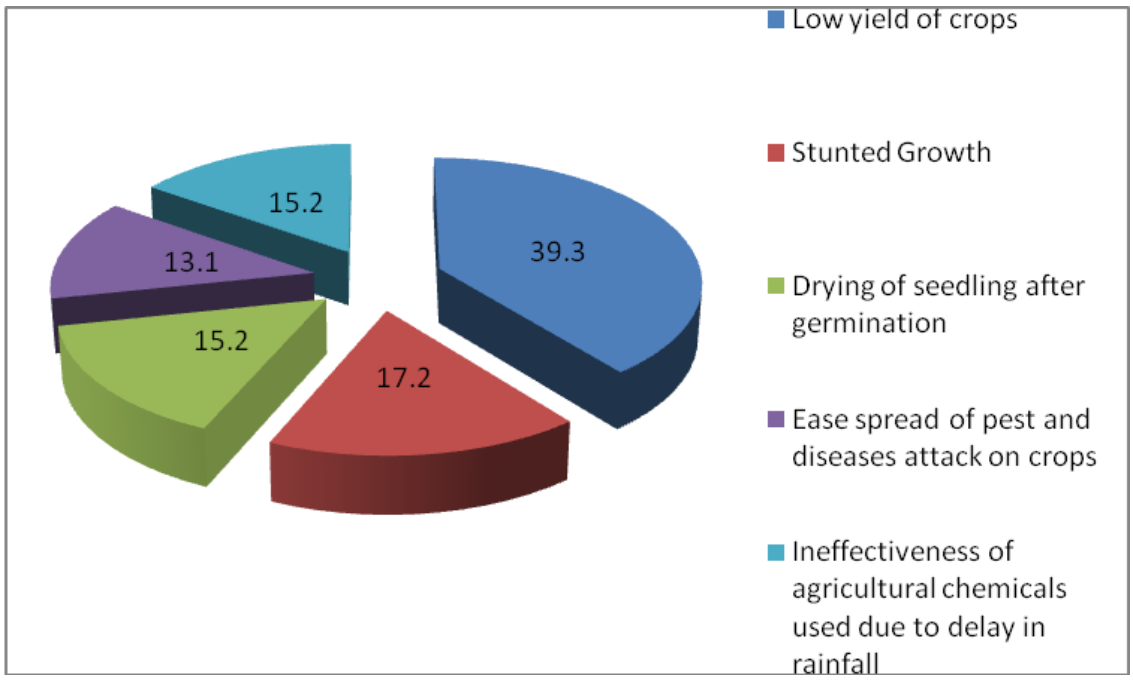


Figure. 4.5 Impact of Climate Change on Crop Production

These findings agree with those of Nyanga, *et al., (2011)*; Apata, *et al., (2009).* that farmers have experienced delayed rainfall and early cessation and excessive rain and

strong winds. Also agree with findings of Molua, (2008) who reported that, performance of agricultural sector depends largely on the return of good rains and the timely and adequate provision of agricultural inputs.

4.5.2 Adaptation Strategies to the Perceived Climate Change

Adaptation to climate variation is a regular feature of our lives and, broadly speaking, we are adapted to cope with a wide range of climatic conditions. Indicators of successful adaptation include the increase in world food production in pace with population growth, increased life expectancy and decreased weather related deaths in developed countries (Schneider et al, 2007, and McMichael et al, 2001). One strategy commonly in use is to increase the capacity to bear losses by accumulating food surpluses, livestock, financial assets and other assets. Risks are hedged by diversifying crops, income sources, food sources and locations of production activities. Exposure to climate hazards has been reduced by relocating, either temporarily or permanently. Variability of production and incomes derived from natural resources have been reduced by restoring degraded lands, using drought resistant seed varieties, harvesting rainfall, adopting irrigation and using seasonal forecasts to optimize farm management.

In many cases the capacity to adapt is increased through public sector assistance such as extension services, education, community development projects, and access to subsidized credit. Figure. 4.6 (a & b). reveal adaptation strategies actually adopted by the respondents in a surveyed area. These strategies are: increase water conservation (68.3%). shading and shelter/ mulching (59.4%) soil conservation (55.0%) move to different site (38.3%) while 34.2%, 20.6% and 19.2% of the respondents implement

water conservation techniques practice, increase irrigation, and increase or reduction in land size cultivated respectively. Also respondents adopted planting of different crops (74.7%). treatment of seed with fungicides before sowing (60.0%). planting different varieties of crops (58.9%). mixed cropping (96.7%) and change in the use of chemical (68.9%).

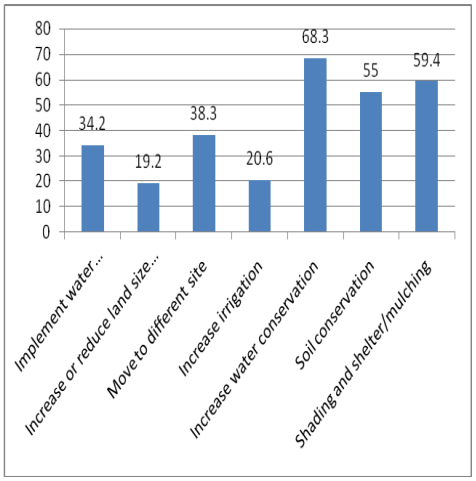


Figure 4.6 (A) Soil Water Strategies

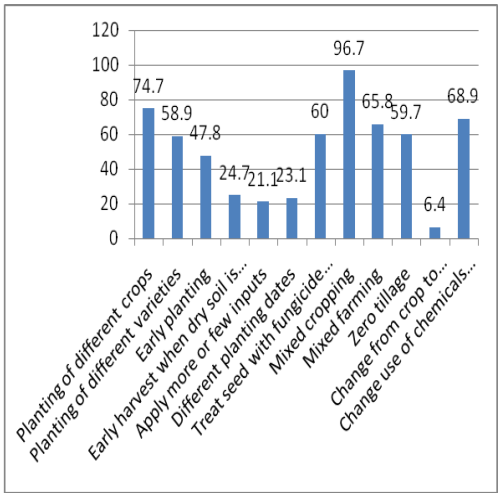


Figure 4.6 (B) Farm Operations

Furthermore, 54.4% and 52.5% of the respondents adopted change of row orientation with respect to slope and application of soil amendments e.g. farmyard manure respectively as the strategies to mitigate effect of climate change. Table 4.6 further revealed that 96.1% adopted food rationing, 86.7% reduce expenditure and 59.2% avoid selling remaining food stocks. However, 86.1% and 11.9% revealed that adequate access to extension facilities and credit facilities are the strategies adopted to mitigate effects of climate change on crop production in the study area. Few farmers have indicated that they use new type of maize seeds that produce maize within a short time and do not require a lot of rain. Therefore, farmers are trying to adapt to the changing climate by changing the type of seeds they use. There was a new type of

cassava that has been introduced which is resistant to disease and weather but farmers indicated that, it does produce a lot of cassava, but the cassava is not very tasty and people do not like to use and therefore no market for it

These results are in line with Molua, (2008). Rudolf and Hermann, (2009) and Apata, *(2009)* who reported that main strategies for reducing climate risk is to diversify production and livelihood systems like soil and water management measures, and plant protection measures that varied to maintain adequate crop yields. Also Maddison, (2006); kurukulasuriya & mendelson, (2006) who reported arable farmers have switched to planting diversified crops, changed planting dates to correspond to the change in precipitation pattern, planting tree crops, mixed cropping and off-farm income generating activities.

4.6 Regression Analysis on Perception of Climate Change and Adaptation Strategies

Results of regression analysis in Table 4.8 shows that increased or reduced land size cultivated (X_1). shading and shelter /mulching (X_2) mixed cropping (X_3) change row Orientation with respect to slope (X_4) Access to extension facilities (X_5) Access to credit facilities (X_6) education level (X_7) years of farming experience (X_8) and zero tillage (X_9) had positive significant relationship with the dependent variable and predicted 60% of the variations in the farmers perceptions of impact on climate change. Experienced farmers have an increased likelihood of using portfolio diversification, changing planting dates, and changing the amount of land under production. These results confirm the findings of Nhemachena and Hassan (2007) in a similar study of adaptation in the Southern Africa region. Experienced farmers have high skills in farming techniques and management and are able to spread risk when

facing climate variability by exploiting strategic complementarities between activities such as crop-livestock integration. The coefficient on farm size is significant and positively correlated with the probability of choosing irrigation as an adaptation measure. Indeed, large-scale farmers are more likely to adapt because they have more capital and resources. Therefore, they can easily invest in irrigation technologies, which demand high investment costs. Moreover, the perception of having highly fertile soil increases the probability that farmers will change their amount of land under cultivation. With an increased probability of taking up portfolio diversification, farmers who have access to extension services are more likely to be aware of changing climatic conditions and to have knowledge of the various management practices that they can use to adapt to changes in climate.

These results agree with the finding of Kurukusuriya & Mendelson, (2006) whose empirical analyses shows that gender, age of the farmer, years of farming experience, household size, education level, access to credit facilities, access to extension services, off-farm income generating activities are among the significant determinants of adoption of climate change. This explains that, the more the perceived impact of climate changes the more the adoption of adaptation strategies to mitigate climate change impact on food crop production.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

The general objective of this study was to assess the small holder farmers' perception on climate change and their adaptation. The overall thrust of this study was to determine the adaptive capacity of farmers to the observed climate changes and the associated risks by suggesting locally developed strategies within local context. The study was conceptualized in the farmer's perception framework whereby the perceived impacts by farmers determined the response options farmers undertake to reduce risks caused by the climate change. Based on the findings of the study, the following conclusions and recommendations were made.

5.1 Conclusion

Currently communities observe and understand the changes that are occurring in their area including climate change associated with variability in rainfall patterns, temperature patterns, wind velocity, and increase of weather related problems as compared to the past. However, there is low understanding on the proper adaptation strategies and the reason of using improved and climate smart agricultural practices. Farmers are sufficiently aware of climate change. The main indicators of climate change found included reduced rainfall, rainfall coming late and ending early, increased temperatures, increased incidences of drought, and decreased crop productivity. Crop diseases also had impact on food availability to most farmers. In general, it has been observed that there is a general decline in crop productivity in all studied areas partly due to climate change impact and partly due to other factors. This

implies the more exposure to extreme weather conditions the more adaptive techniques to reduce the impact. Evidence for farmers' perceived changes in climate is reflected in the adjustment of agricultural calendar and adoption of different adaptation strategies. Survey results confirmed that farmers have shortened the cropping calendar and the majority of the respondents have adjusted their farming practices to counteract the impacts of changes in temperature and rainfall patterns. The common adaptation strategies of farmers were: implementing soil conservation practices, changing planting dates, plant trees for shade, switch to other crop, plant different crop verities, adjust crop management, extend Irrigation coverage, adjust livestock management, change use of capital and labor, change use of chemicals or fertilizers, change quantity of land under cultivation, move to a different site, engage in off-farm activities, use crop and animal diversification, diversify from farming to non farming, build water harvesting schemes, decrease use of water, and reduce number of livestock.

These options are reactive ones, born out of necessity by the farmers themselves. Farmers in the area can be considered as good adopters against climate change impacts. However, their actual adaptations were not the same as their perceived adaptations due to various barriers. Various adaptation strategies included growing of fast maturing crop varieties, growing of drought tolerant crops, buying supplementary foods, micro irrigation, mainly involving wetland cultivation as well as livestock keeping. Risks are hedged by diversifying crops, income sources, food sources and locations of production activities. Exposure to climate hazards has been reduced by relocating, either temporarily or permanently.

5.2 Recommendations

Agricultural inputs are very important for crop production in the villages, however due to high price and lower income of the households the production is very low to them. It is therefore, recommended that the government should provide subsidies on agricultural inputs on seeds, pesticides and fertilizers as the costs are currently too high. The second strategy is to enhance irrigated farming and avoid the fluctuating climate.

Efforts are needed to make smallholder farmers to know the key agents of climate change. Thus, information on weather forecasting should be provided to farmers which will increase their preparedness on climate change shocks.

- Avail extension services inorder provide education on better agricultural practices, climate change, and environmental conservation. Support on micro financing was found critical with the establishment of credit facilities non-restrictive agricultural loans from banks.

- It is further recommended that farmers be given more support from both local NGOs and the government in terms of trainings, information and knowledge sharing, and other fundamental resources that they need in their farming systems. The local knowledge should be integrated with scientific knowledge to improve reliability of weather forecasting which will help to trim down the effects of climate change on agricultural production.

- There is a need to promote systems such as agroforestry and conservation agriculture that promote ecosystem services. Farmers who practice

environmentally friendly adaptation strategies can be paid or compensated (carbon trading) for their initiative as a way of encouraging other farmers to do the same or they can be assisted with high-breed seeds (tolerant to drought and fast growing) and subsidized agricultural inputs from NGOs and the government.

- The study identified lack of knowledge, formulate policy to address appropriate agricultural policy, shortage of labor, water scarcity, land scarcity, poverty or lack of credit or saving services, market problems, lack of information, forage and feed scarcity, lack of agricultural technologies and inputs, lack of health service, and others such as lack of institution, ineffectiveness of an option, strong family ties, lack of job opportunities, etc., as major barriers of adaptation.
- It is recommended that government and stakeholders should put up educational programme tailored to meet the climatic information needs of farmers to enable them cope with the emerging challenges to enhance their production. To achieve this, the Tanzania Meteorological Agency should be well equipped to give accurate information about the weather. NGOs and other private partners should be fully involved in the education and sensitization of farmers on issues bordering climate change, causes and controls.
- Farmers in the area are highly impacted due to lack of appropriate knowledge and access to information in the study area. Though most of studies have suggested that the government should make efforts to ensure that extension services reach the resource poor farmers in rural areas, particularly information and other packages that will help them adjust and readjust to

climate change, still there is a need to have comprehensive study on the appropriateness knowledge these extension officers have so that we can assign them this activity as majority have never attended courses to refresh what they know in the moving fast world knowledge.

5.3 Recommendation for Further Study

1. Though it is known in the study that farming in the district is mostly carried out by women as men are based in towns carrying out off farm activities. There is very little study how we can empower women groups and associations since this can have significant positive impacts for increasing the uptake of adaptation measures by the farmers. The policy framework can also consider promoting women in terms of access to education, assets, and other critical services such as credit, farming technology and inputs supply

2. There is a need of study on local knowledge how it can be integrated with scientific knowledge to improve reliability of weather forecasting which will help to trim down the effects of climate change on agricultural production.

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APPENDICES

Appendix A

Table 4.1 Social characteristics

Code	Attributes	Frequency	Percentage
Age	> 30	13	5
	31 – 35	35	13.5
	36 – 40	45	17.3
	41 – 45	56	21.5
	46 – 50	54	20.8
	51 – above	57	21.9
	Total	260	100
Sex	Males	123	47.3
	Females	137	52.7
	Total	260	100
Marital Status	Single	85	32.7
	Married	80	30.8
	Separated	46	17.7
	Divorced	28	10.8
	Widower	21	8
	Total	260	100
Educational Level	No formal ed	75	28.8
	Primary level	77	29.6
	Secondary level	53	20.5
	Tertiary level	25	9.6
	Others (Madrasa, tradition healer)	30	11.5
	Total	260	100
Duration of Stay in respective village (Years)	1 – 5	85	32.7
	6 – 10	52	20
	11 – 15	61	23.5
	16 – 20	30	11.5
	21 – above	32	12.3
	Total	260	100
Average Household Income per year (Tsh)	> 250,000	136	52.3
	250,000 - 500,000	94	36.2
	500,001 and above	30	11.5
	Total	260	100
Householder Head	Men	109	41.9
	Woman	138	53.1
	Others	13	5

Table 4.2: Farm Asset Ownership

Code	Attributes	Frequency	Percentage
Farm asset Ownership			
a. Farm plots (acres)	1 – 5	138	53.1
	6 – 10	94	36.1
	11 and above	28	10.8
	Total	260	100
b. How was acquired	Inherited	98	37.7
	Purchased	56	21.5
	Given by village Council	106	40.8
	Total	260	100
c. Livestock assets (number of stocks)	Cattle	13	5
	Shoats	20	7.7
	Chickens	118	45.4
	Mixed livestock	109	41.9
	Total	260	100
d. Reasons of keeping livestock	Source of income	141	54.3
	Nutritional reasons	36	13.7
	Safety reason	83	32
e. How was acquired	Inherited	34	13.1
	Purchased	187	71.9
	Given by clan	39	15
	Total	260	100

Table 4.3: Agricultural Production Trends

Code	Attributes	Frequency	Percentage
Categories of Crops grown	Food crops only	37	14.2
	Cash crops only	40	15.4
	Food & Cash	183	70.4
	Total	260	100
Historical Pattern of crop productivity per acre during last 30 years	Increasing	12	4.6
	Decreasing	132	50.8
	Fluctuating	78	30
	No change	38	14.6
	Total	260	100
Major crop change over 10 years	Totally Changed	221	85.2
	Remained the same	10	3.8
	Changed a little	29	11
Estimated average crop yield change over 30 years in Kilogram per hectare.	> 1000	88	33.8
	1001 – 2000	78	30
	2001 – 3000	64	24.6
	3001 and above	30	11.5
	Total	260	100
Reasons of low crop yield	Soil Fertility	58	22.2
	Rain availability	148	56.8
	Diseases	49	18.8
	Agricultural practices	5	2.2

Table 4.4: Access to Meteorological Information's

Code	Attributes	Frequency	Percentage
Accessibility to weather forecast information's	Yes	178	68.5
	No	82	31.5
Sources of weather information's	Met stations	12	4.6
	Media	93	35.8
	Extension officers	102	39.2
	Researchers	9	3.5
	Indigenous local forecasting	10	3.8
	Village meeting	25	9.6
	NGO working in the village	9	3.5
	Total	260	100
Kind of information's accessed	Starting of rain	61	23.5
	End of rain	61	23.5
	Amount of rain	49	18.8
	Drought spells	23	8.8
	Temperature	58	22.3
	Strong winds	8	3.1
	Total	260	100

Table 4.5: Community awareness

Code	Attributes	Frequency	Percentage
Climate change awareness	Aware of it	238	91.5
	Not aware	22	8.5
Sources of awareness	Own observations	77	29.6
	Media(Radio, Newspaper)	64	24.6
	Extension officers	20	7.7
	Researchers	30	11.5
	Indigenous local forecasting	30	11.5
	Village meeting	20	7.7
	NGO working in the village	19	7.3
Years of experiencing climate changes	Recently 1 – 5 years	119	45.8
	Long time 6 – 30 years	141	54.2
Perceptions	High temperature	85	32.7
	Low yields	90	34.6
	Disease outbreaks	35	13.5
	Water evaporation from the ground delayed rainfall	6	2.3
	Undefined Season	3	1.2
	Floods with serious consequences	2	0.8
	Later fruiting of tree crops	28	10.8
	Unusual heavy rainfall	6	2.3
	More longer days than night	5	1.9
	Total	260	100

Table 4.6: Impact of climate change on crop production

Code	Attributes	Frequency	Percentage
Impacts	Low yield of crops	102	39.3
	Stunted Growth	45	17.2
	Drying of seedling after germination	40	15.2
	Ease spread of pest and diseases attack on crops	33	13.1
	Ineffectiveness of agricultural chemicals used due to delay in rainfall	40	15.2
Total		260	100

Table 4.7: Adaptation strategies to the perceived climate change.

Code	Attributes	Frequency	Percentage
Soil water strategies	Implement water conservation techniques	89	34.2
	Increase or reduce land size cultivated	50	19.2
	Move to different site	100	38.3
	Increase irrigation	53	20.6
	Increase water conservation	177	68.3
	Soil conservation	143	55
	Shading and shelter/mulching	154	59.4
Farm Operations	Planting of different crops	194	74.7
	Planting of different varieties	153	58.9
	Early planting	124	47.8
	Early harvest when dry soil is expected	64	24.7
	Apply more or few inputs	31	21.1
	Different planting dates	60	23.1
	Treat seed with fungicide before sowing	156	60
	Mixed cropping	251	96.7
	Mixed farming	171	65.8
	Zero tillage	155	59.7

	Change from crop to livestock production	166	6.4
	Change use of chemicals fertilizer and pesticides	179	68.9
Protection measure	Change row orientation with respect to slope	141	54.4
	Apply soil amendments eg. Farmyard maure	136	52.5
	Increase fertilizer application three days prio to sowing	70	27.2
Household Livelihood	Undertake non-farm economic activities	108	41.4
	Avoid selling remaining food stocks	154	59.2
	Reduce food expenditures	225	86.7
	Ration food	250	96.1
	Migrate to fertile soil	64	24.7
Education and finances	Access to extension facilities	224	86.1
	Access to credit facilities	31	11.9
	Government Policies	49	1.9

Table 4. 8: Regression analysis on perception of climate change and adaptation strategies

Independent Variables	
Constants	56.501 (3.743)*
Farm Size (X1)	0.132 (2.062)*
Shading, shelter and mulching (X2)	0.313 (2.189)*
Mixed cropping (X3)	0.549 (2.520)*
Change row orientation with respect to slope (X4)	0.723 (3.147)*
Access to extension facilities (X5)	0.834 (2.128)*
Access to Credit facilities (X6)	0.379 (2.832)*
Educational level (X7)	0.284 (2.568)*
Years of farming experience (X8)	0.127 (3.231)*
Zero tillage (X9)	0.615 (2.586)*

R^2 -0.612 Adj R -0.734

F – Value – 4.5

*Significant level at 0.05 levels

APPENDIX B

Questionnaire Number |____|____|____|____|

FARMERS PERCEPTIONS ON CLIMATE CHANGE AND THEIR ADAPTATION STRATEGIES A CASE OF NACHINGWEA DISTRICT – LINDI

HOUSEHOLD QUESTIONNAIRE

Household identification and interview summary

District (name):_____ Ward _____

Village name: _____

D D M M Y Y Y Y

Date of interview |__|___||___|___||___|___|___|___|

Time_____

Enumerator (Name)_____

SECTION A: HOUSEHOLD CHARACTERISTICS

1. Age of respondent_____(Years)
3. Sex 1=Male |_____| 2= Female |_____|
4. Marital status 1= single, |__| 2= married |_| 3= separated |__|4= divorced|__| 5= widower |__|
5. Household size (Please record total number of permanent inhabitants): _____persons
6. Gender of household head: 1. Male |__| 2. Female |__|
7. Relationship with head of household

   1. Head |__|2. Spouse |__| 3. Child |__| 4. Brother/sister |__| 5. Parent |__| 6. In law |__|

   7. Grandchild |__| 8. Others (specify)……
8. What is your education level?

   1. Incomplete primary |_____|2. Complete primary |_____| 3. Incomplete secondary

4. Complete secondary |_____| 5. College/University|_ _|

9. How long have you been living at your current residential place? |_____| Years

10. Place of origin

1. Born in the village |__|2. Born outside the village but within the district

3. Born outside the district but within the region |__|

4. Born outside the region |_ _|5. Born outside the country|__|

10. If you moved into this village, when did you settle in? ..... (Year)

11. What was your main reason for settling in this village?

1. In search of agricultural land	1. Yes	2. No
2. In search of business opportunities (Specify)	1. Yes	2. No
3. Following relatives	1. Yes	2. No
4. Marriage	1. Yes	2. No
5. Employment	1. Yes	2. No
6. Unfavorable climate conditions in previous place	1. Yes	2. No

12. Average household income per month (TSH) _____

SECTION B: FARM ASSET OWNERSHIP

13. How much land does your household own (acres) and how did you acquire the land the household owns?

Plots (pieces)	**Size of plot in acres**	**How was acquired *1**	**Condition of the field*2 1. Good 2. Average 3. Bad 4. Worse**
1			
2			
Total			

***1: How was acquired: 1. Inherited 2. Purchased 3. Cleared the bush/ forest 4. Given by Village Council**

***2: Productivity? Soil fertility? Water availability??**

14. Does your household rent or borrow any land for agriculture or any other use? If yes how many acres and how much money does your household pay the owner for use of that land?

Plot	Acres	Price per acre	Place	Condition	Crops grown
1					
2					

15. How many livestock does the household own?

S/N	Livestock	Number Owned			How did you acquired*1	
		Local	Improved	Total	Local	Improved
1	Cattle					
2	Goats					
3	Sheep					
4	Donkeys					
5	Chickens					
6	Other (Specify)					

***1: How did you acquire: 1 Inherited from parents 2. Given by Clan 3. Bought 4. Other (specify)**

16. What other farm asset does your household own (e.g. Farm machinery, equipments etc.)

SECTION C: AGRICULTURAL PRODUCTION AND TRENDS

17. What crops do your household grow (Tick all that apply) and why do you grow such crops?

1. Maize 1. Food 2. Cash 3. Food & Cash 4. Do not grow
2. Beans 1. Food 2. Cash 3. Food & Cash 4. Do not grow
3. Cowpeas 1. Food 2. Cash 3. Food & Cash 4. Do not grow
4. Irish potatoes 1. Food 2. Cash 3. Food & Cash 4. Do not grow
5. Sunflower 1. Food 2. Cash 3. Food & Cash 4. Do not grow
6. Sweet potato 1. Food 2. Cash 3. Food & Cash 4. Do not grow
7. Vegetable 1. Food 2. Cash 3. Food & Cash 4. Do not grow
8. Rice 1. Food 2. Cash 3. Food & Cash 4. Do not grow
9. Other crops (specify)

18. Historical patterns of crop productivity (per acre, during the last 30 years)

1 Maize 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

2 Beans 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

3 Cowpeas 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

4 Irish potatoes 1. Increasing 2.Decreasing 3 Fluctuating 4 Do not know 5 No change

5 Sunflower 1. Increasing 2. Decreasing 3 . Fluctuating 4. Do not know 5. No change

6 Sweet potato 1. Increasing 2. Decreasing 3 Fluctuating 4. Do not know 5. No change

7 Vegetable 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

8 Rice 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

9 Other crops (specify)

19. Estimates of Crop yield change over the past 30 years for selected common crops (in KG unit)

Type	**Yield (per acre) last season (Kg or bags)**	**Yield in past 30 years (Kg or bags)**
1 Maize		
2 Beans		
3 Cowpeas		
4 Green Peas		
5 Irish potatoes		
6 Sweet potato		
7 vegetables		
8 Rice		
9 Other crops (specify)		

20. Has there been any change in type of crops / varieties grown by your household for the past 30 years? 1. Yes 2. No

21. Mention the new and abandoned crops /varieties grown (explain why)

S/N	New crops /varieties grown	Reason for adoption	Abandoned crops / varieties	Reason for abandonment
1				
2				
3				
4				

SECTION D: ACCESS TO METEOROLOGICAL DATA/ INFORMATION

22. Do you have any access to weather forecast information? 1. Yes 2. No

23. What type of weather information do you have access to?

1. Start of rain 1. Yes 2. No
2. End of rain 1. Yes 2. No
3. Amount of rain 1. Yes 2. No
4. Drought spells 1. Yes 2. No
5. Floods 1. Yes 2. No
6. Temperature 1. Yes 2. No
7. Strong winds 1. Yes 2. No
8. Other; (specify) ……

24. What are the source(s) of weather information?

1. District Meteorological station 1. Yes 2. No
2. Tanzania Meteorological Authority through the media 1. Yes 2. No
3. Local (indigenous) weather forecasting 1. Yes 2. No
4. Extension office 1. Yes 2. No
5. Village meeting 1. Yes 2. No
6. Local Newspapers 1. Yes 2. No
7. Researchers 1. Yes 2. No
8. NGOs working in our area 1. Yes 2. No
9. Others; (specify) ……

25. Rank the weather information source mentioned above in terms of reliability from 1 to 5, 1 being the most reliable and 5 being the least reliable.

1. District Meteorological station
2. Tanzania Meteorological Authority through the media
3. Local (indigenous) weather forecasting
4. Extension office
5. Village meeting
6. Local Newspapers
7. Researchers
8. NGOs working in our area
9. Others; (specify) ……

SECTION E: COMMUNITY PERCEPTIONS/KNOWLEDGE ON CLIMATE CHANGE

26. Are you aware that climate is changing? 1. Yes 2. No

What does it mean to you? ……

27. From where have you learnt this? (Tick as appropriate):

1. Own observation 1. Yes 2. No
2. Extension Officer (s) 1. Yes 2. No
3. Village meetings 1. Yes 2. No
4. Told by neighbours 1. Yes 2. No
5. Input suppliers 1. Yes 2. No
6. Told by an NGO working in our area 1. Yes 2. No
7. Researchers 1. Yes 2. No
8. Listening to radio 1. Yes 2. No
9. Tanzania Meteorological Authority 1. Yes 2. No
10. Traditional weather forecasting indicators 1. Yes 2. No
11. Others, (specify) ……

28. When did you learn that the climate is changing? (Tick as appropriate):

1. Recently (1-5 years ago) 2. Long time ago (6-30 years ago) 3. Not applicable

29. Indicate the aspects of climate that have changed/ are changing?

Climate aspect /parameter	**Changed** **1. Yes** **2. No**	**If Changing** **1. Increasing/elongating** **2. Decreasing/shortening**	**Severity*** **(1, 2,3, 4, 5)**
1. Rainfall			
2. Temperature			
3. Seasonal wind strength			
4. Humidity			
5. Onset and dying off of seasons			
6. Rainfall–forming clouds			
7. Sunshine duration			

***1=. More severe 2= Severe 3= Less severe 4=Not severe 5= Not sure**

30. What do you think are the causes of the change in the climate aspects you have pointed out in Question 29 above?

1._____

2._____

3._____

4_____

SECTION F: CLIMATE CHANGE AND AGRICULTURAL PRODUCTIVITY

31. What is the main constraint for increased agricultural production and productivity? Please indicate the 5 major constraints order of importance from 1 to 5: 1 being the most important and 5 the least important

S/N	Constraint	Constraint priority (Rank)
1	Unavailability of improved seeds/breeds	
2	Unavailability of industrial fertilizer/ FYM	
3	Floods	
4	Inadequate extension services	
5	Frequent and prolonged droughts	
6	Erratic rainfall/mistiming of seasons	
7	Unavailability of insecticides	
8	Increased crop pests	
9	Increased crop/plant diseases	
10	Increased livestock pests	
11	Increased livestock diseases	
12	Others; (specify)…..	

32. Which crop pests have been prevalent in the area over the last 30 years?

1. _____ 2. _____ 3. _____

33. What do you think is the cause of the prevalence of these crop pests?

1. High rainfall **2. Low rainfall**

3. High temperature **4. Low temperature**

5. Drought **6. Other (specify) _____**

34. What is the trend of crop pest prevalence? (Specify)

1. Increasing 2. Decreasing 3. No change 4. Do not know

35. To what extent has main crop yield been affected by crop pests?

Type of crops	Status of yields before pests incidence (Kgs / acre)	Status of yield with pest incidence (Kgs / acre)

36. Which crop diseases have been prevalent in the area over the last 30 years?

1. _____ 2. _____ 3. _____

37. What do you think is the cause of the prevalence of crop diseases?

1. High rainfall **2 . Low rainfall**

3. High temperature **4. Low temperature**

5. Drought **6. Others (specify) _____**

38. What is the trend of crop disease prevalence?

1. Decreasing |__| 2. Decreasing |__| 3. No change |__|4. Do not know |__|

39. How have these crop diseases affected yield?

Type of crops	Yields without disease incidence Kgs / acre	Yield with disease incidence Kgs / acre

SECTION G: COMMUNITY ADAPTATION/COPPYING STRATEGIES TO CLIMATE CHANGE.

40. Have you changed your farming practices in order to respond to the change in climate?

1. YES 2. NO

41. What are the practices you have adopted in order to increase crop production under the changing climate? Please use the key below the table to indicate the effectiveness of the practice in improving productivity

Climate-smart practice adopted	**1. Yes 2. No**	**Effectiveness of the practice***1.
1. Crop rotation		
2. Mixed cropping		
3. Ways of land preparation e.g. minimum tillage		
4. Use of agricultural inputs. e.g inorganic fertilizers,		
5. Pest control by using pesticides		
6. Water harvesting (specify method and what crop)		
7. Micro-irrigation		
8. Cultivation in valley bottoms		
9. Timing of farm operations		
10. Planting drought tolerant varieties		
11. Planting early maturing varieties		
12. Planting high yielding varieties (what crops, varieties and hectare)		
13. Reducing area cultivated		
14. Planting high value crops		
15. Agro-forestry		

Climate-smart practice adopted	**1. Yes** **2. No**	**Effectiveness of the practice***1.
16. Mulching		
17. Terracing		
18. Tie ridges		
19. Sunken beds (majaruba)		
20. Crop residue incorporation		
21. Use of composite manure		
22. Use of farm-yard manure		
23. Use of green manure		
24. Agricultural mechanization		

*1. Most effective 2. Effective 3. Less effective 4. Not effective at all

42. What are the changes made in Livestock keeping which are climate change adapting mechanisms? Please use the key below the table to indicate the effectiveness of the coping/adaptation strategy)

Practices	**Effectiveness of changes*1**
(a) Hay and silage making	
(b) Destocking (if any)	
(c) Zero grazing (stall feeding)	
(d) Nomadism	
(e) Planting improved grass / forages	
(f) Change of livestock breeds	
(g) Others (specify)	

*1. Most effective 2. Effective 3. Less effective 4. Not effective at all

43. What are the other climate change coping /adaptation strategies undertaken by your household? Please use the key below the table to indicate the effectiveness of the coping/adaptation strategy)

S/N	Measures/strategies used to adapt to climate change	1. Yes 2. No	Effectiveness of the strategies*1
1	Emphasis on livestock keeping instead of crops		
2	Emphasis on small livestock (small animals)		
3	Distributing livestock herds to different places		
4	Seasonal migration of livestock keepers (Nomadism)		
5	Buying food to bridge food shortage gap		
6	Collecting wild foods		
7	Increased exploitation of forests (Encroachment into protected areas)		
8	Increased exploitation of water resource areas		
9	Movement to key resource-endowed areas (Rural-rural migration)		
10	Social networking		
11	Movement to urban centres during food shortages (Rural – Urban migration)		
12	Relying on remittance		
13	Others (specify)		

***1= Effectiveness of the coping/adaptation strategy: 1. Very effective 2. Effective 3. Not effective 4. Do not know**

44. What are the cost implications of adaptation/coping strategies you are using? (Indicate cost where applicable, otherwise use the scale provided under the table to measure the cost implication of the practice

Climate-smart practice adopted	**Estimated cost***
1. Crop rotation	
2. Mixed cropping	
3. Ways of land preparation e.g. minimum tillage	
4. Use of agricultural inputs. E.g inorganic fertilizers,	
5. Pest control by using pesticides	
6. Water harvesting (specify method and what crop)	
7. Micro-irrigation	
8. Cultivation in valley bottoms	
9. Timing of farm operations	
10. Planting drought tolerant varieties	
11. Planting early maturing varieties	
12. Planting high yielding varieties (what crops, varieties and hectare)	
13. Reducing area cultivated	
14. Planting high value crops	
15. Agro-forestry	
16. Mulching	
17. Terracing	
18. Tie ridges	
19. Sunken beds (majaruba)	
20. Crop residue incorporation	
21. Use of composite manure	
22. Use of farm-yard manure	
23. Use of green manure	
24. Agricultural mechanization	

***1=Very high 2= High 3= moderate 4=Low**

SECTION H: FOOD SECURITY

45a. Does your household have sufficient food? (Tick appropriate)

i) Yes, throughout the year___ ii) No, sometimes ___iii) No, not self sufficient_____

45b. If No, what do think are the major causes of food insecurity in your household?

1._____

2._____

3._____

4._____

46. When during the year may food shortage occur in your household?

	No of Month	January	February	March	April	May	June	July	August	September	October	November	December
Normal years													
Bad Years													

47. How many meals did you eat? In normal year ___ In bad year (year with climate stress)_

48. How does your household deal with immediate and long term food shortage? Are the strategies viable?

	Adapting to food shortage	**Viability***
1	Use of indigenous crop varieties more resistant to drought	
2	Expansion of agricultural activities	
3	Collecting and eating wild foods	
4	Movement to key resource areas	
5	Casual labour (Work for cash)	
6	Casual labour (Work for food)	
7	Migrating to other places	
8	Buying food	
9	Getting assistance from relatives	
10	Selling household assets to buy food	
11	Borrowing food	
12	Reducing the number of meals	
13	Eating unusual foods	
14	Other means (Specify)	

***1= Viability 1. Highly viable 2. Viable 3. Not viable 4. Don't know**

SECTION I: DESIRED INTERVENTIONS/ KNOWLEDGE

49. What knowledge needed to improve agricultural production and resilience to climate change?

Rank them in order of importance (1 being the most important)

Desired intervention Knowledge	**1. Yes 2. No**	**Ranking**
Disease and pest management		
Seed production		
Enhanced extension services		
Training in improved horticultural production (High		
Fish farming		
Fruit propagation and tree planting		
Improved practices of producing high quality		
Market information		
Improved animal management		
Information on Climate change and link with		
Effective climate smart-agricultural practices		

50. What other interventions do you think are necessary to enhance your resilience to climate change?

_____

_____

_____

_____

Thank you for your cooperation