ADAPTATION STRATEGIES BY SMALLHOLDER RICE FARMERS UNDER THE INFLUENCE OF CLIMATE CHANGE: A CASE OF KILOMBERO BASIN, TANZANIA

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ABSTRACT

Climate change is emerging as one of the unprecedented challenges facing smallholder farmers in Tanzania who depend largely on rain-fed agricultural production. Weather forecast and prediction in Tanzania indicate that extremes of drought and flood will be more frequent and inconsistent. These changes affect smallholder farmers due to the fact that these farmers are more vulnerable because of limited resources endowment and low knowledge on how to adapt to climate change impacts. Currently, knowledge within academic and policy making cycles on how these smallholder farmers adapt to climate change impacts is limited to permit planning for effective adaptation strategies. This study therefore assessed adaptation strategies by smallholder rice farmers under the influence of climate change in Kilombero Basin. Specifically, this study determined farmers' perception on climate change attributes, identify the impact of climate change to rice production, identified various adaptation strategies by small scale rice farmers and to examine sustainability of adaptation strategies by small-scale rice farmers. Data collection for this study involved interviews with heads of households using questionnaires, focus group discussion and key informants' interview using checklist questions. Secondary data were obtained from published and unpublished documents. Quantitative data were analyzed using SPSS and content analytical procedures were used to analyze qualitative data. Results indicated that the adaptation to climate change varied by household characteristics, knowledge and practices. Households' assets to permit vibrant adaptations to climate change were found weak and inconsistence in rainfall pattern and inadequate climatic information complicated further the ability of various households to effectively adapt to climate change. In order to improve adaptability to climate change impacts, awareness rising among farmers is recommended through training and information transfer through mass media. Also Tanzania Meteorological

Agency has to put more emphasis on information flow concerning weather forecasts to reach wider groups of smallholder farmers.

DECLARATION

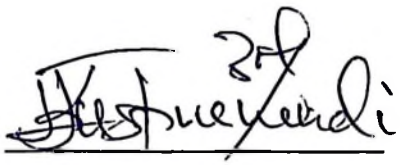
I ROGERS TITO SABUGO, declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and has not been submitted for a similar degree award in any other university.

05.09.2013

Roger Tito Sabugo — Date

MA Candidate

The above declaration is confirmed.



05.09.2013

Dr. Stephen Justice Nindi — Date

Main Supervisor

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This work is dedicated to my family for their tolerance during the whole period of my studies at Sokoine University of Agriculture (SUA), Morogoro. Their prayers made this academic accomplishment possible.

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LIST OF ABBREVIATIONS

CCEE	Collaborating Centre on Energy and Environment
DANIDA	Danish International Development Agency
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GHG	Green House Gas
GVT	Government
ICRAF	International Center for Research in Agroforestry
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
KATRIN	Kilombero Agricultural Research and Training Institute
MDG	Millennium Development Goal
NAPA	National Adaptation Program for Action
NBS	National Bureau of Statistics
NERICA	New Rice for Africa
NGO	Non-Government Organization
NSGRP	National Strategies for Growth and Reduction of Poverty
PRA	Participatory Rural Appraisal
SACCOS	Savings and Credit Cooperative Societies
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
TMA	Tanzania Metrological Agency

UNEP	United Nation Environment Program
UNFCCC	United Nation Framework Convention on Climate Change
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

Climate change is an alteration in the statistical distribution of weather over periods that range from decades to millions of years (Parrish, 1993). It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole earth and recurring can cause it, often cyclical climate patterns such as El Niño-Southern Oscillation or come in the form of more singular events such as the Dust Bowl (Daly, 2005).

Climate change is a global challenge due to warming of average global surface temperature for about 0.8^0C in the past century and 0.6^0C in the past three decades (Hansen, 2006), in large part because of human activities (IPCC, 2001). The Intergovernmental Panel on Climate Change (IPCC) has projected that if greenhouse gas emissions the leading cause of climate change continue to raise, the mean global temperatures will increase by $1.4 - 5.8^0$C by the end of the 21st century.

Thus, adaptation to such catastrophic events is not an overemphasis. Adaptation has been defined as an array of short and long-term strategies tailored in response to crises (reactive) or pre-arranged due to forecasting feedbacks (proactive) and include the diversity of entitlements to which households resort to secure subsistence (Gwambene, 2007). Strategies may already be practiced before drought while others are activated as drought evolves (Eriksen, 2005).

Climate change has much effect in production of agricultural products in sub-Sahara Africa. Some of the effect of climate change to smallholder farmers experienced in sub Saharan African countries including, reducing agricultural productivity, changing rainfall patterns and higher temperatures have forced farmers to shorten the growing season and switch to more expensive hybrid crops. Frequent droughts and floods are eroding assets and knowledge, leaving people more vulnerable to disaster. An upsurge in malaria and cholera requires women to spend more time tending to the sick and less time working to their fields. Farmers are increasingly concerned about the impact of climate change on agriculture and food security.

An increased frequency of floods and droughts: It is widely understood that floods and droughts destroy and erode household assets which are the very means for adaptation. When their frequency and intensity increases, farmers are left with no time to recover from previous impacts through either asset accumulation or acquiring the skills and knowledge necessary for adapting to future climate changes. Consequently, farmers are being subjected to continuous hunger and deeper cycles of poverty and vulnerability (Madison, 2007). Much as we have experienced floods in those days, the impact was somehow not as severe. As time went by, there has been a drop in crop production due to frequent flooding and droughts.

Changes in rainfall patterns, Changes in rainfall have resulted in changes in the growing seasons as well as in crops grown. For example, in the large part of sub Saharan Africa rice used to be grown in November, but it is now being grown in December. One farmer from Malawi explained: "In the past we used to plant our crops after the first rains, but since we started experiencing frequent droughts and floods we are planting our crops much earlier. This is to allow the crops to meet the first rains with the hope that

they will mature before the end of the rainy season and to prevent the crops from being washed away by the floods. Instead of planting a local variety of rice, we have opted for hybrid rice that takes a shorter period to mature". Farmers are now uncertain of when to plant. Farmers now opt for short-season hybrid rice varieties because the growing season is shorter. Rainfall patterns have hindered the growing of long-season local indigenous rice varieties. There has also been a noticeable increase in diseases such as malaria, cholera and dysentery associated with changes in rainfall patterns, and this has created health challenges that are particularly affecting women (Madison, 2007).

With worsening climate change impacts, different countries including Tanzania have prepared the national programmes for adapting with the impact of climate change popularly known as National Adaptation Program of Action (NAPA) to build up the country's capacity to adapt with climate shocks. There is special attention for vulnerable groups such as small scale farmers; the strategy focuses on eight sectors namely agriculture, land use and forestry, fisheries, energy, wildlife, water, human health and gender (UNEP, 2003).

In Tanzania, increasing impacts of climate change in particular drought and floods on rice production have been associated with various adaptation mechanisms (Gwambene, 2007). Example DANIDA has provided financial assistance to Tanzania for development of methodologies and capacity building in Greenhouse Gases (GHGs) mitigation, and for development of coping strategies and assessment of adaptation measures. The project is part of a large effort to support coping strategies, adaptation and mitigation studies in developing countries and is being managed by the United Nation Environmental Programme (UNEP) Collaborating Centre on Energy and Environment (CCEE) (Athumani, 2009).

The programme is based mainly on indigenous knowledge which embodies a wide variety of skills developed outside the formal education system (UNFCCC, 2003). Such adaptation mechanisms may include increased exploitation of non-agricultural activities or increasing wetland cultivation (Majule, 2008). Another example of good adaptation strategies experienced in Uganda, farmers general avoiding elimination of weeds in the soil because they can counter impact of pests that attack crops (Twinomugisha, 2009).

This study examined how small scale rice farmers in Kilombero basin adapt to climate change events given different livelihood assets available at their disposal.

1.1 Problem statement

Agricultural system in Tanzania is largely rain fed-dependent characterized by smallholding production and low technology, which in most cases makes it vulnerable to a number of stressors including climate change (URT, 2001). In such a situation chronic and transitory food insecurity at households are not quite uncommon in most times. These scenarios are also common among small-holder rice farmers in Kilombero basin (URT, 2001).

Although efforts to address agricultural productivity for small scale rice farmers in Kilombero basin are in place engineered by both the Government and Non-Governmental Organizations (NGOs) example providing trainings, workshops and seminars to the household rice farmers on efficient way of growing rice in the area but there is still existence of problem on rice production and small scale farmers experience difficult to device strategies to adapt to emerging exigencies including climate change . There is in need to address new adaptation strategies by small-scale rice farmers due to climate

change so as to improve their livelihood assets hence increase rice production in Kilombero basin since the rice productions have been affected by drought and floods in the area and small scale rice farmers does not have reliable methods to adopt with the climate change impact.

1.2 Justification

The impacts of the climate change include droughts, floods, erratic rains and increase of other extreme natural events. URT (2005) reveals that famine resulting from either floods or drought has become increasingly common since mid-1990s and is undermining food security in Tanzania. Climate Change is likely to intensify drought and increase potential vulnerability of the local poor farm communities to future climate change (Hillel and Rosenzweig, 1989), where crop production are critically important to food security and rural livelihoods. Due to over dependence of rainfall to majority of farm families including rice farmers in Kilombero basin, climate change has become one of the major limiting factors to increased rice productivity hence dwindling livelihood prosperity. On the other hand, adaptation strategies due to increasing impacts of climate change vary between households at any given time due to the varying distribution of opportunities. Identification of factors that shape household opportunities and constraints in adaptation are a starting point for improving rural livelihoods and distinguishing policy measures that address local manifestation to global climate variability issues. Information accrued from the study is expected to be used by rice farmers, local governments, rice-value chain stakeholders and policy makers in order to improve adaptation strategies and hence increase rice production, ensure environmental sustainability and improve people's livelihoods at large.

Besides, this study will help to attaining goals number one and seven of Millennium Development Goals (MDGs) to eradicate extreme poverty and ensure environmental sustainability and the country's Kilimo Kwanza (Agriculture First) initiative whereby the main goal of the initiative is to support small scale farmers in order to increase agricultural productivity in the country and improve their livelihood. The study also feeds to the National Strategies for Growth and Reduction of Poverty (NSGRP) or MKUKUTA in Kiswahili lingua and Tanzania Development Vision 2025 whereby the main goal is to reduce hunger and extreme poverty, the situation which is not uncommon among Tanzanians including small scale rice farmers.

1.3 Objectives

1.3.1 Overall objective

The main objective of the study was to assess adaptation strategies by small-scale rice farmers under the influence of climate change in Kilombero basin.

1.3.2 Specific objectives

i. To determine small-scale farmers perception to climate change attributes
ii. To identify the impacts of climate change felt by small-scale rice farmers
iii. To identify various adaptation strategies to climate change by small-scale rice farmers
iv. To examine sustainability of climate change adaptation strategies by small-scale rice farmers.

1.4 Research questions

i. What are the small-scale farmers' perceptions to climate change issues?

ii. What are the impacts of climate change felt by small-scale farmers to rice production?

iii. What are the various adaptation strategies to climate change adapted by small-scale rice farmers?

iv. What are the sustainability features that characterize adaptation strategies by the small-scale rice farmers?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Climate Change

United Nations Framework Convention on Climate Change (UNFCCC, 2003) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. In the latter sense climate change is synonymous with global warming.

To exemplify this, IPCC (2001) reports that global temperatures have risen by over 0.7°C in the last 100 years and eleven years of the last twelve years (1995-2006) are the warmest on record whereby it was very warm about 0.6°C warmer than the mean 1961 - 1990 temperature. The impact of such temperature rise to smallholder farmers is sometimes undeniably underestimated.

In most African countries farming depends entirely on the quality of the rainy season, a situation that makes Africa particularly vulnerable to climate change. It has been reported that increased droughts could seriously impact the availability of food, as in the horn of Africa and southern Africa during the 1980s and 1990s (IPCC, 2001). Many vulnerable regions, embracing millions of people, are likely to be adversely affected by climate change, including the mixed arid and semi-arid systems in Africa and the coastal regions of eastern Africa, and many of the drier zones of southern Africa (IPCC, 2007). In many developing countries climate change and its variability already emerged as a serious challenge to development, in general, and poverty reduction, in particular. Boko *et al.* (2007) and IPCC (2007) reported that Africa is one of the most vulnerable continents to

climate change and variability. This is partly due to a higher dependence on natural resources, such as agricultural land, forests and water which are very sensitive to climate change that affects the environment. Fischer *et al.* (2005), Thornton *et al.* (2006), and IPCC (2007) reported that some countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will likely reduce the length of growing seasons, as well as force large regions of marginal agricultural potential out of production.

The impacts of climate change (CC) have been the agenda of highest priority in modern times. The impact of climate change especially to millions of poor households mostly residing in Africa is horrifying. To be precise, Africa especially south of the Sahara is one of the most vulnerable regions to impacts of climate change in the world. Previous assessments (IPCC, 2007) concluded that the region is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and over-dependence on rain-fed agriculture. Nindi and Itani (2008) asserts that the problems of climate change are expected to escalate among many subsistence farmers in rural Africa where information flow systems is pathetic and technological changes are slow.

According to IFPRI (2009), agriculture and climate change are inextricably linked. Agriculture is part of the climate change problem, contributing about 13.5 percent of annual greenhouse gas (GHG) emissions (with forestry contributing an additional 19 percent), compared to 13.1 percent from transportation. Agriculture is, however, also part of the solution, offering promising opportunities for mitigating GHG emissions through carbon sequestration, soil and land use management, and biomass production. Climate change threatens agricultural production through higher and more variable temperatures,

changes in precipitation patterns, and increased occurrences of extreme events such as droughts and floods. Thus, if agriculture is not included, or not well included, in the international climate change negotiations, resulting climate change policies could threaten poor farming communities and smallholders in many developing countries. The policies could also impede the ability of smallholders to partake in new economic opportunities that might arise from the negotiations.

Devereux and Maxwell (2001) reported that countries in East Africa for instance are already among the food insecure in the world and climate change and variability will aggravate failing harvests. Having realized the gravity of climate change various conventions, protocols, policies, acts, frameworks, guidelines and programmes have been established and ratified and numerous studies conducted from global to local levels trying to understand the devastating impacts of climate change and take on board specific and trans-boundary initiatives to adapt and mitigate these impacts (EPMS and CEEST, 2006).

Tanzania is not exceptional to this situation where climate change is rapidly emerging as one of the most serious problems affecting many sectors and is considered to be one of the leading threats to sustainable development with adverse impact on environment, human health, food security, economic activities, natural resources and physical infrastructure (IPCC, 2007). Indeed, given the overdependence to rain-fed agriculture by the majority of people living in rural areas of Tanzania, climate change has been one of the major limiting factors in agriculture production thus resulting to natural resource vulnerability, food insecurity and low household incomes. Climate Change are likely to intensify drought and increase potential vulnerability of the communities to future climate change (Hillel and Rosenzweg, 1989), where crop production and livestock keeping are critically important to food security and rural livelihoods.

Certainly, the impacts and adaptations to climate change vary with geographical zones and households due to varying distribution of opportunities in Tanzania and household throughout the country are engaged in different and often multiple adaptation strategies (Liwenga, 2003). Thus, understanding adaptations to climate change impacts is of paramount importance so as to device effective interventions that ensure both livelihood improvements and landscape conservations, which is also important to carbon sequestration under climate change. Thus, this study assessed climate change adaptations strategies in two villages namely Mkasu and Mchombe villages located in Kilombero basin whose despite sharing almost similar climatic conditions but have their households disposed to different livelihood assets which is one of the important basis that influence adaptation at household level.

2.2 Factors Influencing Climate Change

The factors that influence climate change world-wide can be divided into two main categories namely human and natural causes. It is now a global concern that the climatic changes occurring today have been speeded up because of man's activities (IPCC, 2001).

2.2.1 Natural causes to climate change

The earth's climate is influenced and changed through natural causes like volcanic eruptions, ocean current, the earth's orbital changes and solar variations (IPCC, 2001) although these processes are very slow.

Volcanic eruptions: When a volcano erupts it throws out large volumes of sulphur dioxide (SO_2), water vapour, dust, and ash into the atmosphere. Large volumes of gases and ash can influence climatic patterns for years by increasing planetary reflectivity causing atmospheric cooling. Tiny particles called aerosols are produced by volcano;

because they reflect solar energy back into space they have a cooling effect on the world. The greenhouse gas, carbon dioxide (CO_2) is also produced however the CO_2 produced is insignificant when compared to emissions created by humans (IPCC, 2001).

Ocean current: The oceans are a major component of the climate system. Ocean currents move vast amounts of heat across the planet. Winds push horizontally against the sea surface and drive ocean current patterns. Interactions between the ocean and atmosphere can also produce phenomena such as El Niño which occur every after 2 to 6 years (IPCC, 2011), deep ocean circulation of cold water from the poles towards the equator and movement of warm water from the equator back towards the poles. Without this movement the poles would be permanently colder and the equator permanently warmer. The oceans play an important role in determining the atmospheric concentration of CO_2. Changes in ocean circulation affect the climate through the movement of CO_2 into or out of the atmosphere (IPCC, 2001).

Solar variations: The Sun is the source of energy for the Earth's climate system. Although the Sun's energy output appears constant from an everyday point of view, small changes over an extended period of time can lead to climate changes. Some scientists suspect that a portion of the warming in the first half of the 20th century was due to an increase in the output of solar energy. As the sun is the fundamental source of energy that is instrumental in our climate system it would be reasonable to assume that changes in the sun's energy output would cause the climate to change (IPCC, 2001).

2.2.2 Anthropogenic climate change

It has been demonstrated that climate is changing mainly due to man-made greenhouse gases. IPCC (2007) pinpoint that we are already committed to future substantial change over the next 30 years and change is likely to accelerate over the rest of the 21stcentury.There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activities, such as the burning of fossil fuels from industrial activities and transportation and changes in land use, including slash-and-burn agriculture and deforestation (UNFCCC, 2003).

The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles and heavy plants and generate electricity for industries and households. The energy sector is responsible for about three quarters of the carbon dioxide emissions, one fifth of the methane emissions and a large quantity of Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use pattern, deforestation, land clearing for agriculture, and other activities have all led to a rise in the emission of carbon dioxide. Methane is another important greenhouse gas in the atmosphere and it is released from animals such as dairy cows, goats, pigs, buffaloes, camels, horses and sheep. Methane is also emitted during the process of oil drilling, coal mining, leaking gas pipelines, landfills and waste dumps. The certainty of global warming can be seen through some of the natural phenomenon like the effect on crops and extreme weather conditions around the world (IPCC, 2007).

2.2.3 Deforestation as a contributor to climate change

Rainforests every year help to absorb almost 20% of manmade CO_2 emissions therefore deforestation can be classed as a major contributor to the causes of climate change.

Cutting down rainforests faster than they can be replaced has a devastating effect on the carbon emission cycle producing an extra 17% of greenhouse gases. Trees absorb CO_2, more deforestation means more CO_2 build up in the atmosphere. Deforestation by means of cutting down and burning these tropical rainforests usually pave the way for agriculture and industry which often produce even more Carbon dioxide (UNFCCC, 2003).

2.3 Impacts of climate change and variability among smallholder farmers

The potential impacts of climate change and variability among smallholder farmers in sub Saharan Africa encompass not only a narrow understanding of such impacts on food production but also a wider understanding of how such changes and impacts might interact with other environmental, social, economic and political factors that determine the vulnerability of households, communities and countries, as well as their capacity to adapt (Swaminathan, 2000). The impact of climate change among smallholder farmers including small scale rice producers therefore cannot be considered independently of the broader issue of human security (O'Brien, 2006). Climate change and climate variability continue to challenge smallholder farmers, droughts and dry spells are more frequent, rain more inconsistent, and torrential downpours heavier, all phenomena that increase the risk of soil erosion and vegetation damage through runoff. A higher temperature increases the evaporation of soil moisture. Climate change is aggravating water stress which the continent has already experienced, more people are at risk of water stress (IPCC, 2001).

Changes in temperature, rainfall and extension of drought periods in some regions, will have severe implications for crop production. Agricultural losses caused by climate change in western and central Africa are expected to range from 2% to 4% GDP, and

losses of 0.4 % to 1.3% of GDP are predicted for northern and southern Africa (Mendelsohn *al.*, 2000).

The inclusion of climate change and variability in understanding human vulnerability and adaptation is being increasingly explored at household and community levels, as well as through regional agro-climatologically studies in Africa (Verhagen, 2001). Resource-poor farmers and communities use a variety of adaptation strategies to improve their production systems and enhance their livelihoods assets in the face of climate change and variability. Adaptation capacity and choices however are based on a variety of complex causal mechanisms. Crop choices, for example are not based purely on resistance to drought or disease but on factors such as cultural preferences, aroma, palatability and seed storage capacity (Scones, 2005).

2.4 Climate related Adaptation Strategies

Adaptation strategies used by small scale rice farmers in Africa continent include the use of shallow wells and hand-dug wells to supplement the shortfall in water for dry-season irrigation, the use of soil moisture improvement techniques, and mulching. A more efficient use of water through drip irrigation and the choice of high yielding and high-value crops, the use of drought-resistant crop varieties and the improvement of on-farm irrigation, efficiency through the use of better water application technologies are all methods that have been tried by smallholder farmers as adaptation methods to climate change in Nigeria, Senegal, Burkina Faso and Ghana. Agroforestry, crop rotation and rainwater harvesting have all been effective adaptation strategies to climate change and variability. Agricultural diversification such as the integration of livestock and crops (mixed farming) has also being practiced in some of the countries with good results. The alternative use of waste water for irrigation as in peri-urban irrigation schemes is another

strategy for adaptation to climate change. Migration to wetter regions (from drier to wetter regions) in pursuit of wetter and more fertile lands, engagement in off-farm activities are among of the adaptation strategies by small scale farmers in Africa (IPCC,2007).

Small-scale farmers from sub Saharan Africa engage in a range of economic activities as alternative source of food and income when food stocks are exhausted. Faced with drought, agriculturists' households adapt different practices to adapt to and recover from drought impacts. Some studies (Downing, 1985; Sperling, 1989) show that the range of adaptation strategies available to small scale households are increasingly becoming smaller and ineffective. Thus, understanding smallholder farmer's adaptation capacities for the purpose of improvement is paramount to ensure continued productivity under changing environment. Farmers' adaptations include varying planting dates, choice of varieties, use of fertilizers and water management and crop diversification (Mouton, 2001). Countries in southern Africa have proposed a number of strategies and measures geared at adapting their agricultural sector to the adverse effects of climate change.

2.4.1 The use of drought-resistant plants

As the climate becomes warmer, farmers need crops that tolerate heat and drought. Some resilient crops such as barley, cassava, millet and sorghum have been used by farmers in dry lands for many years. Farmers familiar with these crops have much expertise in this area. For example, Sekedo, a drought resistant sorghum for Karamoja in Uganda, is the new short-season, drought-tolerant sorghum which is providing food and income for farmers in northeastern Uganda. Other crops are being improved through plant breeding. Examples include drought-tolerant maize, early maturing maize for regions with short rainy seasons, rice varieties known as NERICA (New Rice for Africa). Growing

NERICA is a farming solution for coping with climate change, social and ecological benefits of growing the multiple economic (IFPRI, 2009).

2.4.2 Forestry and agro forestry

Agro forestry strategies help to counteract the pressures of deforestation by allowing planned harvests of both food and fuel from the same field. Long-term changes in climatic parameters such as temperatures and rainfall may be dealt with quite successfully if the right crop species/varieties or cropping techniques are used. Agroforestry improves soil quality and enhance the conservation of other biomes. Through Agroforestry, farmers' incomes are augmented, since cash crops are planted simultaneously with forest trees .This in turn, translated to greater access to health services, food, shelter and the likes. Besides, agroforestry improves the quality of water and air, thus promoting water and energy conservation (ICRAF, 2008).

Agroforestry is emerging as a promising tool to improve and sustain agricultural productivity and to enhance rural income. Growing multipurpose tree and shrub species with crops and/or animals can provide additional benefit, which the farmers may not obtain with any of these three components alone. Products and services provided by Agroforestry include the improvement of soil fertility; the provision of animal fodder; the creation of a favorable micro-climate for crops, reducing temperature stress and fruits and wood for fuel and construction (Sanchez, 2000; Kwesiga *et al.*, 2003).

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) member countries including Tanzania have specified climate change adaptation strategies targeting sectors in agriculture and livestock, water, natural resources, energy and public health. The most popular climate change adaptation strategies proposed across the 14

member countries are; promotion of early maturing/drought resistant crop varieties, investment in early warning and disaster prevention systems, conservation agriculture and investment in animal disease surveillance systems. Other adaptation strategies include the use of renewable energy sources, promotion of agroforestry, investment in irrigation and water harvesting technologies, protection of coastal marine resources and the use of traditional methods of forest management (UNFCCC, 2010).

Number of feasible adaptation strategies and interventions adapted by small scale rice farmer replicated and up-scaled to mitigate the effects of climate change and cushion vulnerable smallholder farmers against climate shocks and variability. Like, early planting, using of drought resistance rice seeds and planting of tree alongside rice farms to protect from strong winds. However, adaptation and assimilation in development plans has been slow. This can be attributed to a number of factors that affect or hinder adaptation and up-scaling despite the positive results. The primary challenge is to address these factors in such a way as to enhance adaptation capacity. Some of the main factors are economic resources (poverty and economic status), technology development and dissemination, information and skills, infrastructure, governance structure (legal, policy and institutional), socio-cultural perspectives, gender and equity, environmental and health issues, extension services and incentives, and conflicts among different interest groups (Ngigi, 2003; Burton *et al.* 2001).

The preceding discussion has introduced the worldwide and country wide impacts of climate change and various initiatives to address these impacts, focus has been put on the households farmers adaptation strategies due to the climate change.

2.4.3 Conceptual Framework

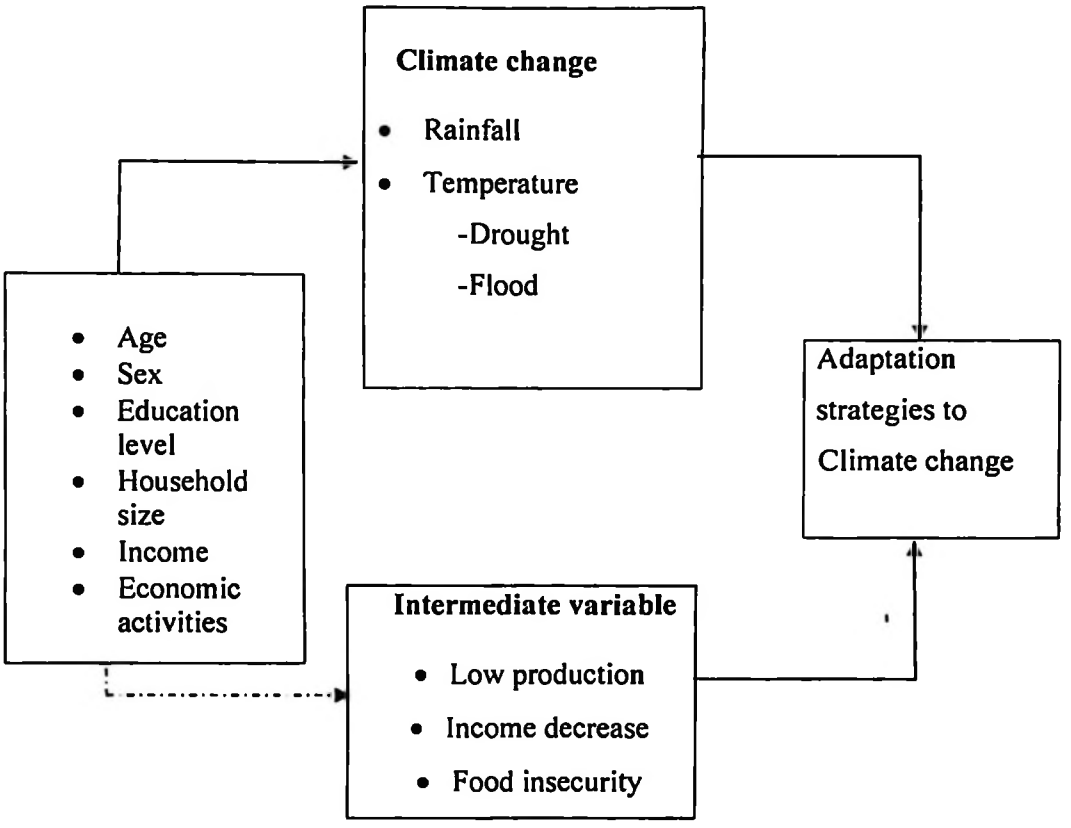
According to Mayeta (2004), a conceptual framework binds facts together and provides guidance towards collection of appropriate data. The importance of conceptual framework lies on the fact that it guides researcher in understanding what data and time that it should be collected.

The conceptual framework of this study based on the assumption that influence of climate change like inconsistence of rainfall and increasing drought affect small scale rice farmers in Kilombero basin, and small scale rice farmers adapt different strategies for cultivation of rice due to the influence of climate change in the area, example of the adaptation strategies are; using of drought resistance rice seeds, shifting cultivation, conduct early plantation, engage into non-farm activities, use of short season rice seeds, using of fertilizers and use of irrigation system.

Despite these adaptive strategies by small scale rice farmers in the area, the production of rice is still low and small scale rice farmers still encounter various difficulties to adapt to the impacts of climate change. Some of the difficult are; shortage of water for irrigation, inadequate supply of drought resistance rice seeds, lack of knowledge to understanding weather pattern and better rice husbandry and lack of income to diversity their production systems.

However to ensure effective adaptation strategies by the small scale rice farmers in the area, the background information such as age, sex, level of education, marital status, household size, economic activities and level of income were observed to see how they affect the performance of independent and dependent variable. Below is the conceptual framework for this study Botha, (1989)

Background **Independent Variables** **Dependent Variable**



The dependent variables, adaptation strategies to climate change have strong relationship with independent variables (climate change attributes which are rainfall and temperature) and independent variables influence strategies in the dependent variables. This study assumes there was weak relationship between background information (household characteristics) and intermediate variables.

..... ▸ Weak relationship

——— ▸ Strong relationship

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Study area

Kilombero basin is found in Kilombero district, which is one of the six districts of Morogoro region, and is located in Southwest of the region. The district lies between Latitude 8°15'0 S and Longitude 36°25'0 E. To the East and North, the district borders Morogoro Rural and Kilosa districts, respectively. It also borders Mufindi and Njombe districts of Iringa region to the northwest, while at its South and South-East extremes it shares borders with Songea Rural district (Ruvuma Region) and Ulanga district, in that order (Figure 1). The district comprises of 19 administrative wards with a population of 321,611 people whereby women accounts for 53.2 percent (URT, 2005). The famous wards for the production of rice in Kilombero basin are Mang'ula, Kiberege, Mchombe, Mkula, Mrimba, Mofu, Mahenge and KPL (Kilombero Plantation Limited).

The study was conducted in two villages (Mchombe and Mkasu), selected from two wards (Mchombe and Kiberege). This was because these villages were situated along the rice plantation areas and rice plantation was one of the major economic activities carried out by the households in the area.

Kilombero Basin is characterized by the presence of Kilombero Sugar Company, which serves as producer and supplier of sugar in the country and the Ruaha River that serves as the producer of hydroelectric power at Kidatu Hydro Power Station. The basin also serves as Ramsar Site and a Game Controlled Area (GCA) whereby Udzungwa national Park is endowed to several tourist potentials. The reason for conducting this survey in

Kilombero basin was because of the potentiality of the basin to rice production and continued decline of rice production every year in Kilombero basin contributed to a greater extent due to changing climate events

3.1.2 Climate and Soils

The Kilombero basin has a tropical climate with a unimodal rainy pattern starting from November/December to May of the following year. Cool dry season lasts from June to August and hot dry season from September to November. The annual rainfall ranges from 500 mm to 1800 mm. Day temperature lie between 20 and 35 degree Celsius with very high air-humidity, which is relative constant during the wet seasons when it generally remains between 70% and 90%. During the hot dry season it may drop as low as 25% (TMA, 2005).

The alluvial lowland of the basin is mostly covered by heavy clay soils which are a result of periodical/permanent flooding and of hydro orphic characteristics. The alluvial uplands, on the other hand are covered by soil of silt-clay sand (TMA, 2005).

3.1.3 Drainage and Vegetation

Drainage system of Kilombero district composed of perennial rivers and dams, among the main perennial rivers are Ruaha, Kilombero, Mpanga, Kihansi, Mchripa and Lwipa. These rivers serve for irrigation, fishing and other for domestic needs used by the farmers. Kihansi and Kidatu dams serve as sources of hydro-electric power in the country. Evergreen vegetation cover of Kilombero district where by covered by rice fields, Udzungwa rain forest, sugar cane plants, maize fields and coconut trees

3.1.4 Economic activities

The main economic activity of the district is agriculture and major food crops grown are rice and maize. Kilombero basin is the potential area for the production of rice in the district and country and large numbers of people who are living in Kilombero basin are highly depending on rice production for their livelihood.

The planting calendar for rice from Kilombero basin is from December to February and weeding starting from March to April, birds scaring usually done on May, also harvesting activities starting from June to July. Production per acre of the rice field is approximated at 5 bags to 20 bags of 100kg of rice (KATRIN, 2008). The price of rice is unpredictable in the area, but it range from 40,000/- to 80,000/- at farm gate price per bag of 100kg and the economic activities in the area are agriculture, livestock keeping and fishing

3.1.5 People and ethnicity of Kilombero District

The tribes dominance in the district are Wambunga, Wandamba, Wabena ,Wapogoro and Wahehe but also Wamasai and Wasukuma are now widely spread in the district, These tribes moved and settled in the districts in search of grazing lands for their cattle.

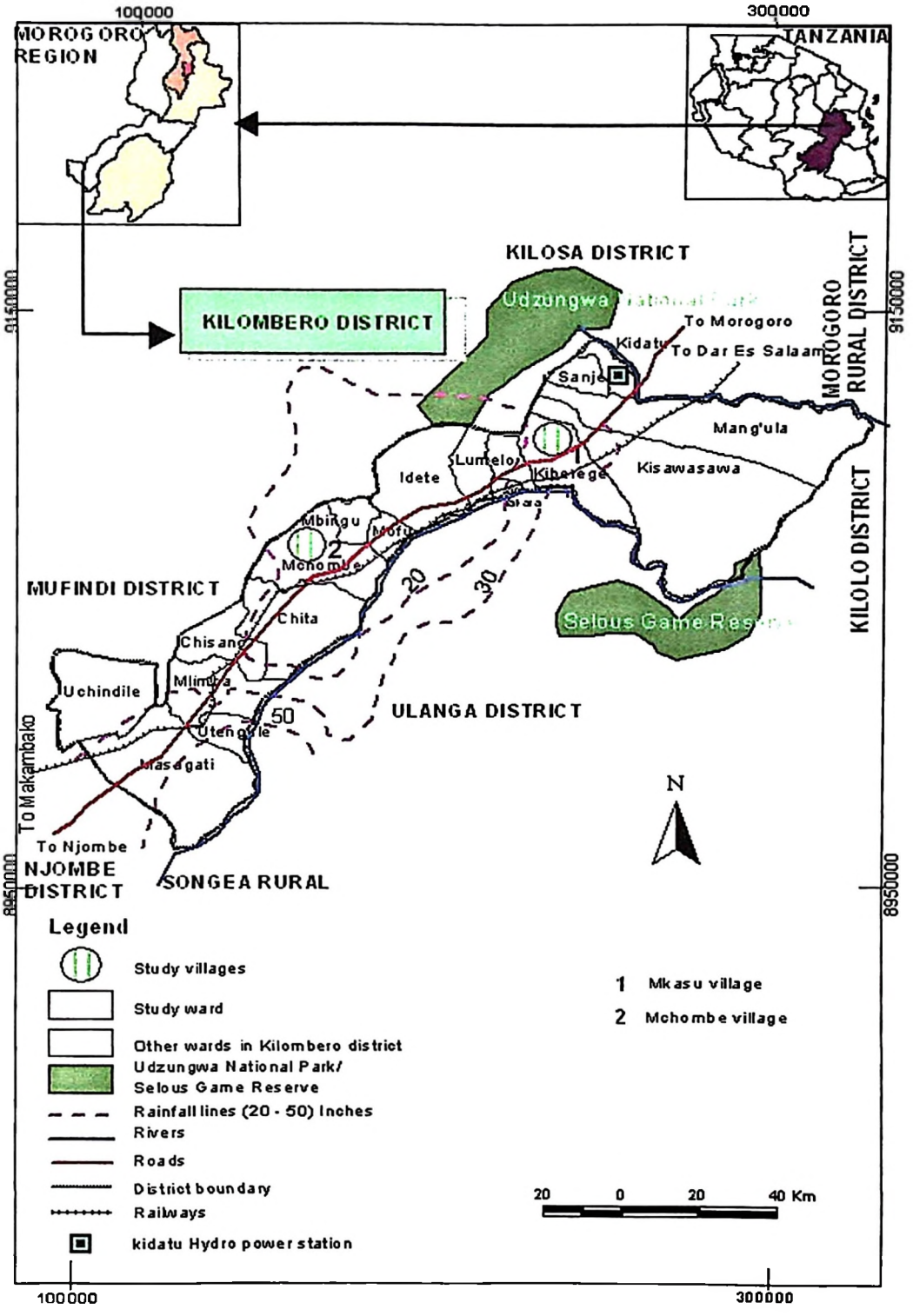


Figure 1: The map of Kilombero District showing the study Villages

3.2 Research Design

A cross-sectional study research design as suggested by Saunders (2007) was employed in this study. The design allows collection of information at one point in time and used for descriptive study as well as for determination of relationship between and among variables.

3.3 Sampling procedures

The study employed simple random sampling to get two wards and two villages from Kilombero district, the wards which were selected are Mchombe and Kiberege as well as villages which were selected are Mchombe and Mkasu.

Stratified sampling technique was employed to select household rice farmers from Mkasu and Mchombe villages. Village leaders assisted in stratifying households into male and female headed households. Three layers category of 'rich', 'middle' and 'poor' (wealth ranking) households was established within household rice farmers as per their perceptions.

Random sampling method was used to ensure bias minimization. In both villages 27 households were categorized as rich and 30 households as middle income households while the category of poor had 43 households. The" Rich" households were described as those that own house thatched by iron sheet, have access to electricity and has clean water and can afford to cultivate more than ten acres of rice farm. The "Middle" households were described as those who own houses thatched by iron sheet and they can afford to cultivate five to ten acres of rice and the "Poor "were those who had house thatched with the grass and no clean water they can afford to cultivate one to five acres of rice field. A total number of 100 households were selected from both Mkasu and

Mchombe villages, thus 50 households from each village were selected. The selection criteria based on wealth ranking from the household farmers helped the study to capture variation of household assets that may characterize household adaptation strategies.

A total of 10 key informants (progressive farmers) 5 from each village were selected using snowball sampling. Also purposive sampling was used to select 10 people that were involved in Focus Group Discussion (FGD) 5 people from each village. The issues discussed with both Key Informants and Focused Groups were the perception of climate change in the area, effect of climate change, adaptive strategies their used for rice production and sustainability of those adaptive strategies.

3.4 Sample size

Matata (2001) argued that having 80-120 respondents is adequate for social-economic studies in sub-Saharan African households. The small-scale rice households were the sampling unity for this study and a total of 100 smallholder rice households were randomly selected as sample size from the study villages.

3.5 Methods of Data Collection

3.5.1 Primary data

A combination of both qualitative and quantitative data collection methods was applied. Both quantitative and qualitative methods play a useful and complementary role in improving our understanding of a situation in a given area.

3.5.1.1 Quantitative data collection methods

Structured questionnaires (Appendix 2) with both close and open-ended questions was designed and used for this study to seek information from the households related to households' perception to climate change issues, their adaptation strategies and other basic household information. Prior to the main survey, pre-testing of the survey tool (questionnaire) was done to test its applicability, validity and reliability. Pre-testing was done at Kibwaya Village in Morogoro rural and not in the study villages. Kibwaya village was selected because is famous for the rice production in Morogoro rural district and it is affected with climate events. Simple random sampling was used to select 10 households who were involved in the pretesting exercise whereby six were male headed households and four were female headed households. Out of 10 people who were pre-tested from Kibwaya village 8 people said climate change affected their production this is due to the fact that their rice production are decreased every year. The same questionnaires which were used in pre-test are also used in the main survey.

3.5.1.2 Qualitative data collection methods

Participatory Rural Appraisal (PRA) techniques formed the basis of qualitative data collection methods. These were used in order to increase participation of other households in the exercise. Focused Group Discussions with rice farmers where applied, the criteria used to select those people who participated in the focused group discussion

was based on the age , people who have resided for long time in the village and people who cultivate rice. Interviews with key informants involved consultations with village leaders and extension workers. Sets of checklist questions in Appendix 3 were used during focus group discussions and in-depth interviews The sample of 10 people were involved in FGD's whereby five male and five female. These villagers also participated in household survey.

3.5.2 Secondary data

Secondary data were collected by revisiting relevant documents available in Kilombero district, Kilombero Agricultural Research and Training Institute (KATRIN), Sokoine National Agricultural Library (SNAL), Ministry of Agriculture and Prime Minister's Office (Disaster Management Division), DALDO (District Agriculture and Livestock Development Officer) from Kilombero and Tanzania Meteorological Agency (TMA). Other information was collected from books, journals, internets and official reports.

3.6 Data Processing and Analysis

Statistical Package for Social Sciences (SPSS) computer programme version 12.0 was used to process and analyze quantitative data from household questionnaire-based interview whereas qualitative data were subjected to content analysis. Different variables within each village and across the villages were analyzed and compared using measures of central tendency like frequency, distribution and percentages presented in figures and tables. Data from interview schedule were coded and recoded before entering in the computer and analyzed.

Qualitative analysis was based on information from focus group discussion, documentary review, observation and in-depth interviews. Content analysis refers to words, meanings,

pictures, symbols, themes or any message that was communicated during the study (Mouton, 2001). The components of semi-structured interviews that were held with key informants and Focus Groups were broken down into smallest meaningful units of information.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings and discussion of the study. The chapter is divided into five sections. Section one highlight the relevant socio-demographic characteristics of respondents. Section two focuses on determination of the farmers perception on climate change attributes. Section three focuses on the impact of climate change to rice production. Section four identifies various adaptation strategies by small-scale rice farmers and section five examines sustainability features that characterize adaptation strategies by the small-scale rice farmers.

4.2 Socio-demographic characteristics of the respondents

Seven aspects of socio-economic characteristics namely age, sex, education level, source and the level of income, economic activities, marital status and size of household were asked and the results are presented in the subsequent sub-sections.

4.2.1 Age of respondents

Age is the most fundamental characteristic of a population. Age structure of a population is a reflection of population dynamics in the past. Age affects the future growth of the population and its structure changes in the future (URT, 2006). The results (Table 1) revealed that, 29% of respondents were between 46 to 55 years, 22% were between 56 to 65 years, 15% were 66 to 75 years, 5% were between 76-85 years, 14% were between 26 to 35 years and 15% were in the age category of 36 to 45 years. This shows that large number of people were at the age category of 26 to 55 years. Such population group falls under economically productive age group since they were within the range of 15 to 64

years old. This is in agreement with URT (2002) and Nindi *et al.* (2010) who stated that economically productive people or active working group people are those who are in the age group of 15 to 64 years old. It can therefore be deduced that the majority of the respondents in the study area who were interviewed are active, energetic and productive to their households and to the community at large.

Table 1: Socio-demographic characteristics of the respondents (n=100)

Parameter	Age range	Villages		Total number of respondents
		Mkasu	Mchombe	
Age in Years	26-35	11(22)	3(6)	14
	36-45	9(18)	6(12)	15
	46-55	18(36)	11(22)	29
	56-65	3(6)	19(38)	22
	66-75	6(12)	9(18)	15
	76 and above	3(6)	2(4)	5
Total		**50(100)**	**50(100)**	**100**
Sex	Male	26(52)	36(72)	62
	Female	24(48)	14(28)	38
Total		**50(100)**	**50(100)**	**100**
Marital status	Single	10(20)	0	10
	Married	34(68)	47(94)	81
	Divorced	3(6)	1(2)	4
	Widowed	3(6)	2(4)	5
Total		**50(100)**	**50(100)**	**100**
Monthly income level	<100,000	46(92)	45(90)	91
	>150,000	3(6)	5(10)	8
	>200,000	1(2)	0	1
Total		**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents in that category

4.2.2 Household characteristics

According to URT (2006), household is defined as a single person or a group of persons who live together and share living expenses. Usually these are husband, wife and children. Other relatives, boarders, visitors and servants are included as members of the households if they were present in the household on the census night. The results showed that the majority of households (62%) were male and 38% were female (Table 1). The situation is a typical to household heading characteristic of most countries situated in sub-Saharan Africa (Manyong *et al.*, 2008).

Despite their relative low number in female in the survey but women made a significant contribution to rice production. They form 60% - 80% of the agricultural labor force in the rural areas (URT, 2006). Women play a major role in rice production in Kilombero basin. They are involved in all aspects of rice production particularly planting, weeding, bird scaring, harvesting, processing and trading where as men were mostly involved in land preparation and trading. Both men and women were engaged in rice harvesting and threshing, while selling rice was traditionally a men's domain. Generally, women in agriculture experience excessive workload due to farm work and household chores and difficulty in accessing the key factors of production such as land, water, credit, capital and appropriate technologies. It is often far easier for men to access these inputs than women. In the study areas households played big role in the adaptation to climate change, like planting of trees around the farm, planting multiple crops (both drought and non-drought resistant crops), using drought resistance rice seeds, practice early plantation of rice and engaged in to off-farm activities such as livestock keeping.

4.2.3 Marital status

Results from the Table 1 show that 81% respondents were married from both villages, where by 34% from Mkasu village and 47% from Mchombe village, while 4% respondent were divorced from both villages, 3% from Mkasu village and 1% from Mchombe village and 5% respondent from both villages were widower, 3% from Mkasu and 2% from Mchombe and also 10% respondent were single from Mkasu village.

The presumption from such results is that both married, single, divorced and widower household heads had literacy level of at least primary education level, which permits them to read and write. Moreover, it is an important level in adapting to agriculture activities and adaptation strategies to climate change which will lead to improve household aspects. This is precisely because education normally has a significant influence on a household's income strategies, land management and labour use (Nkonya *et al.*, 2004). Also these results are typical characteristics of many areas in Tanzania whereby 60% women and 50% men are married (NBS, 2005). Experience from the study areas show that, small holders farmers who are well educated were more aware with climate change compared with those who are not well educated and this was verified by the way those farmers practiced agricultural methodologies by considering environmental issues such as environmental conservation, using of agricultural recommended practices, like planting of trees along the farm in order to reduce soil erosion and preventing strong winding, mix cropping and application of fertilizers

4.2.4 Source and the level of income

Table 1 shows monthly income distribution of households, whereby about 91% of the household income was below Tsh.100, 000/= which is less than 62.5 US$ and 8% of the respondents their income was above Tsh.150, 000/=but not above Tsh. 200,000 and 1% of respondents had their income above 200,000/= per month and the main source of income was agricultural production, mainly from rice production. Income to the farmers contributed to the adaptation to climate change due to the fact that those farmers who had high income can afford to adapt irrigation system during the drought season and cultivate large land of rice field, also can afford to hire labour and using tractors for plowing than those who have low income.

4.2.5 Level of education

table 2 below show that the average education level of the majority of the respondents was primary education 86% followed by only 1% of respondents that had acquired secondary education from Mchombe village and 13% did not attend formal education at all. Mchombe village had 46% of the respondents who attended primary education and Mkasu village had 40% of respondents who attended primary school. The findings revealed that the majority of the farmers had basic education, which is the important to engage in the agricultural innovations. The results concurred with Handley *et al.* (2009) who reported that education is the important parameter regarding to human capital for reducing inequality and poverty and laying the foundations for sustained economic growth, effective institutions and sound governance. Also, these results concurs with Owen *et al.* (2005) who argued that being knowledgeable of something increases the ability to control your livelihood

Smallholder farmers who are well educated are more aware with climate change compared with those who are not well educated and this was verified by the way those

farmers practiced farming activities by considering environmental issues such as environmental conservation/using recommended farming practices. However, there was a slight difference in education level from one village to another. For instance from the Table 2, shows that 46% respondents from Mchombe village attended primary education compared to 40% respondents from Mkasu village attended primary education. The information from the FGD and key informant interviews revealed that distance from primary school is the key reason.

Table 2: Level of education of heads of the households

	Level of education		
Villages	**Primary education**	**Secondary education**	**Not attended**
Mchombe	46(53.4)	1(100)	9(69)
Mkasu	40(46.6)	0(0)	4(31)
Total	**86(100)**	**1(100)**	**13(100)**

Note: Numbers in parentheses along the table are the percentages of respondents

However, formal education level reached by households in the study area is fundamental for efficient household environment management and a prospect for the future as well as creating high esteem to the bearer. This result is in line with Kajembe and Luoga (1996) who argued that education tends to create awareness, positive attitudes, values and motivation. Furthermore education tends to stimulate self-confidence and self-reliance.

4.2.6 Household size according to villages

Typical to most sub-Saharan African countries, Tanzania has a young age structure, which according to URT (2006) is broad at the base with 44% of its total population below 15 years of age and about 52% between 15-64 years of age. This age is generally regarded as working group. The old age population (above 64 years of age) constitutes

only about 4% of the total national population. This means that, over 48% of the total country populations are the dependents of the working age group. The results from the study show that about 65% of rice farmer's households had five to fifteen members of the household, followed by 35% who had one to four members and the average household size for the study area was five (Table 3).This number of members in the household was still high compared to Morogoro whereby average household size of 4.3 (URT, 2006) and larger than respective village average household size of 4.1.

Table 3: Household size according to villages

	Household size in study villages		
Household size categories	**Mkasu**	**Mchombe**	**Total (%)**
1-4	23	12	35
5-10	18	25	43
10-15	9	14	22
Total	**50**	**50**	**100**

This result also may imply that appreciable proportion of income accrued from rice production activities is contributed and shared by members in the family. These results were also supported by URT, (2006) which pointed out that; large household size has significant contribution to economic and domestic activities. However, economists and social thinkers are still debating on the influence of population change on economic growth. Thus, Bloom *et al.* (2001) pointed out that, their discussion fall under three alternative concepts; that population growth restricts, promotes, or is independent of economic growth. They further noted that, these thoughts focused on two aspects, which are population size and growth. Respondents who had high income level can afford to feed large family also can afford to incur the cost of irrigation, using tractor for cultivation and combine harvester for harvesting, hiring labour and applying fertilizers to the farm than those who have low level of income.

4.2.7 Economic activities

During the survey respondents were asked to list main economic activities in their households. The results show that main economic activities was rain fed agricultural production dominated by rice production, followed by livestock keeping activities. Rice production enabled farmers to get food for the subsistence as well as earn income for their households. Figure (2) reveals that rice production activities (75%) were found to contribute a lion share of household income followed by livestock keeping (15%).

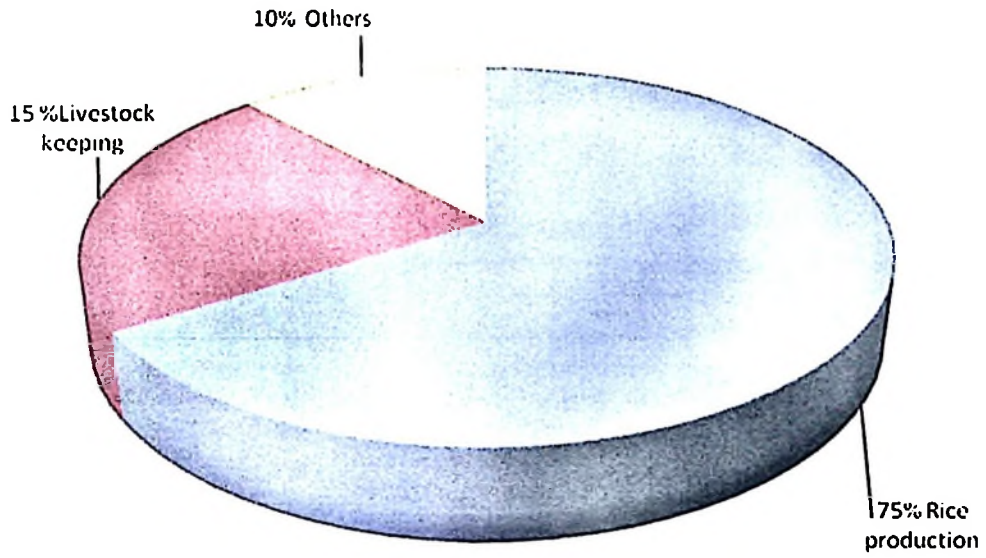


Figure 2: Distribution of respondents according to economic activities

This implies that about (75%) of the respondents were their household main source of income being contributed by rice production. The information from FGD and key informants noted that presence of large numbers of people who were engaged into rice production was because; rice production ensured them of food security and income for their livelihood. Furthermore, from such economic activities, people do benefit from employment opportunities. Majority of those who benefit from such employment pattern were from the adjacent villages and a few were migrants from distant areas. However, the

impact of climate change deteriorate rice production from the household farmers by reduction in rice production, loss of income, reduction in acreage cultivated, and influencing household farmers to change cropping patterns from rice production to other crop.

4.2.8 Size and ownership of land under rice production

Tanzania has 942 600 kilometer square of land, out of which 46% of the total land area is under forests and woodlands. Kilombero district alone has a total of 1341km^2 and about 60% of that land is under rice production (URT, 1997).The study revealed that, majority of the respondents (89%) owned land and only 11% used the rented land (Table 4).

Table 4: Size and ownership of land under rice production

Category	Percentage
Owned land	89
Rented land	11
Total	**100**
Land below 6 acres	43
6 - 10 acres	30
above 10	27
Total	**100**

The study further showed that, out of the land owned by the respondents, 43% of respondents owned land 1-4 acres, 30% owned land above 510 acres and only 27% possessed land above 10 acres which is under rice production (Table 4). All land is owned under customary tenure system. These results coincided with URT (1997) which revealed that 93.4% of the total land area under cultivation is used for small-scale farming by land holders who cultivate the land mainly under customary tenure.

Land play big role to adaptation to climate change to small scale farmers in Kilombero basin, in study area farmers planted trees alongside the rice fields in order to prevent soil erosion and strong wind which is major causes of climate change.

The results still shows the importance of land as a primary asset for survival and development in the study area, since it supports the livelihoods of most rural people. These results corresponded with Kironde (2009) who noted the importance of land in the development of Africa by the fact that around 60% of the population derives their livelihoods and incomes from farming, livestock production and related activities.

Having the majority of respondents (43%) possessing land below 5acres, it indicates that most of rice farmers have land which is not enough for planting rice farm this is typical land ownership scenario among smallholders in Tanzania. A study by Uliwa and Fished (2004) found that about 70% of the farmers in Tanzania cultivate less than one hectare of land which is not enough even for subsistence crop production.

4.2. Small scale rice farmer's perception on climate change and climate events

Perception of the small scale rice farmers on climate change and facts of climate change in Mkasu and Mchombe villages were measured by using open ended questions the results shows that 61% surveyed farmers from both villages perceived that long-term temperatures are warming, 10% farmers from both villages believe precipitation is declining, and 29% farmers from both villages believe there have been pronounced changes in the timing of the rains, also this results are the same with results from FGD and key informant who were reported that temperature are increasing and rainfall are inconsistence in the area.

4.2.2 Effects of climate change in the area

Figure 3 shows the effects of climate change in the study area, 71% of respondents said drought has been increased and 10% of the respondents said there is heavy rainfall in the area and 19% of respondents said there is too hot in the area, also results from focus group discussion and key informant reports that the climate is in inconsistence for long time where by sometime during cultivation season they experience heavy rain fall and some time they experience hot/drought. Both results indicate that the climate is changing in the area.

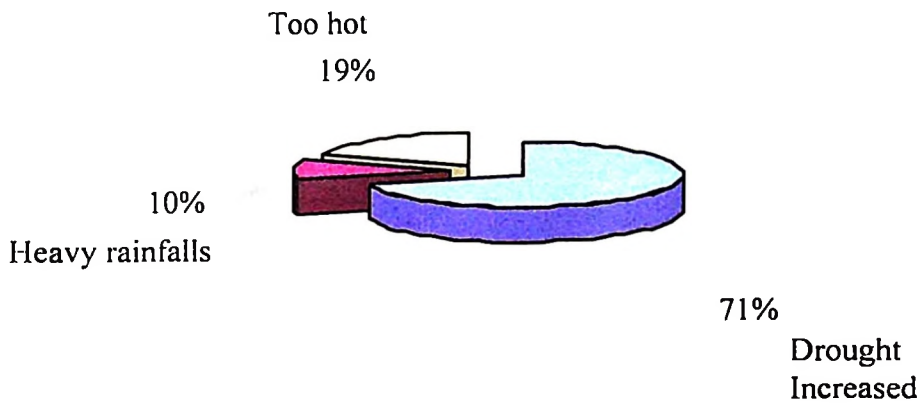


Figure 3: Fact of climate change in the area

4.2.3 Farmers perception on temperature trends from 1970s to 2010

The study identified that annual temperature has changed from the period of 1970s to 2010s. I took that range of time from 1970s to 2010 because i assumed that many respondents could be aware with the temperature trends from that period. Table 5 shows that about 48% of the respondents from Mchombe and Mkasu villages noted that it was cold in the area, while 39% of respondents from Mchombe and Mkasu villages noted that it was normal temperature in the area and about 2% of the respondents from Mchombe and Mkasu villages noted it was hotter. This indicates that there have been substantial elements of climate change in the study area as far as temperature changes are concerned.

Table 5: Farmers perception on temperature trends from 1970s to 2010 (n=100)

	Trend of temperature from 1970s to 2010		
Villages	**Cold**	**Normal**	**Hot**
Mchombe	17(35)	21(54)	1(50)
Mkasu	31(65)	18(46)	1(50)
Total	**48(100)**	**39(100)**	**2(100)**

Note: Numbers in parentheses along the table are the percentages of respondents

4.2.4 Effect of climate change on rice production to small scale rice farmers

Climate change has many effects to the rice production in the area, as partly it causes decline in the production of rice. In turn this brings the challenges to food security. Table 6 shows the effect of climate change in relation to rice production in the area.

Table 6: Effect of climate change to rice production (n=100)

Parameter	Respondent villages		Total (%)
	Mchombe	Mkasu	
Rice are dried because of drought	45(49)	47(51)	92 (100)
Rice farms are thrashed away due tc heavy rainfall	4(100)	0(0)	4(100)
Rice farms attached by insects	1(25)	3 (75)	4(100)
Total	**50**	**50**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents

Table 6 above shows that 45% of the respondents from Mchombe village and 47% from Mkasu village noted that rice farms were drying because of drought this is due to the fact that rice in this area requires ample water to grow. A dry spell of a week in upland rice-growing areas and about two weeks in shallow lowland rice-growing areas can significantly reduce rice yields (IRRI, 2007). Average yield reductions in rain fed, drought-prone areas have ranged from 17% to 40% in severe drought years, leading to production losses and food scarcity (IRRI, 2007). Plate 1 shows the effect of drought in soil structure in rice fields in the Mkasu village.

With the onset of climate change, the intensity and frequency of droughts are predicted to increase in rain fed rice-growing areas and droughts could extend further into water-short irrigated areas .Water scarcity affects more than 23 million hectares of rain fed rice production areas in Africa (IRRI, 2007).

Plate 1: Rice field dried because of shortage of water at Mkasu village

Also reports from the study area revealed that 4% of respondents from Mchombe village said that rice farms are thrashed away due to the heavy rainfall in the study area. Rice can survive in water logging not like many other crops but uncontrolled flooding is a problem because rice cannot survive if submerged under water for long periods of time. Flooding caused by sea-level rises in coastal areas and the predicted increased intensity of tropical storms with climate change will likely hinder rice production. According to IRRI (2007), about 20 million hectares of the world rice-growing area is at risk of occasionally being flooded to submergence level. Major flooding events are likely to increase in frequency with the onslaught of climate change in the rice-growing areas, currently are not exposed to flooding, but will experience floods.

Plate 2: Water flooded on rice field at Mchombe village

About 1% of respondents from Mchombe and 3% of the respondents from Mkasu village noted that rice farms were frequently being attacked by pests like, rice water weevil, Macrosteles fascifrons and Mythimnain in recent years. Rice diseases and pests are strongly influenced by climate change (IRRI, 2007). Water shortages, irregular rainfall patterns, and related water stresses increase the intensity of some diseases, including brown spot and blast. Weed infestation and rice-weed competition are predicted to increase and will represent a major challenge for sustainable rice production. Also, extreme weather events have recently led to dramatic rodent population outbreaks in Africa due to unseasonable and asynchronous cropping. (IRRI, 2007) and noted that drought is the biggest threat to the rice production.

4.2.5 Rice farmers who are most affected by the impacts of climate change

Smallholder farmers are particularly vulnerable to the impacts of changes in the climate that reduce productivity and negatively affect their livelihood. Frequent droughts and

floods have eroded assets and knowledge, leaving people more vulnerable to disasters (Gandure and Alam, 2006), such as water and food shortage, diseases and land degradation. Evidence strongly suggests that increased droughts and floods may be exacerbating poverty levels, leaving many rural farmers trapped in a cycle of poverty and vulnerability to diminishing resources (Phiri *et al.*, 2005).

Table 7 shows which kind of the rice farmers who were affected most by impacts of climate change in the study area, 84% of the respondents from Mchombe and Mkasu villages said small scale rice farmers are the one who are mostly affected by climate change impacts whereas 16% of the respondents from Mkasu and Mchombe villages said all farmers were affected with the climate change impacts. The result shows that small scale rice farmers are the most affected with climate change due to the fact that they don't have enough capital to protect their farms from drought by adapting irrigation system or diversify their livelihood options. This goes similar with the results from focus group discussions (FGDs) and key informant where they revealed that small scale household farmers are the one who mostly affected with the climate change impacts than the large scale farmers. Normally, their access to loans from financial institutions is limited. Their access to extension service on demand driven is also limited hence constrained to new knowledge and technologies on appropriate farming practices. They are over-dependence to rainfall for the cultivation compared to large scale rice farmers who have access to loans from financial institutions and they can cultivate large farms and adapting irrigation system further complicates their livelihood.

Table 7: Most households affected by the impacts of climate change (n=100)

Parameter	Respondent villages		Total (%)
	Mchombe	Mkasu	
Small scale farmers	45(90)	39(78)	84
All farmers	5(10)	11(22)	16
Total	**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents

4.2.6 Yield harvested in the cultivated rice fields (2005)

In this section the respondents were asked about the rice yields harvested per one acre of paddy in (2005). Table 8 shows that 20% respondents from Mkasu and 22% respondents from Mchombe villages harvested one to five bags of rice per one acre, 16% respondents from Mkasu and 18% respondents from Mchombe villages harvested five to ten bags of rice per one acre, 9% respondents from Mkasu and 7% respondents from Mchombe villages harvested ten to fifteen bags of rice per one acre, 4% respondents from Mkasu village harvested fifteen to twenty bags of rice per one acre and 1% farmers from Mkasu and 3% farmers from Mchombe villages harvested twenty to twenty five bags of rice per one acre.

The finding show that large number of farmers reported that their yield were decreasing compared to what they used to harvest in the previous years, and farmers explained that the fluctuation of production is mainly caused by inadequate distribution of rainfall and temperature which impede rice production, result also supported by the Tanzania Meteorological Agency (TMA) which revealed that the total annual distribution of rainfall from 2005 to 2010 is 1820 mm in 2005 and 988.3 mm in 2010 and total mean annual temperature ranges from 32.7°C to 37.9°C (TMA, 2005). According to IRRI, (2007) revealed that rice does better in areas where there is rainfall distribution of

2,500mm within 20-24 weeks but having bellow or above will not be adequate to rice production. These imply that having 1820 mm and 988.3 mm of rainfall and temperature of 31.7°C and 32.9°C from study areas are not well adequate for rice to grow in 2005 - 2010.

Table 8: Rice yield harvested in the respondents fields in the 2002 cropping season

bags of rice harvested by (HH)	Number of respondents		Total number of respondents
	Mkasu village	Mchombe village	
1-5	20(40)	22(44)	42
5-10	16(32)	18(36)	34
10-15	9(18)	7(14)	16
15-20	4(8)	0(0)	4
20-25	1(2)	2(4)	3
25-30	0(0)	1(2)	1
Total	**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents

4.2.7 Rice yield in 2010 cropping seasons

Respondents were asked if production of rice in 2010 season was different compared to that of 2005 season. Results show that 47% of respondents from Mkasu village and 50% from Mchombe village observed no increase in rice production while only 3% of the respondents from Mkasu village observed an increase in the production of rice (Table 9). This indicates that in 2010 production season, rice production has been continued to decline in the study area compared with the 2005 production season. Also results from FGDs and key informants revealed that the production of rice from 2010 cropping season have been declining compared with the 2005 season and they said this is due to the inconsistence of rainfall and temperature which hit in the area.

Table 9: Increased of rice yield in 2010 cropping season

Parameter	Respondent villages		Total (%)
	Mchombe	Mkasu	
Yes	3(6)	0(0)	3
No	47(94)	50(100)	97
Total	**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents

4.3 Small scale farmers adaptation strategies under the influence of climate change

4.3.1 Small scale rice farmer's adaptation strategies

Adaptation to climate change and variability necessitates the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities, and to adapt with the consequences (IPCC, 2001). Adaptation involves the action that people take in response to or in anticipation of projected or actual changes in climate to reduce adverse impacts or take advantage of the opportunities posed by climate change (Parry *et al.*, 2005).

Small scale rice farmers from Mkasu and Mchombe villages were asked on adaptation strategies which they are using for the rice production in the study area, farmers demonstrated different adaptation strategies. Table 10 shows that 11% of the respondents from Mkasu village and 18% from Mchombe village had changed to new early maturing rice variety called TXD SARO 306. Previously, small-scale rice farmers from Kilombero preferred old and traditional rice varieties like Mbawambili, SENGO and Super Kijivu. Farmers ascertained that they have dropped the old varieties because they take long time to mature (about 140-160 days) and they were not resistant to drought hence low yields.

Seven percent of respondents from Mkasu village and nine percent of respondent from Mchombe village had shifted from rice production to other crops production like cassava, maize and beans. Another seven percent from Mkasu and five percent from Mchombe village have adopted irrigation system for the production of rice in the areas. Twenty-two percent of the rice farmers from Mkasu village and seventeen percent from Mchombe village have adapted to early planting in order to allow the crop to meet the first rains with the hope that they will mature before the end of the rainy season. Two percent of respondents from Mkasu and one percent from Mchombe village have adopted the use of Minjingu phosphorate fertilizer in order to increase the production of rice. Only one percent of respondents changed planting date for the purpose of targeting the rainfall in the area. Key informant and FGDs also revealed that they adapt early rice varieties to mature, early plantation of rice, the use of fertilizer from Minjingu, and some they are shifting to production of maize.

Table 10: small scale rice farmer's adaptation strategies

Parameter	Village of residents Mkasu	Mchombe	Total (%)
Changed to another rice variety which is early to mature	11(22)	18(36)	29
Shifting from cultivating rice to other crops	7(14)	9(18)	16
Using irrigation system	7(14)	5(10)	12
Early plantation of rice	22(44)	17(34)	39
Using fertilizer	2(4)	1(2)	3
Changed planting dates of rice	1(2)	0(0)	1
Total	**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses along the table are the percentages of respondents

4.3.2 Challenges to adaptations

Respondents were asked about the challenges which they face while adapting to climate change. Table 11 shows that 13% farmers from Mkasu and Mchombe villages said they had shortage of early maturity rice varieties, 31 % farmers from Mkasu and Mchombe villages they had shortage of water for irrigation of rice farms,18% farmers from Mkasu and Mchombe villages reported that they don't have knowledge on proper way of planting rice, 25% farmers from Mkasu and Mchombe villages said they don't know the weather pattern and 13% farmers from Mkasu and Mchombe villages they lacked capital to diversity their rice cultivation practices in the area, which may reflect hindrances faced by smallholder farmers in accessing financial from micro finance facilities to improve their farming activities .

Such results are concurrent partly with that of FAO (2001) in Nigeria, which revealed that small scale farmers they lack the requisite education, information and training necessary to adapt to climate change, also inadequate extension services and

encouragement of formation of farmers groups for the purpose of getting access to financial services from micro finance facilities have impacted household farmers to adaptation to climate change in Nigeria.

Table 11: Challenges encountered by small scale rice farmers on adaptation strategies

Parameter	Village of residents' Mkasu	Mchombe	Total (%)
Shortage of early maturity rice varieties	8(16)	5(10)	13
Shortage of water for irrigation	14(28)	17(34)	31
Lack of knowledge on proper way of planting rice	8(16)	10(20)	18
Lack of knowledge on understanding the weather pattern	14(28)	11(22)	25
Lack capital to diversify their rice farm	6(12)	7(14)	13
Total	**50(100)**	**50(100)**	**100**

Note: Numbers in parentheses are the percentages along the table

4.3.3 Availability and access to micro finance institution in the villages

The respondents from Mkasu and Mchombe villages where asked if there is the financial facilities in their locality area, and 80% of them from Mchombe and Mkasu villages were reported that there was micro finance facilities in their area, and 20% of the respondents from Mchombe and Mkasu villages were saying there were no micro financial facilities in the villages (Figure 4). It shows that large numbers of small scale farmers were aware with the availability of micro finance institute in their locality.

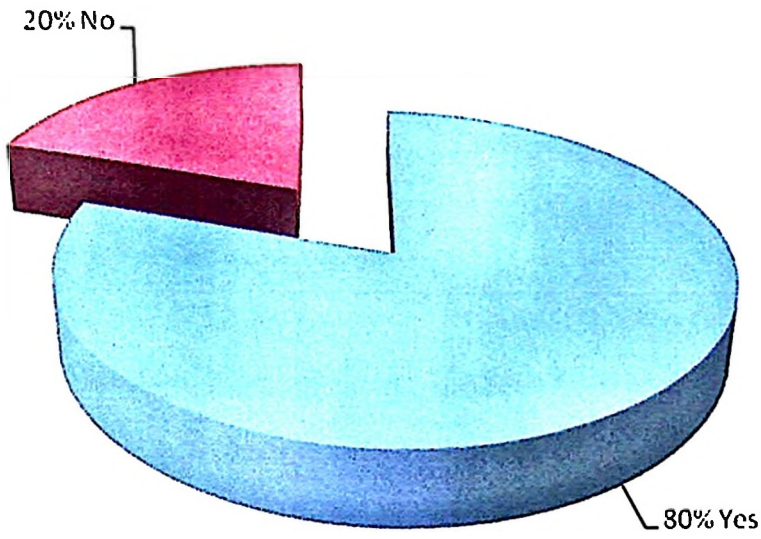


Figure 4: Availability of micro finance institution in the villages

The respondents were asked about their access to micro finance institutions. Table 12 shows that only 2% of the respondents from Mchombe and Mkasu villages had access to loans from micro finance facilities. This is partly due to the fact that farmers are often not credit worth, most of them don't have collateral as assets to access loan from micro finance facilities and most of the productive areas are far distant from the service providers. With respect to financial service, the SACCOS established by farmers are the major sources of the financial services but most are faced with the structural problems and operational hick ups.

This is reality in the case of Tanzania whereby the distribution of micro finance facilities in Tanzania skewed in the favor of urban area dwellers, leaving rural area grossly underserved (Kashuliza *et al.*, 1996). Most micro finance facilities in with an exception of tiny rural based are reluctant to extend their services and trust small scale farmer and also they fear that in the rural area there is poor infrastructure, high risk and high cost of operation (Bikki *et al.*, 2003).

Table 12: Small scale farmer's accessibility to micro finance services

Parameter	Village of residents		
	Mkasu	Mchombe	Total (%)
Yes	0	2	2
No	50	48	98
Total	**50**	**50**	**100**

4.4 Sustainability of the Adaptation Strategies Used by Small Scale Farmers

Sustainability can be defined as an ability or capacity of something to be maintained or to sustain itself. It's about taking what we need to live now, without jeopardizing the potential for people in the future to meet their needs (Rosenbaum, 1993).

Table 13 shows that, out of 29 respondents from both villages reported that they are changed another rice variety like TXD SARO 306 which is early maturing, 17 respondents reported that this strategy is unsustainable due to the inconsistence of rainfall in the area, which makes seeds fail to survive. Out of 16 respondents from both villages reported that were shifting from the cultivation of rice to another crops like cassava and maize and 11 respondents reported that this strategies is unsustainable because of drought destroyed their farms and affecting income. Also 12 respondents from both villages reported that they are using irrigation system for production of rice 10 respondents reported that this strategy is sustainable because they captured water from Kilombero, Ruaha, Mpanga, Kihansi, Mchripa and Lwipa rivers and directing to their rice farms, while 39 respondents from both villages adopted early planting and 32 respondents reported that this strategies is sustainable because it allows the crop to meet the first rains and prevent the crop from being washed away by the floods, and 3 respondents from both villages reported that they are applying fertilizers into their farm and only 2 respondents from both villages reported that this strategy is unsustainable because of inadequate of

rainfall into the area, also only 2 respondents from both villages reported that they change planting date in order to targeting rainfall pattern and both respondents said it is useful. Information from FGD revealed that large number of small scale rice farmers adapting early planting and irrigation system this is because it is sustainable for cultivation of rice than other strategies. FGDs also noted that those farmers that adapted irrigation system and early planting their production was increasing together with their income compared with others.

Table 13: Sustainability of adaptation strategies used by small scale rice farmers

		Village of resident's		
Adaptation strategies	**Reported**	**Mkasu**	**Mchombe**	**Total (%)**
Change to another rice varieties	Adopted	11(22)	18(36)	29
	Unsustainable	7(14)	10(14)	17
		18(36)	**28(50)**	
Shift to another crop	Adopted	7(14)	9(18)	16
	Unsustainable	5(10)	6(12)	11
		12(24)	**15(30)**	
Using irrigation system	Adopted	7(14)	5(10)	12
	Sustainable	6(12)	4(8)	10
		13(26)	**9(18)**	
Early planting	Adopted	22(44)	17(34)	39
	Sustainable	18(20)	14(28)	32
		40(64)	**31(62)**	
Fertilizer application	Adopted	2(4)	1(2)	3
	Unsustainable	1(2)	1(2)	2
		3(6)	**2(4)**	
Change planting date	Adopted	1(2)	1(2)	2
	Sustainable	1(2)	1(2)	2
		2(4)	**2(4)**	

Note: Numbers in parentheses are the percentages along the table

4.5 Suggestions from the households rice farmers to the government, financial institutions and Non-government organization (NGOs)

Respondents were asked to give suggestions about which adaptation strategies have to be used in order to increase the production of rice in the area. Table 14 show that, 23% of

the respondents suggested that the government should increase providing extension services to the area in order to increase the rice production. This was due to the fact that there were not enough extension services in both villages. Likewise, FGDs and key informants suggested that extension services were not adequate in the area, so they sought more support from the government, and non-government organization to help them increasing extension service so as to be able to get better knowledge of rice production. The government and financial institutions like Banks and other formal financial institutions are encouraged to provide micro loan to small scale rice farmers so as they can participate fully in the rice production.

Table 14: Suggestions from the households rice farmers to the government (n=100)

Parameter	Percentages
Government and NGO should increase extension services	23
Government and NGO should help on micro loans	33
Government and NGO should help on pesticides	7
Government and NGO should help on irrigation system	17
Government and NGO should provide low cost fertilizers	20
Total	**100**

About 7% of households noted that government and non-government organization need to ensure prompt accessibility to farm inputs such as pesticides to enable them overcome the negative impacts of pests and diseases. Seventeen percent of the respondents asked the government and non-government organization to help them with the introduction of irrigation system in the area by digging dams to store rainwater while 20% of the respondents said the government can help them with low cost fertilizers.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Climate change has many effects to the production of rice in African farmers including Kilombero farmers. The small scale farmers in Kilombero were found using different adaptation strategies for the production of rice in the area in order to increase production and to adapt to climate change impacts. The study identified that the strategies used by small scale rice farmers in the area include changing to new rice varieties called TXD SARO 306 which is early maturing variety, using of irrigation systems, shifting from cultivating rice to other crops, early planting of rice, and use of Minjingu Rock Phosphate (MRP) fertilizers. But the main adaptation strategy which has been used by large number of farmers was early planting of rice whereby 39% of the respondents were using.

The study also recognized that small scale rice farmers have been experiencing challenges in the production of rice, along with the challenges were, inadequate supply of information on weather pattern, inadequate extension services, inadequate suppy and high cost of rice ipunts, shortage of rainfall, lack of capital since large number of small scale farmers lack access to micro loan from Banks in the area, poor government support with the planning of the rice price and storage.

5.2 Recommendations

i. The government and non-government organization should put more emphasis on educating small scale farmers on extension service it will help to be able to acquire knowledge of best agricultural practices on rice production, and also government and non-government organization should provide good working environment to extension workers so as they can be more committed with their job.

ii. Financial facilities like Banks should open branches into the interior part of rural settings so as to reach large number of small holder farmers in the area. This is because large numbers of rice farmers are small scale and they are living into the interior part of the villages also, financial institutions should facilitate farmers to form groups so that can act as collateral in accessing financial services from Bank.

iii. The government of Tanzania has tried an innovative mechanism to have fertilizer reach the farmers in order to increase fertilizer usage, this mechanism includes subsidizing the farmers for the cost of fertilizer through a voucher scheme. This approach has its ups and downs especially in the rural areas where the cost of transportation and the overall cost for fertilizer are still not economical for the small farmers but could highly benefit large scale farmers or organized large rice farming schemes. So the government should increase on supply of rice inputs in Mkasu and Mchombe villages and for the low cost and it will help to meet the target of the country campaign of KILIMO KWANZA.

iv. Smallholder farmers must adapt to water conservation and water harvesting systems in order to maximize efficient use of rainfall. The government and non-government organization should help rice farmers to build dams to store the rain water for irrigation system, by doing so farmers will get access to water for irrigation. Government, non-government organization and financial institutions need to create market infrastructure and conducive policy and institutional frameworks for rice

production; this will help motivate small scale farmers to increase production of rice in the area.

v. The government has to mainstream climate change adaptations strategies in the development planning process so as to encourage many stakeholders to participate in effective climate adaptation.

vi. The Meteorological Agency has to put more emphasis on information deliver concerning weathering forecast to the farmers in the area.

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APPENDICES

Appendix 1: Household Questionnaire

SOKOINEUNIVERSITY OF AGRICULTURE (SUA)

DEVELOPMENT STUDIES INSTITUTES (DSI)

MASTERS OF ART IN RURAL DEVELOPMENT (MARD)

Questionnaire on the study of adaptation strategies by smallholder rice farmers under the influence of climate change: A case of Kilombero basin

Background information

Please answer the following questions sincerely.

Economic category 1. Rich 2. Middle 3. Poor

1.0 Household identification

Village	
Ward.1.Kiberege (.....) 2. Mchombe (.....)	
District	
Division	
Name of head of farm family	

1.1 **Demographics**

Household Member	**ID code**	**Sex** Male=1 Female=2	**Marital Status** Singe=1 Monogamously Married=2 Polygamous Married=3 Divorced=4 Widowed=5 Separated=6 Other(specify)=7	**Age** (years)	**Relationship to the household Head** Head=1 Spouse=2 Son/daughter=3 Relative=4 Un-related=5	**Schooling** Attended Before=1 Attending now=2 **Young to** attend=3 Never attended=4	**Number of years of schooling completed** (if attended or is attending school)
	01						
	02						
	03						
	04						
	05						
	06						
	07						
	08						

9. Circle your income level per month? (1) <100000/= (2) >150000/= (3)>200000/=

10. Farm size: ..... (Specify hectares/acres) farm size under rice production

11. Do you have your own rice farm land?(1) Yes,(2) No

12. How did you acquire rice farm land you own?(1) Buy (2) Inherit (3) Given by village government (4) other specify

13. If rice farm land was bought how much did you pay per acre/plot?

14. If land was hired how much did you pay last rice cropping season?

15. Do you have rice farm land deed? (1) Yes,(2) No

16. Are there extension services in your area? (1) Yes (2)No

17. If yes, do you get extension services? (1) Yes (2)No

18. How many times are you get extension services per year?(1) one time (2) two times (3) three times (4) four times (5) five +

19. What are the common topics do you discuss with extension officers?

    1.....

    2.....

    3.....

20. Are there any institutions dealing with micro loan in this area? (1) Yes (2)No

21. If yes, have you ever accessed loans for rice cultivation? (1) Yes (2)No

22. If yes, what specifically did the loan assist you in your rice production?

    Purchased :(1) Fertilizers (2) Implements (3) Improved seeds (4) Expansion of farm (5) Others (please specify)

Farmers' perception on climate change to rice production

1. Are you aware of the fact that currently the weather has been varying ?(1)Yes (2)No

2. If yes, what do you think are the indicators that the weather/environment has been behaving abnormally

   (1).....

   (2).....

   (3).....

   (4).....

3. What used to be the state of temperature before 1970s? (1) Warm (2) cool (3) Hot(4) don't know

4. What has been happening in terms of the number of the hot days/months of the year in the past 20 years?

   (1) Have stayed the same (2) have increased (3) don't know

5. What is the effect of climate change on rice production?

.....

6. Do the Government and NGOs helping you in the production of rice due to the climate change? (1) Yes (2) No,

7. If yes, how is government and NGOs help you in the production of rice?.....

8.Is there any changes on (days/months) have the *vuli* rains been lasting in a year in the past 20 years? (1) Less than a month (2) 1 month (3) 2 months (4)3 months (5)more than 3 months

9.What has been happening in terms of the number of days/ months of *masika* rains in the past 20 years? (1) Have increased (2)have stayed the same (3) have decreased (4) don't know

10. How long (days/months) have the *masika* rains been lasting in a year in the past 20 years?

(1) Less than a month (2) 1 month (3) 2 months (4) 3 months (5) more than 3 months

11. Have you experienced any shifts in the rain seasons in the year over the past 20 years?

(1) Yes (2) No

12. Which year was good for you in the production of rice?

13. Which year was bad for you in the rice production?

14. Please indicate the months which the two rain seasons were experienced in the two periods before 1970s and now.

	PERIOD	
Rain seasons	Months in a year (Before 1980s)	Months (Now, up to 20 years ago)
Vuli	.....	1.....
	.....	2.....

	.....	3.....
	.....	4.....
Masika	.....	1.....
	.....	2.....
	.....	3.....
	.....	4.....

15. Have you ever experienced any droughts in the area for the past 15 years? (1)Yes (2) No

16. If yes, what has been the frequency of drought occurrence in recent years (now up to 15 years ago)? (1) Increased (2) Decreased (3) No change (4) Don't know

17. What can be the reasons for these climatic variations observed above? Please circle the right answer.

    (1) Human activities (2) Punishment from God due to increase in evils (3) gods are angry because people have stopped offering sacrifice (4) others

Climate impacts facing household rice farmers:

Please select the best answer from the alternative answers provided.

1. Who are the people mostly affected by climate change?

   (1) Poor (2) Rich (3) None(4) All

2. The threat of climate change is more on:

   i. Health
   ii. Agricultural production
   iii. Fuel wood availability
   iv. Cropping
   v. Instigating disaster
   vi. Biodiversity quality and sustainability

3. Can you please tell which year had good (adequate) rains in the past 5 years? (1) 2005 (2) 2006 (3) 2007 (4) 2008 (5) 2009. Please tick the appropriate response.

4. Which year had poor rains in the past 5 years? (1) 2005 (2) 2006 (3) 2007 (4) 2008 (5) 2009.(Please tick the appropriate response).

5. How many hectares have you cultivate in the last season?

6. Is the rice production increased in the last cropping season compared with other years?(1) Yes (2) No

7. If yes, how many bags of rice have you harvested in the last season?

8. If no, how many bags of rice have you harvested in the last season?

Climate change and adaptation strategies on rice production

1. Does climate change have any impact in your farming activities? (Yes/No)

2. Does climate change have any impact in rice production? (Yes/No)

3. If yes, have you made any strategies to adapt due to climate change on rice production? (Yes/No)

4. If yes, below are strategies in adapting to climate change on rice production, State whether you practice one or not.

   i. Planting Different Varieties of rice (Yes/No)

ii. Cultivating Different crops (Yes/No)
iii. Shortening growing season (Yes/No)
iv. Reducing the extent of land used for crop production (Yes/No)
v. Increasing the extent of land used for crop production (Yes/No)
vi. Changing to irrigation farming (Yes/No)
vii. The use of chemical fertilizer (Yes/No)
viii. Reserve water for irrigation (Yes/No)
ix. Mulching (Yes/No)
x. Changing planting dates (Yes/No)
xi. Switching from farm to no-farm activities (Yes/No)
xii. Migrate to towns or other villages for the better life
xiii. Others (Yes/No)
(Please mention)
.....

5. What are you recommend to be done so that will help small-holder rice farmers to better adapt to problems caused by climate change?

.....

6. What other adjustments in your farming have you made to the changes in timing of rains? (Please list)
.....

7. What other adjustments in your farming have you made in response to the changes in temperature? (Please
list).....

8. What are the hindrances to adaptation of modern techniques to combating climate change?

1. Lack of improved seeds (Yes/No)
2. Lack of access to water for irrigation farming (Yes/No)
3. Lack of current knowledge on adaptation methods (Yes/No)
4. Lack of information on weather incidence (Yes/No)
5. Lack of money to acquired modern techniques (Yes/No)
6. There is no hindrance to adaptation (Yes/No)
7. Others (Please mention)

Sustainability of adaptation strategies by small-holder rice farmers

1. Is the strategy you have adapted is useful? (1) Yes (2) No
2. The strategies you have adapted help you to increase your income? (1) Yes (2) No
3. How do you think now you have increased your income? Please circle any one options (1) I built a new house (2) I bought a Car (3) I sent my children to private school (4) I bought new clothes and shoes (5) I eating three times per day (6)increased numbers of rice bags (7) others specify.....
4. Did the Government and NGO address new adaptation strategies apart from the one you have adapt?(1) Yes,(2) No
5. If yes, what are those strategies?

   .....

THANK YOU FOR PARTICIPATION

Appendix 2: Checklist for key informants

SOKOINEUNIVERSITY OF AGRICULTURE (SUA)

DEVELOPMENT STUDIES INSTITUTES (DSI)

MASTERS OF ART IN RURAL DEVELOPMENT (MARD)

General information

Village.....

Wards 1.Kiberege.....2.Mchome.....

1. What do you understand by the term climate change?
2. How many rain seasons do you have in this area?
3. Has the rain frequency changed for the past 20-30 years ago?
4. Which month in the year did *vuli* rains begin and end in the past years before 1990?
5. Which month were the *masika* rains begin and end in the past years before 1990?
6. Which month in the year did *vuli* rains begin and end after 1990?
7. Which month were the *masika* rains begin and end after 1990?
8. Has the temperature been decreasing over the past 20-30 years ago?
9. What are the causes of climate change?
10. What is the impact of climate change on rice production?
11. What are the adaptation strategies are you using to produce rice due to climate change?
12. How is the sustainability of adaptation strategies you use?
13. Do you own land for rice production?
14. How many hectares of land under rice production do you have?
15. How many bags of paddy did you harvest last season?
16. Is the production increased or decreased?
17. Do you have extension services in the village?

18. Did you have access of loan from Bank to support your rice production?

19. How government and NGOs helping you to produce more rice due to climate change?

THANK YOU FOR PARTICIPATION

Appendix 3: Checklist of Questions to focus group discussion

SOKOINEUNIVERSITY OF AGRICULTURE (SUA)

DEVELOPMENT STUDIES INSTITUTES (DSI)

MASTERS OF ART IN RURAL DEVELOPMENT (MARD)

Village.....

Wards 1.Kiberege.....2.Mchome.....

1. What do you understand by the term climate change?
2. What are indicators of climate change?
3. How many rain seasons do you have in this area?
4. What are the causes of climate change?
5. What is the impact of climate change on rice production?
6. What are those adaptation strategies you're using to produce rice due to climate change?
7. Are adaptation strategies which your using for rice production helps you to increase income?
8. What is the sustainability of those adaptation strategies which you're using for rice production?
9. How many hectares of land under rice production do you have?
10. Are the rice farmers getting access of farming inputs in this area?
11. Are the farmers getting access to micro loan for the rice production?
12. How many hectare of land did you cultivate rice in the last cropping season?
13. How many bags of rice did you got in the last season?
14. Is the rice production decline in your area?

THANK YOU FOR THE PARTICIPATION