SOCIAL NETWORKS INFLUENCING CLIMATE CHANGE ADAPTATION AMONG SMALLHOLDER FARMERS IN MVOMERO DISTRICT, TANZANIA

SOCIAL NETWORKS INFLUENCING CLIMATE CHANGE ADAPTATION AMONG SMALLHOLDER FARMERS IN MVOMERO DISTRICT, TANZANIA

By

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A Dissertation Submitted to the Faculty of Social Sciences in Partial Fulfillment of the Requirements for Award of the Degree of Master of Science in Project Planning and Management (MSc. PPM) of Mzumbe University

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CERTIFICATION

We, the undersigned, certify that we have read and hereby recommend for acceptance by the Mzumbe University, a dissertation entitled "***Social Networks Influencing Climate Change Adaptation among SmallHolder Farmers in Mvomero District, Tanzania***" in partial fulfillment of the requirements for the award of degree of Master of Science in Project Planning and Management (MSc. PPM) of Mzumbe University.

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Accepted for the Board of the faculty of Social Sciences

CHAIRPERSON, FACULTY OF SOCIAL SCIENCES

DECLARATION AND COPYRIGHT

I, Msyangi M. Kuruchumila, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

Signature_____

Date_____

ACKNOLEDGEMENT

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DEDICATION

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ABBREVIATIONS AND ACRONYMS

CCCS	Climate Change Communication Strategy
EMA	Environmental Management Act
FGDs	Focus Group Discussions
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
MWO	World Meteorological Organization
NAPA	National Adaptation Programs for Actions
NASAP	National Adaptation Strategy and Action Plan
NCCS	National Climate Change Strategy
NEMC	National Environmental Management Council
NGOs	Non-Governmental Organizations
SDGs	Sustainable Development Goals
TMA	Tanzania Meteorological Agency
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate change
UNESCO	United Nations Educational, Scientific and Cultural
URT	United Republic of Tanzania
USAIDs	United States Aids
VEOs	Village Executive Officers
VICOBA	Village Community Bank
WEOs	Ward Executive Officers

ABSTRACT

This study investigated the influence of social networks on climate change adaptation among smallholder farmers in Mvomero District-Tanzania. The study used data from a cross-sectional survey of 200 smallholder farmers in Mlali and Mzumbe wards. This study adopted both quantitative and qualitative approaches. Questionnaires and focus group discussions were used as the methods of data collection. For quantitative data, the study employed descriptive analysis and probit regression model for analysis of the relationship of interest. The study used STATA13.1 to analyze the quantitative data. The study used content analysis for the qualitative data. The findings obtained from this study indicate that the dominant climate change adaptation strategies used by smallholder farmers in Mvomero District are changing planting dates or periods, the use of improved seeds and breeds, livestock diversification, diversification to non-farm activities, and crop diversification. Majority of respondents have strong ties within their social networks as up to 92% of the respondents have reciprocal ties. Moreover, friendship ties, strong ties, social network size, social network duration and group affiliation were found to influence different climate change adaptation strategies. In the light of the findings, it is reasonable to think that awareness raising on the benefits of social networks should constitute good agenda in agriculture policies formulation. These are essential tool which enable smallholder farmers to adapt to climate change. Therefore, policy makers should not only appreciate the influence of social networks on climate change adaptation among smallholder farmers but also provide an enabling environment for social ties.

Key words: Social networks, Climate change, and Climate change adaptation strategies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION AND PROBLEM SETTING

1.0 Introduction

This chapter presents the background of the study, statement of the problem, objectives of the study, research questions, scope of the study, significance of the study and organization of the study.

1.1 Background of the study

1.1.1 Climate change historical trends in Africa

Climate change is a complex phenomenon that has a short, medium, and long-term effects on ecosystems and natural resources, physical infrastructure, and many other aspects of life (Paul, Weinthal, Bellemare, & Jeuland, 2016). Climate change is one of the challenges of 21st century. It is a global spectacle that results from increased effects of greenhouse gases which is caused by emission of gases from industrial activities in most case. Other human and non human resultant activities include deforestation, biotic process, variation in solar radiations received by the earth, volcanic eruptions and the use of fossil fuels. These in turn lead to the destruction of Ozone layer and finally leads to the global warming which cause an increase in the level of temperature and unpredictable rainfall patterns (Ojija *et al*., 2017).

Climate change has both direct and indirect impacts on agriculture, forests, biodiversity, tourism, water resources, health, and livelihoods (Ojija *et al*., 2017). Many countries face these problems, leave alone the developing countries. However, the severity of the effects of climate change differs depending on the ability to adapt.

The historical trends of climate in Africa shows a temperature increase by around 0.7^0C in many continents during the twentieth century. Some indicators also show a decrease in amount of rainfall in the south of the Sahara and an increase in amount of rainfall in East and Central Africa. This was expected to persist in the twenty first century with the rise in the sea level. The level of temperature has been on increasing

trend besides increase in precipitation pattern for about 2% in West Africa, 7% in East Africa and 4% in Southern Africa (Sani & Chalchisa, 2016).

Africa is especially at a high risk with regard to climate change and variability because of large number of people who are poor and that most of them depend on small scale farming activities. These are highly sensitive to rainfall variability and changes in the level of temperature (Sani & Chalchisa, 2016). An increase in temperature and extreme rainfall reduce agricultural productivity for many reasons. There is a direct (positive) relationship between agricultural productivity and average temperature and rainfall for crops produced by farmers in many places (Ajao & Ogunniyi, 2011). Farmers adapt to different climatic condition by choosing the optimal mix of crops. The variation of the climate (mainly in terms of rainfall or temperature) affects the productivity of agricultural produces and consequently the profitability of agriculture (Sani & Chalchisa, 2016).

1.1.2 Climate change trends in Tanzania

The climate of Tanzania varies from place to place in accordance with the geographical location of different places, altitude, relief and vegetation cover. The predictions show that the mean daily temperature will increase by 3^0C to 5^0C throughout the country and the mean annual temperature will increase by 2^0C- 4^0C.It was also predicted that there will be an increase in the level of rainfall in some parts while some other parts will experience decrease in rainfall pattern. By 2100 Tanzania is anticipated to have a decrease in rainfall patterns of between 0% - 20% (Mwandosya *et al*.., 1998).

The climate change pattern in Tanzania is inconsistent and unpredictable (Agrawal *et al*.., 2013). Recent findings show that temperature has increased and precipitation has decreased in many areas of the country. An average annual temperature is anticipated to increase by 2.2^0C and rainfall to decrease by 100 mm by 2100 (URT, 2007; URT, 2003; Agrawal *et al*., 2003; Houghton *et al*., 2001). In Tanzania irrigation practices are limited to a large extent and that many people who are engaged with agricultural activities depend on the rainfall for the production of both

cash and food crops. Changes in the climatic condition in different places are expected to severely affect the crops and the cropping patterns.

1.1.3 Climate change adaptation strategies

Adaptation strategies are limited due to lack of proper technology, inputs exchanging, lack of education, funds, and other information constraints (Komba & Muchapondwa, 2015). Most of the people especially youths in rural areas are attracted to migrate to urban centers for some other economic activities to sustain their living (Boansi, Tambo, & Müller, 2017). In many parts of the developing countries especially in agricultural areas, several research reports on agricultural adaptation strategies cite soil conservation, changing planting dates, crop mix, planting trees, shifting from crops production to livestock keeping and irrigation as the mostly used methods of adaptation (Deressa *et al*., 2009).

Decisions on various adaptation strategies are often made by individuals, groups within the society, different organizations, and sometimes government on behalf of the society at large. The effectiveness of the climate change adaptation strategies depends on the social acceptability of the adaptation alternatives. Sometimes, it depends on the compounding factors of economic globalization and other trends (O'Brien & Leinchenko, 2000).

The impacts of climate change are well acknowledged by Intergovernmental Panel on Climate Change (IPCC), the World Meteorological Organization (MWO), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), and United Nations Educational, Scientific and Cultural Organization (UNESCO). As highlighted in various climate change literatures, the key impacts of climate change include changes in the sea level, changes in the intensity, timing and spatial distribution of precipitation, changes in temperature, and frequent extreme droughts, tropical storms and floods (IPCC, 2007b; USAID, 2009; UNDP, 2009). This in-turn led to drop in agricultural productivity which resulted to problems of food insecurity among smallholder farmers and the entire community. Therefore, the communities should be involved to recognize their roles and

responsibilities in dealing with climate changes. This fast tracks positive impacts in crop productivity and the assurance of food security for their livelihood.

1.1.4 Initiatives to combat climate change effects

Sustainable development goals (SDGs), the 2030 agenda for sustainable development addresses the issues related to climate change. Goal number 13 indicates the need to take urgent action to combat climate change and its impacts by strengthening resilient and adaptive capacity to climate related hazards and natural disasters in all countries. The goal further advocates for integration of climate change measures into national policies, strategies and planning, improving education, awareness rising, and human institution capacity on climate change mitigation, adaptation, impact reduction and early warning.

Moreover, the National Adaptation Programs for Actions (NAPAs) is another initiative as a program which provides a process for less developed countries (LDCs) to identify priority activities that respond to their vital and immediate needs to adapt to climate change, These help to address factors which would increase vulnerability and or cost at a future stage (URT, 2012). Guidelines for the NAPAs process assist LDCs to undertake the steps and activities that can ensure effective adaptation based on their different level of progress. With such adaptation, those countries are able to select steps and activities to undertake in order to move forward. NAPAs process should be coordinated with national sustainable development plans, objectives, policies and programmes coordination and consistency are important elements of that process. After the identification of the adaptation strategies required measures may be taken. This might have positive impacts on agriculture sector, especially to most of the people in LDCs.

It has long been recognized that social capital is vital to the lived experiences of coping strategies against risk (Zeigler, Brunn& Johnson, 1996). Social capital portrays the concept of relationship, trust, reciprocity, and exchange. The evolution of common rules, as well as the power or role of social networks gives a role to civil society and collective actions for climate change adaptation among smallholder

farmers. Trust and reciprocity are important for the networking social capital to build adaptive capacity. The main reason is that there are number of uncertainties that are related to the predictions of climate change impacts and thus risks particularly in relation to community based adaptation activities that remain un-conceptualized by Community Based Adaptation Practitioners. Communities can embark on adaptation responses that might turn out to be wrong because of incorrect predictions of climate changes. This may consequently lead to social relations and communications based on trust and reciprocity between communities and community leaders. Other actors should be established to reveal the level of difficulty of the situation and allow communities to build trust with those other actors who support their adaptation strategies (Dodman & Mitlin, 2011).

Social networks refer to a set of social relationships or connection among people or group of people within a certain environment or society (Johanson & Mattsson, 1992). The relationship can either be among organizations (Inter-organizational relationships) or among individuals (Interpersonal relationships). According to Pelling & High (2005) interpersonal relationship that shape the social network and derive from reciprocity can fall under the two categories namely bridging social capital and bonding social capital.

These categories are essential in understanding the direction and the strength of social capital that have been explored by different authors in various literatures related to social capital and adaptive capacity (Pelling & High, 2005; Jones, *et al*.., 2012; Brunie, 2009; Adger, 2003, Leonard & Pelling, 2010). Bonding social relationships are defined as intra- community relationships (Brunie, 2009). It is also a feature of social economic group, for example common religious and common ethnic. The private and public sector should invest in strengthening social networks so as to provide sustainable structure which will support the individuals and the community which are affected by the climate change.

Information is power as it plays a vital role in any decision making process regarding to the issues related to the climate change adaptation. It is vital for the development of appropriate adaptation and mitigation measures (CCCS, 2012). Climate Change

Communication Strategy is one of the initiatives taken by Tanzanian government to enhance climate change awareness to the society. Low level of awareness among members of the society is due to the absence of strong mechanism of climate change communication which may enhance communication of climate change adaptation knowledge (NCCCS, 2012).

1.2 Statement of the Problem

Climate change has posed critical challenges to smallholder farmers in rural areas that have little adaptive capacity on climate change. Agriculture is the major sector of the economy which employ up to about 80% of the total country's population (Majule, Rioux, Mpanda, & Karttunen, 2015).Climate change effects lead to low productivity in agriculture sector and food insecurity. This in the same course intensifies poverty in rural society where smallholder farmers are highly engaged in subsistence agriculture (Sani & Chalchisa, 2016).

Several initiatives have been taken by the government of Tanzania in dealing with climate change impacts. For example, the establishment of National Adaptation Program for Actions (NAPA, 2007) provides a process for identifying the priority activities that respond to vital and instant needs to adapt to climate change (URT, 2012). Others initiative include authorization of Environmental Management Act (EMA, 2004); National Adaptation Strategy and Action Plan (NASAP, 2009) and National Climate Change Strategy (NCCS, 2012).

Tanzania is also engaged to a number of international and regional environmental treaties (NEMC, 1994; URT, 2007). All these are attempts to combat climate change impacts and other environmental challenges. Despite all the efforts climate change problems remains rampant and adoption of adaptation mechanisms is limited. Studies have shown that lack of adequate information, finances and other resources are the major constraints to adaptations to climate change (Ngaruiya *et al*., 2017). Studies have also shown that a number of factors influence adoption of climate change adaptation strategies. These include, age, gender/ sex, education level, household size, and strong ties. However, social networks have received limited

research attention in understanding adoption of adaptation strategies. Social networks provide access to resources including information, finance and, moral and psychological supports (Milanzi, 2012). These can be used to overcome constraints such as adaptation to climate change. Therefore, this study investigated the influence of social networks on the choice of climate change adaptation strategies among smallholder farmers in Mlali and Mzumbe wards of Mvomero District in Morogoro-Tanzania.

1.3 Objective of the study

1.3.1 General objective of the study

The main objective of this investigation was to assess the influence of social networks on climate change adaptation among smallholder farmers in Mvomero District, Tanzania.

1.3.2 Specific objectives of the study

i. To identify dominant climate change adaptation strategies pursued by smallholder farmers in order to cope with the effects of climate change in Mvomero District.
ii. To identify the types of social network ties exploited by smallholder farmers in Mvomero District for overcoming climate change problems.
iii. To examine the influence of social network ties on the choice of climate change adaptation strategies among smallholder farmers in Mvomero District.

1.4 Research questions

i. What types of climate change adaptation strategies are pursued by smallholder farmers to cope with the effects of climate change in Mvomero District?
ii. What are the types of social network ties exploited by smallholder farmers in Mvomero District for overcoming climate change problems?

iii. How do social networks influence the choice of climate change adaptation strategies among smallholder farmers in Mvomero District?

1.5 Scope of the study

The study confined itself to social networks and climate change adaptation issues in relation to small scale agricultural activities. The study was conducted in Mlali and Mzumbe wards in Mvomero District as it was confined to the social networks influence on climate change adaptation among smallholder farmers in the respective areas of study.

1.6 Rationale and Significances of the study

The findings of this study are beneficial to the researchers, farmers, government of Tanzania (policy makers) and other researchers.

For the researcher, the study was done as part of the requirement i.e. in partial fulfillment for the award of degree of Master of Science in Project Planning and Management.

For policy makers; the findings shed light on the measures to be taken to address climate change problems and enhance adaptation behaviors that might be useful to the smallholder farmers. Policy makers may also use the findings of this study in establishment of various policies of climate change and environment.

For smallholder farmers; the findings and recommendations of this study may be useful to the smallholder farmers in determining appropriate adaptation strategies and social ties to exploit.

For other researchers; this study stimulates future research and provides a base for the literature review on social networks and climate change adaptation strategies by exploring other social networks variables both relationship properties and structural properties of social networks in the context of Tanzania.

1.7 Organization of the study

The study is organized into six chapters. Chapter one presents introduction which includes: problem setting, statement of the problem, objectives of the study, research questions, scope of the study, rationale or significance of the study, and organization of the study. Chapter two presents theoretical literature review, empirical literature review, discussion of literature review and study positioning and conceptual framework. Chapter three presents methodology and tools used in this study. Chapter four presents presentation of findings. Chapter five presents discussion of findings, and chapter six presents summary, conclusion, policy implications, area for further studies as well as the limitation of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews some literature related to this study. The literature reviewed aimed at gathering views of other authors in relation to the influence of social networks on climate change adaptation. The sources of review are journals, articles, books, reports, and other relevant documents. This chapter also includes the definitions of key concepts, theoretical literature review, theories related to the study, conceptual framework, and empirical literature review.

2.1 Theoretical literature review

2.1.1 Definitions of key concepts

2.1.1.1 Social networks

Social networks refer to a set of social relationships involving actors (People and organizations) with an environment (Johanson & Mattsson, 1992). The relationship can be either be among organizations (Inter-organizational relationships) or among individuals/Interpersonal relationships (Milanzi, 2012). Social networks can also mean resources that actors derive from specific social structures (Baker, 1990).

In this study, social networks are used to refer to the articulation of a social relationship attributed or achieved among smallholder farmers and other stakeholders in the respective areas of the study. The main focus is the social relationship between smallholder farmers and other stakeholders such as Government officials, and Non- Governmental Organizations (NGOs) which may be useful in knowledge or information sharing with regard to the challenges of climate change adaptation to smallholder farmers.

Therefore, social networks provide glue which facilitates cooperation, exchange of information and innovation.

2.1.1.2 Climate change adaptation

Climate change is unusual variations in climatic conditions whose effects on parts of the earth are widely noticeable. Climatic changes persist for an extended period of time typically decades or centuries (IPCC, 2007).

Climate change adaptation refers to the adjustment in natural or human systems in response to actual or expected climatic stimulus or their effects, which moderate harm or utilize beneficial opportunities (IPCC, 2007a). Climate change adaptation may also mean a response to changes in climate that seeks to decrease the vulnerability of social and biological systems to relative sudden changes and thus offset the effects of global warming. Climate change adaptation can be defined as actions taken to help communities and ecosystems to cope with changes in climatic condition (UNFCCC, 2007). Adger *et al*., (2007) defined adaptation as the ability or potential of a system to take action effectively to unpredictability and change, and it includes adjustment in behavior and resources as well as technology.

Climate change adaptation strategies refers to the adjustments in social and economic systems made in response to actual or expected climate change effects in order to reduce the vulnerability in the society to change in the climate system (Miller, 2008; Olmos, 2001). Adaptation strategies can also refer to the alternative activities in which households engage in order to secure the daily livelihoods including their food and income during drought seasons (Orindi & Murray, 2005). Decision on what strategies of adaptation are usually made by individuals, groups within the society, organizations, governments on behalf of the society (Majule *et al*., 2013). The government of Tanzania has undertaken several efforts including the preparation of the National Adaptation Program for Actions (NAPAs) in 2007 which seeks to identify instant and essential climate change adaptation actions and government of Tanzania also made agreements with the United Nations on the Framework Convention on Climate Change Protocol in 1996 and 2002 respectively all those strategies were taken so as to make sure that climate change issues are addressed at national level.

As mentioned earlier, some adaptation measures are such as rainfall harvesting and investments, construction of huge dams for water storage, all these measures require some collective action and this can be well controlled and functioning if there is good social networks among community members in a particular society. Most of the society nowadays they have gained some knowledge, skills, technology, institutional arrangements, and strategies that are crucial in adapting to long-term climate changes. Social networks provide access to local adaptation strategies in the society, which differ from one society to another since societies are always adapted to climate change by making preparations based on their resources they have and the knowledge obtained from previous weather patterns. At individual level households may use the adaptation strategies on the base of their easier to be executed, the gap between execution and the effects, the cost of execution and compatibility with other measures (Admassie *et al*.., 2008)

2.1.1.5 Smallholder farmers

Smallholder farmers may refer to as farmers who hold small portion of land for their agricultural practices. There are various definitions of smallholder farmers in various literatures. Hall (2009) suggests that the distinction between smallholder farmers and commercial farmers lies on the degree of labor intensity and that the smallholders appear to be equated with farming that relies mainly on household labors. The concept of smallholder farmers brings another term called “small scale farmer” and “peasant farmer”. Smallholder farmers are characterized by limited amount of land for production, constraints to labor, lack of market share in agricultural produces, limited inputs and other factors including capital (Lupatu & Matee, 2001).

2.2 Review of theoretical Perspectives of the study

This study applied social capital theory to explain social networks influence on climate change adaptations.

The theory of social capital can be viewed in two different levels such as group level and individual level. Group level is all about collective actions which consist of two different perspectives, one is how groups can build up social capital as a collective

asset and another perspective is how such collective assets can facilitate and increase members' chances in life (Lin, 2001:22).

According to Bourdieu (1986) defined social capital as the aggregation of potential resources which are lined to the possession of a durable network of institutionalized relationship of mutual acquaintances and recognitions. Therefore, Bourdieu viewed social capital as creation of group members which is a collective asset shared by its members with clear boundaries, limitations of exchange, and also mutual recognition. As explained by Bourdieu group affiliations as a part of social networks can be a collective asset shared by the smallholder farmers through sharing social network benefits which alter their ability in the choices of climate change adaptation strategies.

As regard individual perspective of the social capital (Lin, 2001) explained that an individual can gain access and use two types of resources namely personal and social resources. Personal resources are those resources that are owned by an individual privately (private ownership), example ownership of materials, or properties. (Flap, 1999) viewed social capital as mobilized social resources of individuals: defined social capital based on (i) number of people within the social network of individuals and who are ready to assist when the need arises; (ii) the strength of the relationship among the network members indicates readiness to help each other and (iii) Personal members' network resources. Therefore, the concept of social capital can be placed into three major components such as moral obligations and norms, social values (trust), and social networks (Putnam, 1995).

The theory of social capital at individual level focuses on the resources implanted in individual's network. Furthermore, it focuses on how to access to and use the resources which benefits individual's actions. Social capital is expressed as valued good in the society as it is the resource which can be used by individuals for the purpose of gaining the access to different resources such as financial resources, and knowledge or information. According to Bourdieu (1986) the larger the social capital depends highly on the extent of the size of the network (i.e. number of ties an individual has in his or her networks). The social capital utilization depends on the

heterogeneity of the network members (Lin, 2001). Therefore, smallholder farmers should have network with the people with different socio-economic status such as family members, social groups, and government officials.

Social capital is criticized for diversity of its definition and it is not easy to have exact measurement i.e. difficult to calculate the exact amount of social capital volume for an individual (Haynes, 2009). The diversity of the social capital meaning brought a problem to comparable conceptualization and measurement which may in-turn leads to the misleading results and predictions especially in the context of quantitative research. Therefore, this study is going to investigate how social networks as a component of social capital can have influence on the choice of climate change adaptation strategies among smallholder farmers using mixed approaches both quantitative and qualitative.

2.3 Empirical literature review

2.3.1 Climate change and adaptation strategies

Deressa *et al*., (2009) conducted their study in Ethiopia using secondary data obtained from a cross sectional survey done among 1000 mixed crop and livestock farmers by Ethiopian Development Research Institute (EDRI). The purpose of the study was to identify the major methods used by farmers to adapt climate change. The study used Heckman's sample selection model in analyzing the variables of the study. The main conclusion of their study was that the level of education, gender, age, and wealth of household, access to extension and credit, information on climate, agro-ecological settings and temperature all factors influence farmers' choice in climate change adaptation.

Ajao and Ogunninyi (2011) conducted a study in Oyo state in Nigeria. The study aimed at examining the farmers' adaptation strategies to climate change in Ogbomoso agricultural zone of Oyo state in Nigeria. A multistage sampling procedure was used, and a total of 150 famers were interviewed. The study used Probit Model and the main conclusion was that "the long-term improvement

investments commonly adapted by the study area were tree planting or agro forestry, and surface cover".

Komba and Muchapondwa (2015) conducted survey of 534 randomly selected among farms households by using questionnaires; the main objective of the study was to identify the adaptation to climate change strategies by smallholder farmers in Tanzania. The study adopted the Heckman Sample selection model and Multinomial Probit Model (MNP). The findings of their study revealed that use of short-season crops (use of improved variety seeds and breeds, irrigation, planting trees and changing planting dates are the dominant method the farmers prefer to respond towards climate changes, but most of the farmers did not take any adaptation measures due to different challenges such as lack of funds, shortage of water, poor planning and shortage of seeds.

Tesfaye and Seifu (2016) conducted a cross-sectional survey of 296 households by using a semi structured questionnaire in Ethiopia whereas the main objective was to examine perceptions on climate change and its threats; identify adaptive strategies and factors influencing adaptation decisions. The methods of data analysis used were multivariate probit model. The findings of the study was that, majority of households interviewed were aware about climate change and its associated impacts on income, food security, diversity, forest resources, livestock and crops. The adaptation strategies mostly used were planting varieties of crops, changing planting dates, the use of water and soil conservation techniques as well as engagement in non-farming activities. The study addressed that the adaptation is influenced by gender, household size, farm size, and distance from the market.

Joshi, Ji, and Joshi (2017) conducted a survey of 120 households among households in Nepal using questionnaires to assess the perceptions and major practices and technologies adopted to mitigate climate change impacts in Nepal. The study adopted binary logistic regression model for analysis. The study found that the decision to adapt is affected mostly by the size of the land, perceived threat to food security, education, gender, perceived increase in drought, threat during rainy season, and off-income and most of the households are aware about climate change

and its impacts especially on food security though not all household adapt to climate change to reduce the impacts and increase resilient.

Ngaruiya *et al*. (2017) conducted a cross sectional survey of 450 households in Pakistan. The major purpose was to explore the institutional aspect of adaptation in social networks in climate change adaptation in agriculture. The study used Social Network Analysis (SNA) as the method of analysis and their findings indicated lack of adequate information, finances and other resources are the major constraints that hinder the process of climate change adaptation. However findings from social network analysis indicated that the network had low density (weak ties) and public institutions are poorly presented in social networks as well as extension services are key institution in climate change adaptation network.

2.4 Discussions of literature and study positioning

This review has evidenced some studies around the focus of this study. Some of these studies include Othieno (2014) who assessed the effects of social networks characteristics on the flow of climate change adaptation information in Kenya. Osei (2015) examined the impact of network based social capital on climate change adaptation strategies among smallholder farmers in Ghana. Ngaruiya *et al..,* (2017) explored the institutional aspect of adaptation in social networks in climate change adaptation in agriculture in Pakistan. These studies examined structural properties of social networks including structural holes, network density, reciprocity and clustering. The current study focused on the relational properties of social network namely social network size, social network duration as well as social network composition.

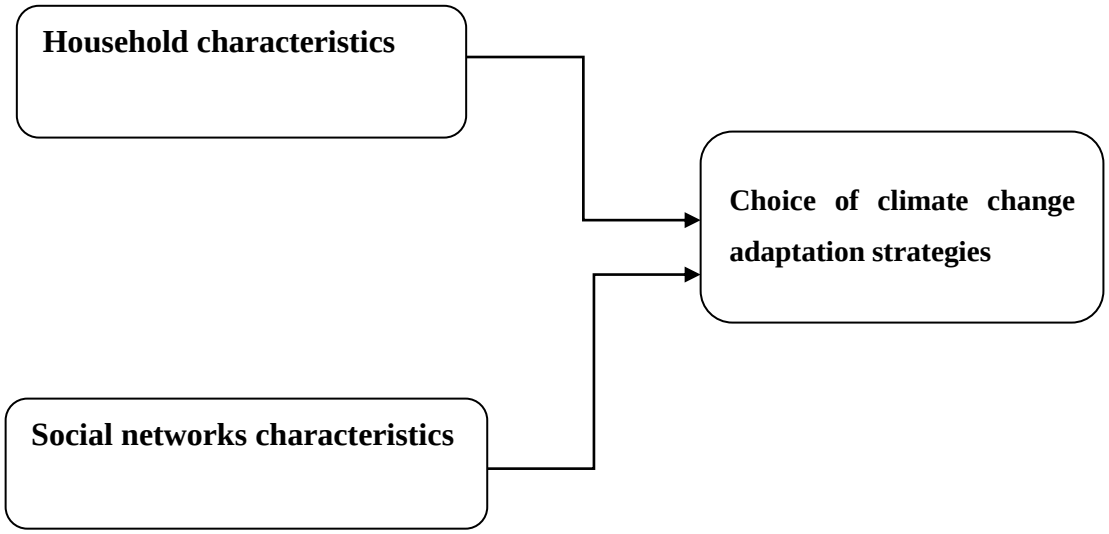
There is limited empirical literature on social networks and climate change adaptation especially in the Tanzanian context. Hence, this study intended to investigate the influence of social networks on the choice of climate change adaptation among smallholder farmers in Tanzania. The study was geared towards testing the assumptions of social network theory to determine whether or not they are valid in the context of Tanzania, a developing economy. It was assumed that

previous results lacked external validity given those countries in socioeconomic and institutional developments.

2.5 Conceptual framework

The conceptual framework explains the relationship that exists between independent variables and dependent variables. Adom *et al.., (*2018) defined a conceptual framework is a diagrammatic representation that shows the relationship between the dependent variable and independent variables of the study. The study aimed at assessing the influence of social networks on the choice of climate change adaptation strategies among smallholder farmers. Social network variables identified include social networks characteristics (strong ties, friendship ties, social network size, and social network duration and group affiliation). Earlier studies found these variables to be important in climate change adaptation among smallholder farmers (Deressa *et al.*, 2009; Tesfaye & Seifu, 2016).

Figure 2.1 Conceptual framework



Source: Researcher's own design (2019)

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents methodologies which were used in the study. It describes the research design, sampling procedures, data collection methods, methods of analysis, validity and reliability of the research instruments, ethical consideration of the study and variables with their respective measurements.

3.1 Research design

Research design is a blue print that enables the researcher to come up with solutions to those problems and guides the researcher in various stages of research. Research design is a grand research plan which determines what a researcher is going to examine and analyze in the field (Milanzi, 2009:32).

A research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari, 2004). On the other hand, Orodho (2003) defines a research design as the outline or plan that is used to generate answers to research question.

This study used a cross-sectional survey design because it allowed for relative quick and easy collection of data at one point in time.

3.2 Area of the study

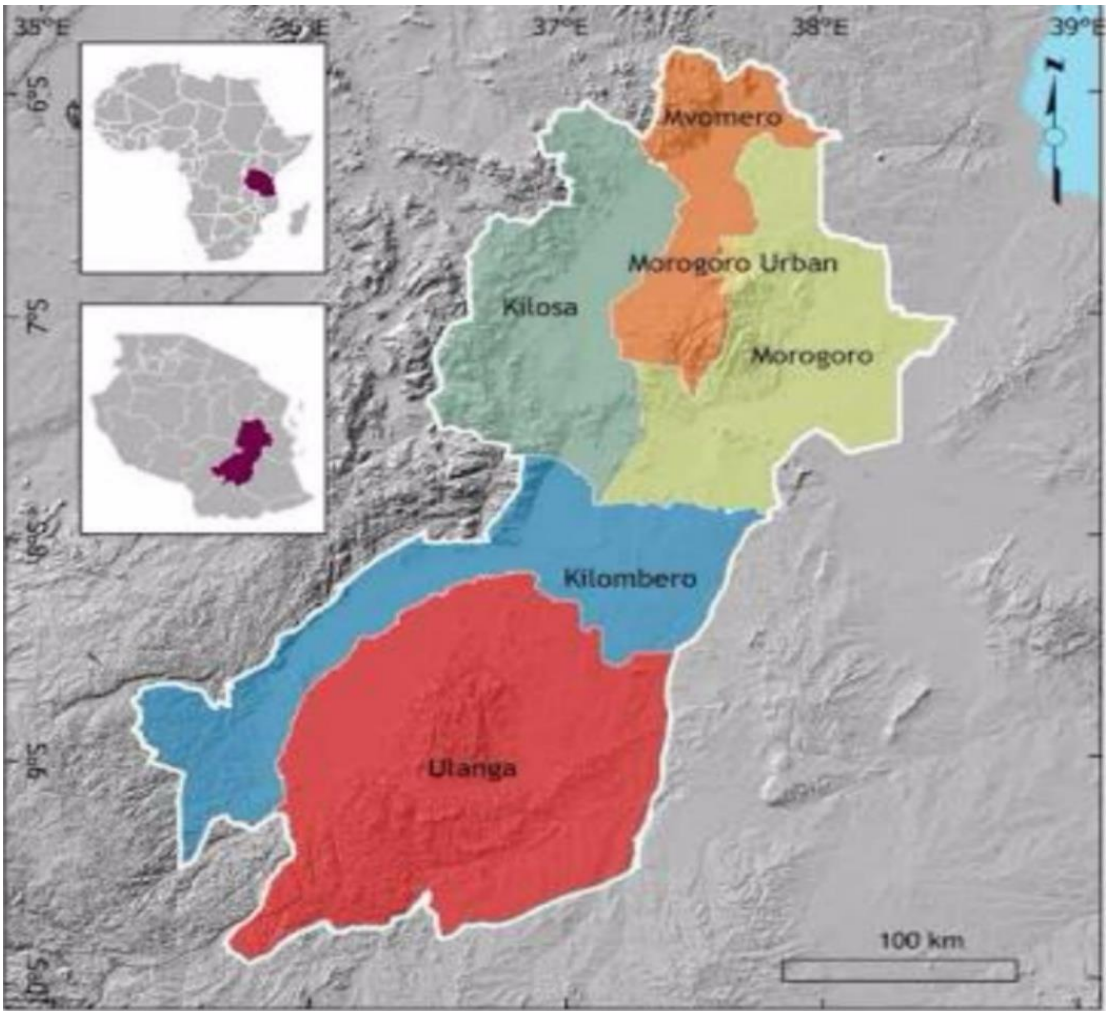
This study was conducted in Mlali and Mzumbe wards because the selected areas are among the areas which have been experiencing severe impacts of climate change especially increase in temperature and unpredictable rainfall patterns (Magita & Sangeda, 2017). Therefore, the targeted area was expected to provide sufficient information to this study.

Mvomero District is one among seven districts of Morogoro Region. Other districts include Kilosa, Ulanga, Kilombero, Morogoro District, Gairo and Morogoro Urban. Mvomero District borders Handeni district on the Northern part, Morogoro municipality on the Southern part, Bagamoyo District on the Eastern part and Kilosa District on Western part. The district is found on the North-East part of Morogoro Region lying between 8^0 and 10^0 00'' latitude of the south equator and lying between longitude 37^0 0'' and 28^0 22''East. The district has a total of 7325 km^2. Mvomero District has a total of 30 wards. According to the national population census of 2012, Mvomero District has a total of 260,525 people.

The study was conducted in the Mlali and Mzumbe wards. Mlali and Mzumbe wards are among the wards in Mvomero District in Morogoro region. According to national census statistics of 2012 there are 23,320 and 19,056 people in Mlali and Mzumbe wards, respectively. In Mlali ward, Kipera, Mkuyuni, Lugono, Kinyenze and Mlali are the villages which were included in this study which have 4193 households. Mzumbe ward, consists of Vikenge, Sangasanga, Changarawe, Mnyanza and Tangeni are the villages which were included in this study which have 4760 number of households.

The main activities are farming and livestock keeping. Most farmers are engaged in maize and horticultural (tomatoes) production for both food and commercial purposes.

Figure 3.1 A map of Morogoro Region

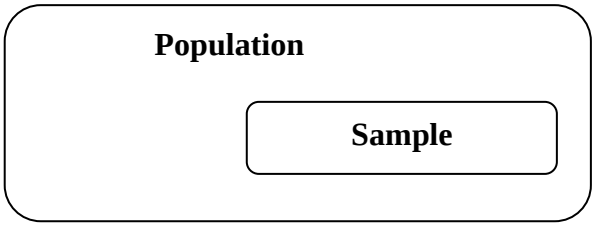


Source: Google maps

3.3 Population and Unit of analysis

A population is the total collection of elements from which the researcher wishes to make some inferences (Cooper & Schindler, 2007). Adam and Kamuzora (2008) pointed out that mathematicians usually define population as the universal set and a sample size as a subset as shown in figure 3.2

Figure 3.2: Population and sample



Source: Adam and Kamuzora (2008)

According to National Census Statistics of 2012, Mvomero District has a total of people about 260,525. Mvomero has a total of 30 wards as administrative divisions. Two wards were selected namely Mlali and Mzumbe.

The unit of analysis in this study was the smallholder farmers who live in Mzumbe and Mlali wards in Mvomero District, Morogoro Region in Tanzania.

3.4 Sample size and sampling frame

A sampling frame is defined as a listing of the inhabitants units from which a sample size is to be extracted at any stage of sampling (Ishak & Abubakar, 2014). Thus, the sampling frame in this study was obtained from wards' households; 4193 and 4760 from Mlali and Mzumbe wards respectively.

A sample size is a small part of a large population which is thought to be representative of a large population. The study used a sample of 200 smallholder farmers. This helped the researcher to obtain fairly accurate characteristics of the entire population.

The sample size is obtained by using the following formula.

$$n = \frac{Z^2 * P\ (1-P)}{d^2}$$

Where; n – Sample size required

Z- Reliability coefficient at 95% level of confidence (1.96)

P- Estimated prevalence (0.5)

d- Level of precision (10%)

Source: Daniel, (1999)

$$n = \frac{(1.96)^2 * 0.5\ (1-0.5)}{(0.1)^2}$$

n= 192.08

Therefore, the number of the respondents that was involved in this study was 200. This was trusted to provide a fair proportion of respondents from each village within the study area.

3.4.3 Sampling techniques

In order to come up with unit of analysis which would support in this study, the researcher used purposive sampling technique. Purposive sampling technique is defined as a non-probability sample that is selected based on characteristics of a population and the objective of the study (Palys & Atchison, 2008).

Purposive sampling was adopted in order to obtain a sample of household heads (male or female) Mlali and Mzumbe wards' villages. The purpose of using this purposive sampling technique was to obtain information from the intended respondents (household heads who are smallholder farmers) based on the objectives of the study.

3.5 Types and Sources of Data

Primary data was collected from respondents using questionnaires and focus group discussion. The source of primary data consisted of closed and open ended questions. A researcher distributed the tools among respondents and collected them

after they had been by respective respondents in village. This data was also collected through discussion from focus group discussion which was done.

Secondary data means second hand information/ data that is not collected by the researcher for the first time. Secondary data was obtained from other sources like internet sources, and articles and journals from libraries in order to help researcher to come up with relevant conclusion and recommendations. It also gives back up to primary data. In this study, secondary data helped a researcher to understand the climate change adaptation strategies and its limitations.

3.6 Method of data collection

The nature of the research design determines the methods of data collection. In this study the researcher used questionnaires and focus group discussion as dominant data collection methods.

3.6.1 Questionnaires

Questionnaire is a self-administered schedule of questions and statements. Both open-ended and closed-ended questionnaires were administered using interview protocol to the smallholder farmers from different villages of Mlali and Mzumbe wards. This was due to the nature and size of the respondents' population and that it was done to ensure more accuracy of information from the respondents. The questionnaires were pre-tested for its reliability and validity in the study population of the respective areas of the study.

Questionnaires were distributed to the smallholder farmers of Mvomero District (Mlali and Mzumbe wards) who were the respondent of this study. A total of 200 questionnaires were administered to the respondents in each respective wards. A total of 200 questionnaires were distributed to 200 respondents from 10 villages, whereas 5 villages from Mlali wards and other 5 villages from Mzumbe ward. The villages from Mlali ward include Lugono, Mlali, Kipera, Mkuyuni and Kinyenze and those from Mzumbe ward are Changarawe, Sangasanga, Tangeni, Mnyanza and

Vikenge village. The response rate was 100% because the questionnaires were administered by using interview protocol.

3.6.2 Focus group discussions

This method was used to collect opinions and suggestion of smallholder farmers on the different aspects of social ties and climate change adaptation strategies as it was not possible to be captured in questionnaires.

The focus group discussions were conducted among smallholder farmers of 6 to 10 participants who were selected using purposive sampling technique. Those who answered the questionnaire correct were selected as the participant of the Focus Group Discussions to discuss the subject matter. In order to enhance the validity of information, the points of respondents were recorded by an audio tape. FGDs were used in order to allow a full participation of the respondents as it encourages freedom of expression to participants. This enabled the researcher to obtain more information and with detailed explanations. The FGDs sought to capture information related to how the respondents benefited from group membership with regard to the choice of climate change adaptation strategies. The names of the respondents were coded interns of alphabet U, V, W, X, Y and Z and the villages were represented by numbers such as village1, village2, and village3

3.7 Variables and their measurements

Climate change adaptation strategies are the dependent variable of the study. The independent variables of the study are household's characteristics (Age, sex, education level, household size and type of economic activities). For social networks, the study included tie strength, friendship ties, social network size, social network duration, and group affiliation.

Table 3.1: Variables used in Econometric Analysis

Variable	Definition	Measurement	Nature of data	Expectation relationship
Age	Age of the respondents	Years	Continuous	+/-
Sex	Sex of the respondents	0=Female 1=Male	Nominal	+/-
Household size	The total number of people who reside in household	Numbers	Continuous	+
Economic activities	The activities in which the respondents are engaged in	Farming = 1 Non farming = 0	Categorical	_
Proportional of strong ties	The number of strong ties against weak ties	Ratio of strong ties over weak ties	Continuous	+
Friendship ties	Proportional of friends in a social network of respondent	Ratio of friends against acquaintances	Continuous	+
Social network size	The number of people in a social network	Numbers	Continuous	+
Social network duration	The length of social network relationship	Years	Continuous	+
Group affiliation	The association membership of the respondents	Member = 1 Non-member = 0	Categorical	+

Source: Researcher' own construct (2019)

3.8 Methods of Data analysis

3.8.1 Descriptive Analysis

In order to obtain descriptive statistics (frequencies and percentages) STATA 13.1 were used. Descriptive statistics were used to analyze data on selected socio-demographic factors and social networks variables.

3.8.2 Econometric Analysis

In this study there are five dependent variables; these are the dominant climate change adaptation strategies and that all are binary in nature which take value of 0 zero (0) and one (1) for no adaptation of strategies and presence adaptation strategies, respectively.

Probit model was used in examining the decision to adopt climate change adaptation strategies (1=farmer adapts any strategies; 0=otherwise) hence, the random error is systematically distributed about zero (Wooldridge, 2009). Binary choice models assume that individuals are faced with a choice between two alternatives and the choice of any of the two depends on certain factors (Robert & Daniel, 1998). Given that the dependent variable Y is binary, and can be regressed on a number of independent variables (Maddala, 1977), the probit model can be presented as:

$$Prob(Y = \frac{1}{X} = \Phi(X'\beta)$$

Whereby Prob denotes probability, $\ddot{O}$ denotes the cumulative standard normal distribution function and β is a vector of the parameters to be estimated (Robert &Daniel, 1998). Let's observe some variable say Y which takes the values between 0 and 1 and define the latent variable Y* as:

$$Y^* = X_i\beta + \varepsilon$$

Where $Y^*$is the dependent variable of adaptation strategy for climatic change or not adapting, $X_i$isexplanatory variable that influence social ties on the choice of climate change adaptation strategies among smallholder farmers in Mvomero District. They are categorised into house hold characteristics and social network characteristics such as age, marital status, education level, occupation, household size, social tie strength, among others. β are the parameters coefficients to be estimated, ε is the error term that is normally distributed with N (0, 1) Here, the dependent variable Y can be observed if y>0 which signifies adaptation, and y=0 which signifies no adaptation. i.e.

$$Y_i = \begin{cases} 1, if small scale farmer adapt strategy for climate change \\ 0, otherwise \end{cases}$$

Therefore, the probability that Y=1 given X is estimated using the standard normal cumulative function which was illustrated by the equation below

$$prob(y_i = \frac{1}{X}\emptyset(S) = \int_{-\infty}^{-S} (2\pi)^{-1/2} e^{-s^2/2}\, ds$$

Where $S = X_i\beta$

The standard normal transformation $\Phi(S)$ constraints for the probability to lie between 0 and 1

Equation (iii) can be interpreted as; probability expressed as conditional probability that a small scale farmer adapt strategy to overcome the problems of climatic changes given certain explanatory factors X_i. The above model was estimated using the likelihood function given as;

$$L = \prod_{i=1}^{n} \theta\,(X_p\beta)^{y_i}[1 - \theta(X_i\beta)]^{1-y_i}$$

Nevertheless it was convenient to use the log likelihood function given as

$$ln = \sum_{i=1}^{n} \{y_i \ln[\theta(X_i\beta)] + \ (1 - y_i)\ln\,[1 - \theta(X_i\beta)]\}$$

Therefore, we look for $\hat{\beta}$estimates that maximize the log likelihood function. The probit model facilitates in interpretation of the significance of coefficients and the sign. It is therefore appropriate to estimate the marginal effects in order to interpret both the sign and magnitude. The marginal effect shows the change in probability of $y = 1$ per unit change in independent variable$X$. It was calculated as

$$\partial p/\partial xj = \theta(X_i\beta)\beta_j$$

The independent variables X_i, are factors influence of social ties on the choice of climate change adaptation strategies among smallholder farmers in Mvomero District which categories into household characteristics and social network characteristics is determined by some factors (Maddala, 1977), such that;

$$Y_i = \beta X_i + \varepsilon_i$$

Where Y_i is a dependent variable, it takes a value of 1 if a particular adaptation strategy is chosen, and 0 if otherwise.

X_i= a vector of explanatory variables as described in Table 3.1,

$\beta =$ a vector of parameters to be estimated.

ε_i= error term

The basic framework for analysis is provided by the random utility model where respondents are assumed to choose among a range of discrete number of alternatives to maximize their utility. Random utility theory states that a respondent's utility can be decomposed into a systematic and random component of utility. That is, total utility is the sum of observable and unobservable components

$$U_{ij}(choice\ j\ for\ individual\ i) = V_{ij} + e_{ij}$$

The utility level U_{ij}, which is individual $i's$ utility from choosing alternative *j*, is determined by the systematic component of utility of $V_{ij}$and random components, e_{ij}, which is assumed to be independently and identically distributed with type I extreme value (Gumbel) distribution (Greene, 2003). The random component represents the unknown components the consumers' utility function.

Consumer *i*chooses alternative *j* if

$U_{ij} > U_{ik}$ for all $k \neq j$

The probability of individual *i*choosing alternative *j* is equal to the probability that the utility of alternative *j* is greater than the utilities of all other alternatives in the choice set (Greene, 2003)

$$P_{ij} = \Pr(U_{ij} > U_{ik})\ \forall k \neq j$$

3.9 Validity and Reliability of Research

3.9.1 Validity

Krishnaswami (1993) defined validity as the effectiveness (or success) of an instrument in measuring the specific property which it intends to measure. Validity of data may mean measurement of whether the phenomenon of the study claimed to exist, actually exist. Data validity determines whether the research instruments truly measure the planned research results (Joppe, 2000). It measures the results in drawing conclusions and propositions. In order to increase the content validity of the instruments, translation of questionnaires from English language to Swahili language simplified the communication process with the respondents. The quality of translation was ensured by back translation to English language in order to increase their clarity and accuracy of the contents.

3.9.2 Reliability

Data reliability refers to as the degree to which the results of the study are consistent over time and portray a specific presentation of the total population under the study phenomenon (Jope, 2000). Reliability may also mean the extent in which the study findings are consistency and reliable. The assumption implicit in the instance on the reliability is that valuable and useful knowledge about the words must demonstrate continuity.

Therefore, in order to ensure the quality of data is maintained, the following measures were considered from the pre-testing step to the data analysis step. Firstly, the questionnaires pre-testing were carried out of 3 respondents which were not among the surveyed sample. The challenges encountered, time spent and other suggestions for improvement were taken into consideration for the purpose of improving the questionnaire as an instrument of data collection. Secondly, the questionnaires were structured in such a way that some questions were designed to ask for related information but in different way to ensure the internal consistency.

In maintaining the consistency of responses from the respondents, questionnaires were coded in Microsoft excel on daily basis before going to the field the next day.

3.10 Ethical Consideration

The study considered all required ethical standards of the research. Research clearance permit was granted by Mvomero District council, Ward offices in Mlali and Mzumbe as well as village governments of the respective wards. In all these processes, Mzumbe University provided an introduction letter, showing that the research had been approved after satisfying research requirements of the University.

There was the consideration of consent of participants before data collection procedures since they agreed to be participants. The participants were informed about the objective of the study and why the study is important to them and other stakeholders.

Only respondents who were willing to participate in the study were recruited for the study. In addition, participants ensured confidentiality of any accessed information or data. As a part of ethical procedures, the names of the respondents do not appear in data presentation.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.0 Introduction

This chapter presents the findings obtained from household responses with regard to how the social networks influence climate change adaptation among smallholder farmers. Descriptive statistics gives the demographic data and the results on household responses towards climate change. The econometric analysis presents the quantitative findings, in which the household characteristics (variables) and social network variables are examined with respect to the climate change adaptation strategies. The empirical analysis helped to explain the relationship among the independent variables and the dependent variables. The major findings of this study have been summarized at the end of this chapter.

4.1.1 Presentation of demographic profile of respondents

Demographic information of the respondents is shown in Table 4.1.

Table 4.1 Demographic profile of respondents

S/N	Variable	Description	Frequency	Percentage (%)
1	Sex	Male	104	52.00
		Female	96	48.00
	Marital status	Single	23	11.50
2		Married	94	47.00
		Cohabited	42	21.00
		Divorced	29	14.50
		Widowed	12	6.00

Source: (Research findings, 2019).

4.1.2 Sex of respondents

Finding in table 4.1 shows that 52% of the respondents were male while female were 48%. Based on the findings, the issue of gender is decisive in the choice of climate change adaptation strategies.

4.1.3 Marital status of respondents

Table 4.1 shows that marital status of the respondents is described; up to 11.5%of respondents were single, 47% were married, 21% were cohabited, 14.5% were divorced and 6% were widows. Thus, majority of the respondents are married.

4.1.4 Age of respondents

Statistical analysis results show that the mean age of the respondents was 45.07 years whereas the minimum age of the respondent was 19 years with a maximum age of the respondent as 77 years. This implies a standard deviation of 14.292 as it is presented in table 4.2

4.1.5 Household size

Statistics shows that the mean household size of the respondent is 4.71.Whereas the minimum number of household size is 1, the maximum number of household size is 10 with the standard deviation of 1.948. This shows that the gap in household size is not very large as presented in table 4.2 below.

Table 4.2 Household size and Respondents age

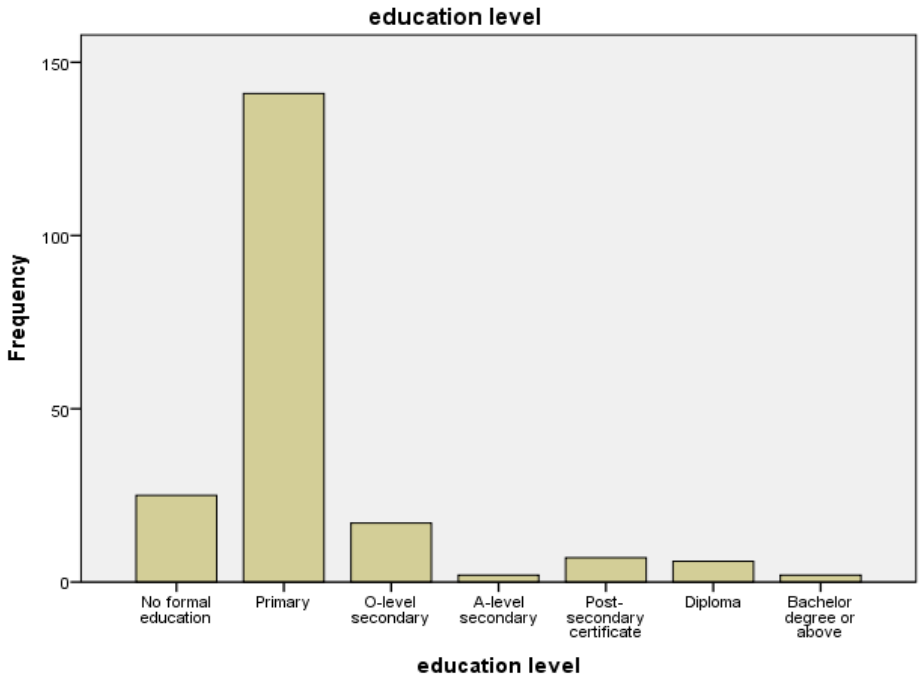
Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	200	19	77	45.07	14.292
Household size	200	1	10	4.71	1.948

Source: Research findings (2019).

4.1.6 Educational level

Statistics shows that the largest number of the respondents possesses primary education. A total of 141 respondents out of 200 respondents have primary education, which is equivalent to 70.5% of the total respondents. Figure 4.1 shows the educational level of respondents.

Figure 4.1 Education level of respondents



Source: Research findings (2019).

The findings indicate that education level is essential factor in the choice of climate change adaptation strategies.

4.2 Membership in association

Results of analysis of membership to socio-economic association are presented in table 4.3. The table shows that majority (61.5%) are members of political association.

Table 4.3 Membership association/ groups

S/N	Type of association	Status	Frequency	Percentage (%)
1	Farmer based organization	Member	48	24.00
2	Finance/ saving and credit association	Member	68	34.00
3	Business or trade association	Member	19	9.50
4	Religious/ spiritual group	Member	89	44.50
5	Political association	Member	123	61.50

Source: (Research findings, 2019).

The frequencies presented on the table above exceed the sample size since the respondent had multiple answers of groups in which they are engaged. The findings show that membership association constitute important factors in the choice of climate change adaptation strategies.

4.3 Access and use of smart phone access among respondents

Table 4.4 shows the results of analysis of access to smart phone. About 77% of the respondents do not have access to smart phone (access here is used to mean ownership/possession of the device or regularly obtaining from a friend or relative).

Table: 4.4 Access and use of smart phone

Smart phone access	Frequency	Percentage (%)
No	154	77.00
Yes	46	23.00
Total	200	100.00
Smart phone use on climate change information		
No	25	54.35
Yes	21	45.65
Total	46	100.00

Source: Research findings (2019).

4.4 Land ownership status of the respondents

Analysis shows that on average smallholder farmers in the study area own 2.42 acres of land. Findings show that most of the respondents own a portion of land which enables them to practice small-scale farming for their livelihood.

4.5 Analysis of climate change and adaptation strategies

Analysis of the climate change awareness among the smallholder farmers shows that all the respondents are aware about the changes in climatic condition in their area. Within the last ten years, 100% of the respondent noticed a change of climatic condition.

Table 4.5 presents the statistics of climate changes experienced by the respondents in their respective areas over the past ten (10) years.

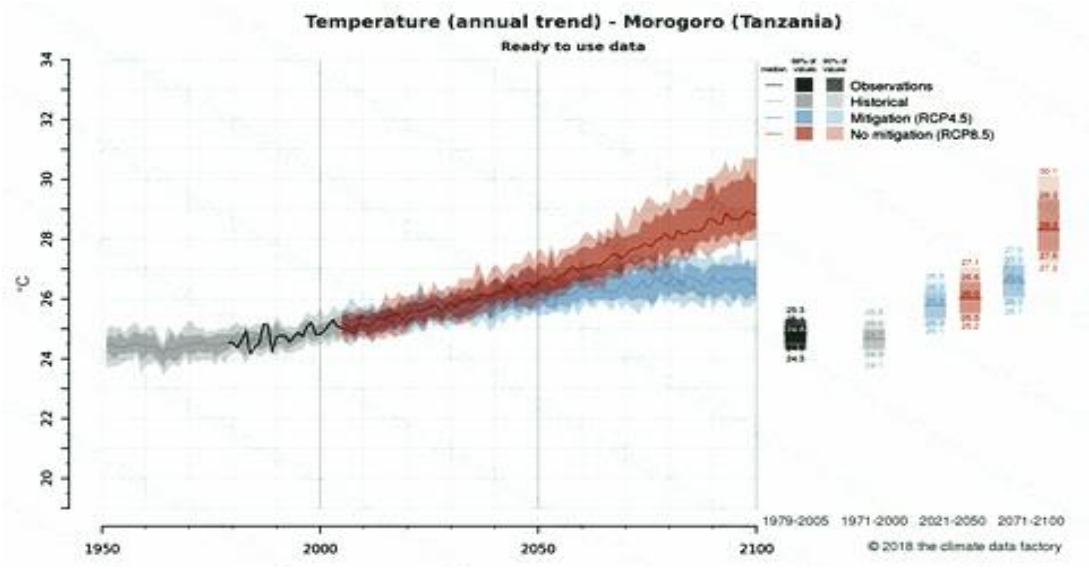
Table 4.5 Climatic change observed over the past ten (10) years

S/N	Climate condition	Outcome	Frequency	Percentage (%)
1	Increased amount of rainfall	Yes	59	29.50
		No	141	70.50
2	Decreased amount of rainfall	Yes	162	81.00
		No	38	19.00
3	Unpredictable rainfall patterns	Yes	185	92.50
		No	15	7.50
4	Increased temperature	Yes	183	91.50
		No	17	8.50
5	Decreased temperature	Yes	51	25.50
		No	149	74.50
6	Prolonged drought	Yes	34	17.00
		No	166	83.00

Source: Research findings (2019)

The results show that over the past ten years there is a decrease in rainfall pattern, unpredictable rainfall patterns, increasing temperature. The results also show that there has been no prolonged drought. The TMA (2016) data indicates similar trends as shown in figure 4.2 and 4.3.

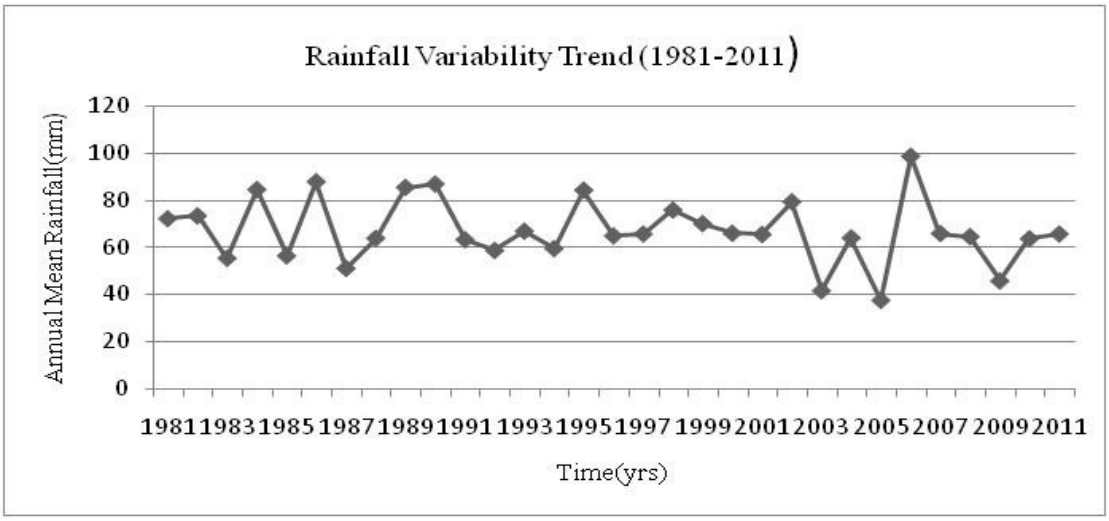
Figure 4.2 Temperature (annual trend and its predictions) in Morogoro



Source: Tanzania Meteorological Agency (2016)

Figure 4.2 shows that there is an increase trend in annual temperature from time to time.

Figure 4.3 Rainfall Variability Trend (1981-2011)



Source: Tanzania Meteorological Agency (2016)

Figure 4.3 shows that there has been unpredictable trend of rainfall patterns since 2007.

4.5.1 Climate change adaptation strategies

The analysis shows that, 70% use changing cropping/planting dates and periods, 65.5% use livestock diversification, 64% use improved variety seeds and/ or breeds. Up to 55.5% use crop diversification and mixing (multiple cropping) and 55.5% use diversification to non-farm activities as the mostly adaptation strategies adopted.

Table 4.6 Adaptation strategies adopted

S/N	Adaptation strategy	Outcome	Frequency	Percentage (%)
1	Crop diversification & mixing (multiple cropping)	Yes	111	55.50
		No	89	44.5
2	Diversification to non-farming activities	Yes	111	55.50
		No	89	44.50
3	Practicing small scale irrigation	Yes	88	44.00
		No	112	56.00
4	Crop sharing as payment of working as causal farm labor	Yes	17	8.50
		No	183	91.50
5	soil & water conservations	Yes	94	47.00
		No	106	53.00
6	Livestock diversification	Yes	131	65.50
		No	69	34.50
7	Changing cropping/planting dates and periods	Yes	140	70.00
		No	60	30.00
8	Use improved variety and seeds and/ or breeds	Yes	128	64.00
		No	72	36.00

Source: Research findings (2019).

4.6.1 Social network size of the respondents

Results show that, the minimum size of the social network is 1 member while the maximum size of the social network is 15 members. Here, the mean social network size is 2.94 with the standard deviation of 2.907

4.6.2 Social tie strength

Results show that the minimum social network duration is 1 year while the maximum social network duration is 50 years. The mean social network duration is 15.68 years with the standard deviation of 11.42

4.6.3 Social Network Composition

Friendship network

Table 4.7 shows that, the minimum proportion of friends in the social networks of the respondents is 1 and the maximum proportion of friends in the social networks is 1.The mean proportion of friends in social network of the respondent is 0.93 while the standard deviation is 0.25

Table 4.7 shows the result of analysis of network composition. The analysis of sex composition shows that the proportion of female in a network is 25.5%. Descriptive statistics shows that the proportion of farmers in a network is 58%. This indicates that most of the respondents are associated with their fellow farmer in their respective social networks compared to non-farmers.

Table 4.7 Sex, occupation, and reciprocity proportional in social networks

S/N	Proportionality of social network composition	Proportion	Percentage (%)
1	Proportion of female in social network	0.255	25.50
2	Proportion of farmers in social network	0.58	58.00
3	Proportion of reciprocity in social network	0.92	92.00

Source: Research findings (2019).

4.6.4 Access to extension services

Table 4.8 shows that 71.5% of the respondents do not have contact with their extension officers.

Table 4.8 Smallholder farmers' Access to Extension Services

S/N	Contact with extension officer	Outcome	Frequency	Percentage (%)
1	Contacts with extension officers	None	143	71.50
		Once	23	11.50
		Twice	8	4.00
		Three times	2	1.00
		More than three times	24	12.00

Source: Research findings (2019).

Results presented in table 4.9 shows that 92% of extension officers are from the government.

Table 4.9 Sources of extension services

S/N	Type of organization extension officers come from	Frequency	Percentage (%)
1	Non-Governmental Organizations (NGOs)	15	7.50
2	Government	184	92.00
3	Private firm	7	3.50
4	I don't know	38	19.00

Source: Research findings (2019).

4.6.5 Network benefits

Table 4.10 shows that 76% of the respondents receive information, 63.5% of the respondents receive advice, and only 23% of the respondents receive financial or material support from their social networks.

Table 4.10 Type of support received from social networks

S/N	Type of Benefits	Outcome	Frequency	Percentage (%)
1	Information	Yes	152	76.00
		No	48	24.00
2	Advice	Yes	127	63.50
		No	73	36.50
3	Financial or material support	Yes	46	23.00
		No	154	77.00

Source: Research findings (2019)

4.6.6 Channels used to receive information on weather and climate predictions

Table 4.11 shows that, 97% use Radio/ Television and 57% use neighbors, friends, and family & household members as their major channels used to receive information.

Table 4.11 Media used for weather and climate information access

S/N	Type of channel	Frequency	Percentage (%)
1	Extension officers/ Village leaders	46	23.00
2	Radio & Television	194	97.00
3	Mobile phone/ ICT	48	24.00
4	Others	114	57.00

Source: Research findings (2019)

The study conducted a focus group discussion. During focus group discussion respondent Y from village2 addressed her opinions based on the channels in which they use to obtain information about climate change issues and weather forecast which was supported by majority of respondents as she said.

> *In most cases we obtain information regarding to climate change through different media like radio and television, and sometimes through our friends and relatives within and outside our community (social network) may inform/ share necessary information about climate change and whether forecast.*

4.7 Econometric Analysis

Econometric analysis involved the use of probit regression analysis for the factors affecting social-networks and their influence on the choice of climate change adaptation strategies. The first row of Table 4.12 shows the dependent variables, which are regressed against the explanatory variables listed in the first column of the same table.

Prior to econometric analysis, a pair wise correlation analysis was done, whose results are shown in Appendix III A, Appendix III B and Appendix III C. The analysis shows that there is no high coefficient of variables and this imply that there were no multicollinearity problems.

Table 4.12 Probit regression result

	Model1 (Use of improved variety seeds and or breeds)		Model2 (Diversification to non-farm activities)		Model 3 (Livestock diversification)		Model4 (Crop diversification and crop mixing)		Model5 (Changing planting dates and periods)	
Independent variables	Coef	Marginal effect	Coef	Marginal effect	Coef	Marginal effect	Coef	Marginal effect	Coef	Marginal effect
Age	-.365 (0.279)	-.134	-.345 (0.276)	-.136	.102 (0.748)	.037	.063 (0.838)	.025	-.190 (0.557)	-.064
Sex	-.0733 (0.733)	-.027	.380* (0.066)	.149	-.468** (0.027)	-.169	-.219 (0.277)	-.086	.031 (0.884)	.011
Non formal education	-1.881*** (0.001)	-.632	.072 (0.872)	.028	.409 (0.359)	.137	.245 (0.578)	.095	.254 (0.559)	.081
Primary education	-1.062** (0.043)	-.339	.117 (0.757)	.046	.838** (0.022)	.314	.188 (0.601)	.074	.694* (0.052)	.249
Secondary education	-.718 (0.242)	-.279	.221 (0.643)	.086	.178 (0.694)	.062	-.166 (0.716)	-.066	.334 (0.460)	.104
Farming activities	.126 (0.537)	.0463	.090195** (0.028)	-.170	.138 (0.490)	.050	.302 (0.114)	.119	.185 (0.366)	.063
Household size	-.027 (0.900)	-.010	.090 (0.658)	.036	.242 (0.240)	.088	.120 (0.542)	.047	-.144 (0.485)	-.049
Network size	.069* (0.094)	.0255	.050 (0.183)	.0198	.087** (0.031)	.031	.032 (0.335)	.013	.008 (0.825)	.003
Network duration	.012 (0.212)	.004	-.028*** (0.002)	-.011	-.008 (0.342)	.031	-.004 (0.653)	-.002	.003 (0.751)	.001
Strong ties	-.289 (0.398)	-.106	-.348 (0.293)	-.137	.217 (0.506)	.079	.870*** (0.008)	.343	.150 (0.642)	.051
Friendship ties	1.412*** (0.006)	.518	.322 (0.414)	.127	-.030 (0.943)	-.011	-.377 (0.358)	-.149	.826** (0.037)	.281
Group affiliation	-.059 (0.855)	-.021	.538* (0.083)	.212	.043 (0.886)	.016	.492 (0.104)	.194	.212 (0.471)	.075
Constant	1.429 (0.374)		1.025 (0.466)		-1.101 (0.437)		-1.271 (0.351)		-.315 (0.823)	
Number of observations	199		199		199		199		199	
Log like hood	108.215		117.623		116.103		128.496		113.346	
LR Chi2 (12)	42.89		38.41		24.66		16.22		15.23	
P-value	0.000		0.000		0.017		0.182		0.229	
Pseudo R2	0.165		0.140		0.096		0.059		0.063	

Note; Figures in bracket are p values: *p<.10, **p<.05 ***p<.01

4.7.1 Model specification test

Testing the fitness of the model was done to test how well the data fits the model in each dependent variable using the percentage of correct prediction as well as Hosmer leme-show test as presented below;

In improved seeds and breeds, the model is statistically significant (Prob>chi^2 = 0.000). Pseudo $R^2$is 0.165, which shows that the dependent variables explained by the independent variables by 16.5%.

The percentage of correct predictions was 73.37%, which means that the variables used in the model were correctly classified and Hosmer- Leme-show test (Prob> chi2 = 0.772). This indicates that the overall fitness of the model was good.

In diversification to non-farm activities the fitness of the data in terms of Prob>ch2 is statistically significant (Prob>chi2 = 0.000). Pseudo R2 = 0.140, suggesting that the dependent variable is explained by the independent variables by 14%.

The percentage of correct predictions was 70.35%, which means that the variables used in the model were correctly classified and Hosmer-Lemeshow test (Prob> chi2 = 0.287). This indicates that the overall fitness of the model was good.

In livestock diversification, the model fitness test suggests that the model is significant (Prob>chi2 = 0.017) at the 5% level. Pseudo R^2 = 0.096 which shows that dependent variable is explained by independent variables by 9.6%.

The percentage of correct predictions was 67.34%which means that the variables used in the model were correctly classified. Hosmer-Lemeshow test (Prob> chi2 = 0.329) indicates that the overall fitness of the model was good.

In crop diversification, the model fitness test suggests that the overall model fit is poor (Prob>chi2 = 0.182). Though strong ties appeared to be significant, this does not make the entire to fit well in the data set. Similarly, the Pseudo $R^2$of 0.059 is generally low by any standard.

It suggests that only 5.9% of the variability of the choice of crop diversification strategy is explained by the independent variables included in the analysis.

The percentage of correct predictions was 61.81%, which suggests that the predictor variables used in the model were correctly classified. Hosmer-Lemeshow test shows that Prob> chi2 = 0.329 which indicates that the overall fitness of the model was good.

In changing planting dates, the test of the model fitness (Prob>chi2 = 0.182) was poor. Though explanatory variable primary education and friendship ties were significant, it seems they do not explain the overall model very well. The Pseudo $R^2$of 0.059 suggests that only 5.9% of the variability in the dependent variable is accounted for the explanatory variables included in the model. Similarly, the percentage of correct predictions (61.81%) is not reasonably high. Furthermore, Hosmer-Lemeshow test (Prob> chi2 = 0.329) which indicates that the overall fitness of the model was good. On the whole, the test of model fit does not look very good for the dependent variable, change of planting dates.

4.7.2 Results of Regression Analysis

Thus, in these variables some of them showed to be significant and these are;

(a) In terms of the use of improved seeds and breeds (Table 4.12), non-formal education, primary education, social network size and friendship ties appeared to be significant. These variables influence the choice of using improved seeds and breeds. The interpretation of the coefficients are:

- Non-formal education category was considered statistically significant at 1% with the coefficient of -1.881 and p-value (0.001). This influences the use of improved seeds and breeds negatively at 1% significant level. The marginal effect coefficient suggests that the probability of a smallholder farmer using improved seeds and breeds is lower by 63% for smallholder farmers with no formal education, other factors being constant. This imply that using improved variety of seeds and breeds need some knowledge and skills so as

to alter the ability of applying the improved seeds and breeds as an adaptation strategy.

- Smallholder farmers with primary education have a 33.9% lower probability of using improved variety seeds and breeds needs as compared to those with secondary or post-secondary education.

- Adoption of improved seeds has a positive relation with network size (coefficient=0.069; p-value=0.094). The marginal effect coefficient suggests that an additional number of ties increase the probability of a smallholder farmer using improved seeds and breeds by 2.6%, other factors being constant. This implies that smallholder farmers with large numbers have an opportunity of access more information regarding the importance of using improved seeds for overcoming climate change problems in agriculture.

- Friendship ties have positive relation with use of improved seeds (coefficient=1.412; p-value=0.06). The marginal effect coefficient is 51.8%, suggesting that a smallholder farmer with additional friendship tie has 51.8% higher probability of adopting improved seed for overcoming climate change problems.

(d) In terms of diversification to non-farm activities strategy, sex, farming activities, social network duration and group affiliation were found to be significantly influencing the decision (see Table 4.12). The significant variables can be interpreted as follows:

- Sex of the smallholder farmer is significant at the 10% level (coefficient =0.380;p-value=0.066). The marginal effect coefficient suggests that male smallholders have a higher probability (by 14.9%) of diversifying into non-farm activities compared to female smallholders, other factors being constant. This implies that diversification is gender sensitive.

- Farming activity is associated with less likelihood of adopting non-farm activities (coefficient=0.090; p=0.028). The marginal effect coefficient

suggests that smallholders whose predominantly depend on farming have a 17% less probability of diversifying into non-farm activities.

- Social relation (network) duration was positive and statistically different from zero at the 1% level (coefficient =0.028;p=0.002) and. This suggests that the longer one stays in a relationship the greater the chance of diversifying into non-farm activities. Network duration is a characteristic of a strong tie; hence, strong ties tend to transmit trustful information. Those exploiting strong are likely to receive advice and moral support that influence their decision to adopt a diversification strategy.

- Group membership is associated with a choice of diversification strategy (coefficient=0.538; p=0.083). The marginal effect coefficient suggests that a smallholder affiliated with a socioeconomic grouping has a 21.2% higher of diversifying into non-farm activity compared to the counterpart, other factors being constant. Group affiliation is a social capital. Thus, the result implies that social capital matters in the adoption of the adoption strategies especially, diversification into non-farm activities.

The study conducted a focus group discussion and asked the respondents on whether there are benefits obtained from the membership to a certain association; respondent X from village1 said:

> *…Sometimes they are helpful since we have some of the groups in our society like (Faraja Group) which is farm based association where the members of this group normally receive some important information and support (financial) from donors and also those who are members of VICOBA can have ability to adapt climate change since they can even secure loan from their association and using that money to finance the implementation of a particular climate change adaptation strategy for example the use of improved seeds and or breeds needs money to purchase those seeds and apply in the farming activities.*

(c) Sex, primary education and social network size were found to be significantly influencing the decision of livestock diversification. The interpretations of significant variables are as follows:

- Sex was found to be significant at the 5% level (coefficient = -0.468;p=value 0.027). This suggests that a male smallholder famer is less likely to choose livestock diversification strategy.

- Smallholders with primary education are more likely to adopt livestock diversification (coefficient =0.838;p=0.022). The marginal effect coefficient (0.314) suggests that smallholders with primary education have higher probability (by 31%) of deciding in favour of livestock diversification, other factors being constant.

- Network size was found to significant at the 5% level (coefficient =0.087;p=0.031). The larger the size of network (number of contacts) the more likely smallholder to choose livestock diversification.

(d) For the crop diversification equation (Table 4.12), the variable such as strong tie was found to be significant at the 1% level (coefficient =0.870;p=0.008).The marginal effect coefficient suggest that an additional number of strong ties increases the probability of adopting crop diversification strategy by 34 percent, other factors being constant.

(e) In terms of changing of crop planting dates, primary education and friendship tie were found to be significant;

As regard primary education (coefficient = 0.694; p=0.052), the results suggest that smallholders with primary education are more likely to change the planting dates as compared to their counterparts. The marginal effect coefficient indicates that those with primary level education have higher probability (by 24.9%) of adopting a change of planting date as a strategy for overcoming the challenges of climate change;

- The variable friendship ties (coefficient=0.870; p=0.008) is significant at 1% level. This indicates that changing of planting dates is positively associated with the number of friendship ties smallholders cultivate. Its marginal effect coefficient is 0.281, suggesting that additional number of friendship tie increases the probability of a smallholder farmer use changing planting dates or periods by 28.1%, other factors being constant.

CHAPTER FIVE

DISCUSSIONS OF THE FINDINGS

5.0 Introduction

This chapter discusses in detail the findings obtained from the preceding chapter. The discussion focuses on the significant results emanating from descriptive and econometric analyses. The discussion is organized in regard to specific objectives.

The analysis of the first objective identified dominant climate change adaptation strategies pursued by smallholder farmers in the study area. The analysis of the second objective determined the main types of social relations/networks exploited by the smallholder farmers as the channels through which information, advice and material/moral supports pertinent to climate change and adaptations are obtained. In the last objective, the study examined whether or not the types of social relations exploited by smallholder farmers influence the choice of the adaptation strategies pursued by smallholder farmers. In this chapter, significant results are discussed. The chapter is organized as follows. Section 5.1 discusses the dominant climate change adaptation strategies. This is followed by the discussions on the main types of social networks exploited in section 5.2. The last section (5.3) presents the discussions of the relationship between the types of social relations and the choice of the type of climate change adaptation strategies pursued.

5.1 Dominant climate change adaptation strategies

The first objectives ought to identify the dominant climate change adaptation strategies that are mostly used by the smallholder farmers in the study area.

The analysis showed that 70% used changing cropping/planting dates and periods, 65.5% use livestock diversification, 64% use the use improved variety seeds and/ or breeds, 55.5% use crop diversification and mixing (multiple cropping). In addition, 55.5% of respondents used diversification to non-farm activities as the mostly used adaptation strategies.

Deressa *et al*. (2009) reported that agricultural adaptation measures such as crop mixing, cropping/ changing planting dates and periods and shifting from crops production to livestock keeping are the mostly used method of climate change adaptation. Komba and Muchapondwa (2015) revealed that the use of short-season crops (use of improved variety seeds and breeds, irrigation, and changing planting dates are among dominant climate change adaptation strategies used by the farmers. The use of improved variety seeds and breeds, and changing planting dates are similar to the findings of this study but irrigation is contrary to this study since few farmers (44%) only used irrigation as the strategy of adapting climate change in order to overcome negative impacts of climate change on agricultural productivity.

Ngaruiya *et al.* (2017) found that crop diversification was a dominant climate change adaptation strategy used by the farmers. Moreover, Tesfaye and Seifu (2016) also discovered that crop diversification, changing planting dates or periods and diversification to non-farm activities were the dominant climate change adaptation strategies commonly used by smallholder farmers.

Furthermore, changing cropping/planting dates and periods, livestock diversification, the use improved variety seeds and/ or breeds, crop diversification and mixing (multiple cropping), and diversification to non-farm activities featured as mostly used adaptation strategies in the study place. The choice of a certain adaptation strategy depends on the resources in place, knowledge obtained from previous weather patterns, easiest means of adapting, cost of execution as well as compatibility with other adaptation measures (Admassie *et al.,* 2008)

5.2 Dominant social network ties exploited by smallholder farmers

The second objective of this study was to identify dominant social network ties exploited by smallholder farmers in Mvomero District. The study explored two types of social ties, namely; strong ties and weak ties. Dominant social network ties exploited by smallholder farmers are strong ties since 92% of social network ties are reciprocal. The strong ties seem to be an important variable in choice of crop diversification and crop mixing among smallholder farmers.

The study also revealed that most of the respondents exploited friendship ties to a greater extent. This implies that, smallholder farmers are more likely to explore information from friends, advice or other supports pertaining to the choice of climate change adaptation strategies.

Therefore, strong ties are essential in sharing information and other forms of support among smallholder farmers. Strong ties are characterized by high level of trust, frequent contact and high degree of closeness. These spur confidence and intimacy, making it easy for individuals in these networks to support one another.

5.3 Social-networks' influence on choice of climate change adaptation strategies

The third objective was to examine the influence of social network ties on the choice of climate change adaptation strategies. In order to establish the factors of Social-networks influence on climate change adaptation strategies among smallholder farmers were as follows; the dependent variables used in the analysis included improved seeds, Diversification to Non-farm activities, Livestock diversification, Crop diversification Changing planting dates. Independent variables involved different categories of Age, Sex, Education Level (Non-formal education, primary education, & secondary education), Economic activities (farming & non-farming), household size, social network size, social network duration, proportion of strong tie (strong ties), proportion of friends in a network (friendship ties), members association (group affiliation).

The empirical analysis has shown that, some variables significantly influence the choice of climate change adaptation strategies. These include education (non-formal education and primary education), social network size, and friendship ties. Deressa *et al*.., (2009) also revealed that education level has influence on farmers' choice of climate change adaptation.

Sex, farming activities, social network duration and group affiliation (group membership association) are important variables influencing smallholder farmers' adoption of diversification to non-farming activities. According to Bourdieu (1986), group affiliations and social networks duration (strength of relationships) are

important variables which influence choices of climate change adaptation strategies. Social network (experience) duration have a negative relationship while group affiliation influences the use of improved variety seeds and or breeds positively. For the variable sex, the findings are similar to Tesfaye and Seifu (2016) who revealed that gender/sex, and farming activities (farm size) influence the choice of adaptation strategies among smallholder farmers.

Sex, primary education, social network size are important variables influencing livestock diversification among smallholder farmers towards adapting climate changes positively. According to Bourdieu (1986) social capital depends highly on network size. Smallholder farmers with large network size are likely to have access to more information and other supports like financial and material support as compared to smallholder farmers with small network size.

A strong tie is an important variable which have influence on crop diversification and crop mixing as the climate change adaptation strategy. Strong ties influence the decision to adapt to changing climate through crop diversification. The study also found that friendship ties are essential variable that influence the decision to change planting dates among smallholder farmers as an adaptation strategy. According to Social Capital Theory, the strong relationship among network members makes easier the information exchange about the climate change adaptation strategies.

Moreover, the study did not find a significant relationship between age and choice of climate change adaptation strategies among smallholder farmers. This contradicts Deressa *et al*. (2009), who discovered that age is important variable influencing farmers' choice on climate change adaptation this might be because of the difference in context of the studies. Similarly, the findings on household size in this study contradicts those in Tesfaye and Seifu (2016) who found that household size has significant influence on the choice of adaptation strategies among smallholder farmers.

CHAPTER SIX

SUMMARY, CONCLUSSION AND POLICY IMPLICATIONS

6.0 Introduction

This chapter presents the summary of findings, conclusion and policy implication of the study. The chapter is divided into three sections. The first section summarizes the results. The second section presents conclusion of the study, third section presents the policy implications of the study, and fourth section presents the areas for further studies, whereas the last section gives the limitation of the study.

6.1 Summary and Conclusion

The study assessed the influence of social networks on climate change adaptation among 200 smallholder farmers in Mlali and Mzumbe wards in Mvomero District, Morogoro region in Tanzania. The analysis was done using descriptive statistics and econometric analyses. The probit model was employed to estimate the influence of independent variables to the dependent variables. The summary of the study is presented below.

The analysis on the awareness of respondents about changes in climatic condition was done prior to the determination of dominant climate change adaptation strategies. It was observed that all respondents were aware and/or experienced the following changes over the past ten years:

- Decreasing rainfall patterns
- Unpredictable rainfall patterns
- Increasing temperature.

On the dominant climate change adaptation strategies, smallholder farmers were found to use improved seeds, diversify to non-farm activities, diversify livestock and crop as well as change planting dates. On the social relations used to obtain information, advice or material and moral support, smallholder farmers were found to exploit large social network size and strong ties (friendship ties).

Social network size was found to be an important variable influencing livestock diversification among smallholder farmers in adapting to climate changes. Strong ties influenced crop diversification whereas friendship ties were essential for the choice of changing planting dates or periods.

The study revealed that most of the social network ties exploited by smallholder farmers are strong ties and they have positive influence on the choice of crop diversification, crop mixing as well as changing planting dates or periods. The findings confirmed that friendship tie (family & friends) is also indicator of strong tie as according to this study.

On social network benefits the study discovered that benefits of social network experienced mostly by respondents are information and advice as compared to material or financial support. The findings indicated that, 76% of the respondents received information and 63.5% of the respondents received advice whereas only 23% of the respondents received financial or material support. Furthermore, the study revealed that most of smallholder famers lack extension services because they do not have contact with their extension officers; hence they lack necessary information about climate change adaptation strategies.

Thus, the government (policy makers) should acknowledge the vital role played by the social networks on choice of climate change adaptation strategies. Such networks should be used as tool for policy makers to promote climate change adaptation issues.

6.2 Policy implications

Social networks play a great role in providing information, advice and material support (e.g. finance) for climate change adaptations. Through information from social relations, smallholder farmers understand the adaptation strategy to choose in order to minimize the effects of climate change.

Awareness raising on the benefits derived from social networks should be a good agenda in agriculture policies because they are essential tools which enable smallholder farmers to adapt to climate change. Thus, policy makers should acknowledge the influence of social networks on climate change adaptation among smallholder farmers.

6.3 Recommendations

i. Different forms of support should be given to smallholder farmers, especially financial support and education support from different stakeholders like government and Non- Governmental Organizations. These may be in terms of providing access to loans and education so that they can have better farming methods and be able to curb the effect of climate changes.
ii. The findings of this study suggest that, policy makers should acknowledge the importance of social networks in the choice of climate change adaptation strategies. Therefore, using knowledge from the social networks will highlight the emphasis for the need of social networks among smallholder farmers. Such networks will alter their ability in making choices regarding climate change adaptation strategies.
iii. Similar studies should be carried out with the main focus on the social networks' benefit and their influence on climate change adaptation strategies among smallholder farmers.

6.4 Limitation of the study

The findings of the study should be interpreted within the following limitation.

The study was conducted in Mvomero District (Mlali and Mzumbe ward) in Morogoro region, Tanzania. Thus, the findings might be region-specific. Future studies could use sample of households from other regions in the country or from the context of other nations of similar set-up to test and extend the generalizations of this findings.

6.5 Area for further research

The study was confined to social networks (relationship properties) and climate change adaptation issues among smallholder farmers. This study identified important social network variables influencing the choice of climate change adaptation strategies among smallholder farmers. The study was confined to Mlali and Mzumbe wards in Mvomero District. The researcher recommends that social networks issues be given research attention to cover different contexts of Tanzania and explore more social networks variables that might be important for the choice of climate change adaptation strategies.

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APPENDICES

APPENDIX I: HOUSEHOLD LEVEL QUESTIONNAIRE

The aim of this research is to understand social networks as they influence information and communication about climate change adaptations among smallholder farmers in Mlali and Mzumbe wards. You are among the people who have been selected to participate in this research that you will be requested by the researcher. The information you provide will be treated with confidentially and used for study and learning purposes only. Therefore, your cooperation will greatly be appreciated.

SECTION A: RESPONDENT SOCIO-DEMOGRAPHIC INFORMATION

Q1. The name of the respondent (At least 2 names) ……

Name of the village of residence: ……

Q2. What is your status in this household?

Household head	Spouse of household head	Elder child (must be aged above 18)	Others, please specify

Q3. The year of birth of respondent: …….

Q4. Sex: Male ( ) Female ( )

Q5. What is the marital status of the respondent? (Please tick where appropriate)

Single	Married	Cohabited	Divorced	Widowed

Q6. How many people live in your household? ……..

Q7. What is the highest level of education? (Please tick where appropriate)

No formal education	Primary	O-level Secondary	A-level Secondary	Post-secondary certificate	Diploma	Bachelor Degree or above	Others (please specify)

Q8. Household land ownership status by the last growing season (2017)?

Total land owned (In acres)	Amount of land hired-in (In acres)	Amount of land hired- out (In acres)	Amount of land cultivated (In acres)

Q9. What were the main types of crops that you cultivated in the 2017 growing season on the land mentioned in Q.8 above?

	Name of the Crop	Amount harvested (kgs, bags etc)	Amount sold (kgs/bags)	Price/ Income earned	Do you irrigate these crops 1= Yes, 0= No
1					
2					
3					
4					
5					

Q10. Please list in the order of importance (in terms of income contribution) the main economic activities you have been engaged with.

	Economic activity	Average earning (in Tshs) for the past 12 months
1.		
2.		
3.		
4.		
5.		

Q11. Are you a member of any of the following socio-economic group/association? Please tick all that apply

	Type of association	1=Yes; 0=No	If yes, do you hold any leadership position? 1= Yes, 0= No
1.	Farmer based organization		
2.	Finance/saving and credit association		
3.	Business or trade association		
4.	Religious/spiritual group		
5.	Political association		
6.	Others (please specify)……..….		

SECTION B: CLIMATE CHANGE AND ADAPTATION INFORMATION

Q12. Have you noticed a change of climatic condition in your area within the last ten years?

Yes ( ) No ( ) I don't know ( )

Q13. Have you noticed the following changes in climate over the past ten years? (Please tick in the appropriate column)

	Yes	No
Increased amount of rainfall		
Decreased amount rainfall		
Unpredictable rainfall patterns		
Increased temperature		
Decreased in temperature		
Prolonged drought		

Q14. In overcoming the problems mentioned in Q.13, have you adopted any of the following strategies?

Adopted strategy	1=Yes; 0=No
Crop diversification and mixing (multiple cropping)	
Diversification to non- farming activities	
Practicing small scale irrigation	
Crop sharing as a payment of working as a casual farm labor	
Soil and water conservations	
Livestock diversification	
Changing cropping/planting dates and periods	
Use improved variety seeds and/or breeds	

Q15. Do you have access to smart phone?

A. Yes, I have my own smart phone. ( )

B. Yes, I can regularly use a smart phone of a friend or relative. ( )

C. No ( )

Q16. Do you use the smart phone to obtain information on climate change and climate change adaptation?

Yes ( ) No ( )

If yes specify how …….....

Q17. For what other reasons do you use the smart phone?

……

……

Q18. Through which channels do you receive information on weather forecast and seasonal climate predictions (For example, predictions on dry seasons to come or wet season to come)? (Tick all that apply)

A. Extension officers ( )

B. Radio ( )

C. Neighbors and friends ( )

D. Village leaders/ village council ( )

E. Internet ( )

F. Family and household members ( )

G. Television ( )

H. Text messages ( )

I. Other channel, please specify……

SECTION C: SOCIAL NETWORKS OF RESPONDENTS

Q19. In Q.14, you indicated different strategies you adopted in order to adapt to climate change effects. In the last growing season, to whom did you most often turn for information, advice, and/or assistance/support (e.g. financial or material) in order to learn and/or deal with the climate change related problems?

No:	Name of the Person	Sex (1=male; 0=female	Age	Relationship? 1=Family member; 2=Relative; 3=Friend; 4=Acquaintance 5= Other (Please specify)	Occupation	How long have you known this person? (in years)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

Q20. Describe the characteristics of the relationship with the person mentioned in Q.19?

Person	What did you receive from this person (1=Information; 2=Advice; 3=Support/assistance e.g. finance or material)	Do you give information/advice/support to this person? (1=Yes; 0= No)	How often do you usually contact this person in a month (In previous growing season)? 1=None; 2=Once; 3=Twice; 4=Thrice; 5=Four times or more	To what extent do you trust this person? 1=I do not trust at all; 2=I do not trust him/her; 3=I trust him/her somehow; 4=I trust him/her; 5=I trust him/her very much	How close are you to this person? 1=Not close at all; 2=Not close; 3=Somehow close; 4=Close; 5=Very close
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

Q21. (A). How often did you have contact with the extension officers in the past growing season (2017)? (Please tick)

None	Once	Twice	Three times	More than 3 times

(B). Where do the extension officers come from? (Please circle where appropriate)

A. Non Government Organizations (NGOs)

B. Government

C. Private firm

D. I don’t know

E. Others (Please specify) ……

Q22. In your opinion, what should be done to overcome the climate change effects and to improve the wellbeing of smallholder farmers?

i. ……
ii. ……
iii. ……
iv. ……
v. ……

Conclusion and Thank you!

Thank you for taking part in my survey and research project. Would you like to participate in a focused group discussion?

Yes ( ) No ( )

APPENDIX II: FOCUS GROUP DISCUSSION GUIDING QUESTIONS

1. Based from your experiences, how climate changes affected you?

2. i. Which are the climate change adaptation strategies that you normally use them to curb the negative effects of climate change?

   ii. Why do you apply the mentioned strategies?

   iii. Regardless the challenges you are facing in the issues of climate change adaptation, which climate change adaptation do you prefer most and can be useful in your farming activities?

3. i. How do you obtain information about changes in climate and who give you those information?

   ii. Do you think having friends, and relatives (social network) whom you share some information, advice, and material support (financial support) it is helpful for you in adapting towards climate change?

   iii. Which kind of information or resource you are missing and it is a setback for you to deal with the effect of climate changes?

4. i. You have different associations or groups in your community, for you to be a member of a certain association is it helpful for you to have ability to adapt climate changes?

   ii. Do you have people or institution from which you can get any support whether financial support, of knowledge support (information)?

5. What should be done to improve your ability to adapt climate changes?

APPENDIX: 1II A: Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Improved seeds	1.000																
2	Diversification to non-farm activities	0.020	1.000															
3	Livestock diversification	0.0035	0.006	1.000														
4	Crop diversification	-0022	-0.073	0.027	1.000													
5	Changing planting dates or periods	0.282	0.138	0.099	0.160	1.000												
6	Age	-0.154	-0.172	0.047	0.036	-0.064	1.000											
7	Household size	-0.043	0.041	0.120	0.058	-0.041	0.001	1.000										
8	Sex	-0.072	0.156	-0.166	-0.046	0.018	-0.195	-0.057	1.000									
9	Non formal education	-0.284	-0.027	-0.139	0.004	-0.048	0.111	-0.035	0.242	1.000								
10	Primary education	0.040	-0.006	0.246	0.087	0.048	0.080	0.103	-0.059	-0.584	1.000							
11	Secondary education	0.101	-0.050	-0.088	0.087	0.054	-0.151	0.027	-0.141	-0.123	-0.501	1.000						
12	Farming	-0.003	-0.0205	0.072	0.118	0.053	0.010	0.040	-0.123	-0.023	0.126	-0.100	1.000					
13	Network size	0.193	0.165	0.145	0.023	0.055	-0.116	-0.001	0.013	-0.149	0.089	0.060	-0.181	1.000				
14	Network duration	0.081	-0.262	-0.030	-0.002	0.053	0.269	-0.052	-0.022	-0.025	0.072	-0.011	0.041	0.014	1.000			
15	Strong ties	-0.048	-0.117	-0.0144	0.156	0.055	-0.017	-0.095	0.123	0.056	-0.002	-0.098	0.052	-0.163	0.169	1.000		
16	Friendship ties	0.300	0.055	-0.014	-0.031	0.208	-0.202	-0.098	0.038	-0.131	0.031	0.026	-0.120	0.141	0.141	0.110	1.000	
17	Group affiliation	0.012	0.165	0.056	0.103	0.060	0.066	0.089	0.045	-0.140	0.132	0.015	-0.083	0.136	-0.040	-0.039	0.016	1.000

APPENDIX III B: Correlation matrix: (adaptation strategies & house hold characteristics)

		1	2	3	4	5	6	7	8	9	10	11	12
1	Improved seeds	1.000											
2	Diversification to non-farm activities	0.020	1.000										
3	Livestock diversification	0.0035	0.006	1.000									
4	Crop diversification	-0022	-0.073	0.027	1.000								
5	Changing planting dates or periods	0.282	0.138	0.099	0.160	1.000							
6	Age	-0.154	-0.172	0.047	0.036	-0.064	1.000						
7	Household size	-0.043	0.041	0.120	0.058	-0.041	0.001	1.000					
8	Sex	-0.072	0.156	-0.166	-0.046	0.018	-0.195	-0.057	1.000				
9	Non formal education	-0.284	-0.027	-0.139	0.004	-0.048	0.111	-0.035	0.242	1.000			
10	Primary education	0.040	-0.006	0.246	0.087	0.048	0.080	0.103	-0.059	-0.584	1.000		
11	Secondary education	0.101	-0.050	-0.088	0.087	0.054	-0.151	0.027	-0.141	-0.123	-0.501	1.000	
12	Farming	-0.003	-0.0205	0.072	0.118	0.053	0.010	0.040	-0.123	-0.023	0.126	-0.100	1.000

APPENDIX III C: Correlation matrix: (adaptation strategies & social network characteristics)

		1	2	3	4	5	13	14	15	16	17
1	Improved seeds	1.000									
2	Diversification to non-farm activities	0.020	1.000								
3	Livestock diversification	0.0035	0.006	1.000							
4	Crop diversification	-0022	-0.073	0.027	1.000						
5	Changing planting dates or periods	0.282	0.138	0.099	0.160	1.000					
13	Network size	0.193	0.165	0.145	0.023	0.055	1.000				
14	Network duration	0.081	-0.262	-0.030	-0.002	0.053	0.014	1.000			
15	Strong ties	-0.048	-0.117	-0.0144	0.156	0.055	-0.163	0.169	1.000		
16	Friendship ties	0.300	0.055	-0.014	-0.031	0.208	0.141	0.141	0.110	1.000	
17	Group affiliation	0.012	0.165	0.056	0.103	0.060	0.136	-0.040	-0.039	0.016	1.000

APPENDIX IV: LITERATURE REVIEW MATRIX

Authors	Main Concepts & Objectives	Methods	Main findings & Conclusions
Abraham, E. M. (2018).	• To synthesize lessons literature on adaptation to demonstrate that African countries can explore the opportunities and challenges inherent in climate variability and change.	• This paper is a review of previous research in the field of climate change, mitigation, adaptation and vulnerability in Africa.	• The evidence suggests that Africa recognize it is time to take action on the impacts of climate change. • The key emerging lessons are that climate change adaptation should be mainstreamed into development plans of nations. • Key stakeholders have a role to play in adaptation; hence stakeholders involvement is a key.
Abidi, Ngaruiya et al. (2017)	• Social nets in agric climate change adaptation - the institutional aspect of adaptation is yet to be explored.	• Survey questionnaire to 450 farm HH in Ghana • SNA focusing on two variables i.e. structure hole & density. • Types institutions/nets: government institutions, private & community	• CC causes a decrease in crop production and increase in pests and diseases • Changing crop varieties, sowing dates, input mixes and planting trees are key adaptation measures used • Constraints to adaptation: lack of information, finances and resources • Extension services are key institutions
Van Aelst, K &Holvoet, N (2017)	• Estimates the factors influencing adaptation in Mvomero District. • Role of wives intrahousehold decision making in adaptation decisions.	• Mixed method = a survey (questionnaire) and qualitative semi-structured interviews. Random sample of 343 married women. • Logistic regression	• Climatic challenges: unpredictable rainfall, warmer & higher dry season & decreasing flow of Ruvu river • Identified 18 adaptation strategies. • Wives are more involved in intra-household adaptation decision-making more likely to engaged in non-farm income-earning activities; more likely to plant cover crops and drought-resistant crops. • Certain gendered preferences in adaptation to climate change exist; hence,

			women knowledge should be allowed to inform policy issues.
Jiri, O, Mafongoya, P. &Chivenge, P (2017).	• To determine factors that increase resilience and cause smallholder farmers to adapt better to climate change and vulnerability	• The study was conducted in Zimbabwe • Sample size is 100. • The study applied vulnerability resilience model & binary logit model for factors of adaptation decisions •	• Access to extension services better adaptation abilities. • Younger farmers were likely to adapt. • House size & credit access probability of adaptation. • In general, small farmers access to information & technology is a key for adaptive capability and resilience.
Huong, Bo & Fahad (2017)	• To examine climate change awareness; and identify factors affecting awareness and adaptation probability	• Survey questionnaire administered to 335 randomly selected households in 6 provinces, Vietnam. • Households engaged in agriculture, fishing, & livestock keeping. • Climate change variables: drought, untimely rains, abnormal temperature, landslides, pestilent insects, flashflood & water shortage. • Adaptations: adjustment of crops & varieties; adjustment to planting calendar; adjustment to planting techniques; off-farm jobs, & water management. • Logistic regression model	• Awareness of climate change is associated with household characteristics. • Household, farm & institutional characteristics as well as non-farm income adaptation
Mishra, A &Pede, V (2017)	• To examine factors for intra-household perceptions on climate change and its effects; • To investigate the perceptions of climatic stress on operators' & spouses' adaptation strategies (farm & financial strategies).	• HH survey involving 214 Hhs in Vietnam's Melkong delta, with husband and wife being interviewed differently. • Probit & negative binomial count data or simply the Hurdle count model •	• There existence differences in intra-household adaptation strategies. • In the presence of climatic stress, spouses are less likely to adapt such stress with farm enterprise strategies, but rather more likely to adapt financial strategies. • In the presence of climatic stress, farm operators are more likely to adapt both farm enterprise financial strategies.

			• Conclusions: investment in climate smart agriculture can help HH in managing climatic stress.
Joshi, Ji & Joshi (2017)	• To assess perceptions and major practices and technologies adopted to mitigate climate change impacts in Nepal.	• Survey questionnaire/structured • Random selection of 120 households • Binary logistic regression	• Decision to adapt is affected by size of land, perceived threat to food security, education, gender, perceived increase of drought threat during rainy season, and off-income. • HHs are aware of climate change, and its impact on food security. • Not all HHs adapt to climate change to reduce impacts and increase resilience.
Cadger et al (2016)	• Institutions and organizations and actors outside the community that promote agriculture. •	• SNA involving 131 smallholder farmers in Ghana • Focus variables: network density, composition and size • Analysis used ANOVA; SNA used UCINET software.	• Male have larger networks; Understanding farmer network structure is critical for effective agricultural development interventions in terms of improving the exchange of information for effective and sustainable agricultural land management practice.
Tesfaye &Seifu (2016)***	• To examine perceptions on climate change and its threat; identify adaptive strategies and factors influencing adaptation decisions.	• Cross-sectional survey of 296 HHs in Eastern Ethiopia using semi-structured questionnaire. • Multivariate probit model accounting for simultaneous adaptation choice behavior • Variables: socioeconomic & demographic; institutional & market characteristics; sources of income & livelihoods, crop production, geographic features, climate change perceptions and adaptation.	• majority of HHs are aware of climate change and its associated impacts on income, food security, diversity, forest resources, livestock & crops. • Adaptation: cultivating different crops, planting different crop varieties, changing planting dates, use of water & soil conservation techniques, conservational agricultural practices, & engaging in non-farm activities. • Adaptation is influenced by gender, HH size, farm size, distance from market, & number of plots. • Future research: the impact of adaptation on increasing adaptive capacity.
Kanyama, A &Mwalongo, T	• To examine the challenges of using	• Data collection: household	• There is a challenge of CC and

(2016)	indigenous knowledge on climate change adaptation for maize and bean production in Mbeya rural.	survey questionnaire, key informant interview, FGD, and field observation. • Data analysis: cross tabulation; qualitative = structural-functional and content analysis •	variability with decreasing rainfall trend and increasing temperature trend. • Effects: Decrease and variability of rainfall decline in productivity. • Adaptation: IK specific strategies = traditional irrigation, traditional terracing, traditional food preservation, mixed cropping, shifting cultivation, & valley bottom cultivation. • IK strategies do not help to improve productivity = not effective. IK is not often supported by the government due to lack of trust and insufficient fund to promote it.
Sani, S., &Chalchisa, T. (2016).	• To determine farmers perception, impact and adaptation strategies to climate and change among smallholder farmers.	• Multivariate analysis& Chi square test.	• There should be government interventions so as to ensure that small farmers have access to flexible and affordable credit/loan facilities in order to embark on effective coping in response to changing climate.
Gomez, Norma (2015) Komba, C &Muchapondwa, E (2015)	• Specifically, the study examines the impact of climate change on food production (maize, banana and durian). • The study estimates both the determinants of climate change adaptation and its corresponding effect on farm productivity. • To investigate whether farmers in Tanzania recognize and, consequently, adapt to it in their agricultural activities.	• Primary data from 541 farmers in Philipines, selected using multistage stratified sampling. • Probit model was used for adaptation decision. • Stochastic frontier model for the effect of adaptation on farm productivity. • Survey of 534 randomly selected farm households. • Probit model used for examining the decision to adopt climate change adaptation strategies (1=farmer adapts any strategies; 0=otherwise).	• Adaptation is affected by information about future climate change conditions, social capital, access to credit, access to formal extension, & farmer-to-farmer extension. Others include age, education &Hh size. • Adaptation significantly affect farm productivity as it helps in coping with adverse effects and risks of climate change. • Climate change variables: recognition of precipitation & temperature, which farmers do and adapt to it in various ways. • Adaptation strategies: short-season crops, drought-resistant crops, irrigation, changing planting dates, & tree planting.

	•	• Multinomial probit model with selection bias was used for outcome equation. The assumption is that each choice of an adaptation strategy is independent from another choice. (If adapts, 1, 2,….n for each strategy adopted) •	• Adaptation of short season crop increase with temperature intensity, access to support from govt & community groups; but it decreases by growing rice as a major crop. •
Rao, P.H. &Thamizhvanan, A (2014)	• To assess awareness of private sector considers on impact of CC & vulnerability of the poor. • To investigate significant linkages between awareness of climate change and willingness to support mitigation & adaptation strategies.	• Survey questionnaire to 158 junior corporate executives (MBA program). • Non-probability, accidental/incidental sampling • Descriptive analysis, exploratory factor analysis, & SEM/confirmatory.	• Significance aware on the impact of climate change in the area, though awareness to vulnerability of the poor is insignificant. • There is significant linkage between awareness and willingness to support adaptation strategies.
Shaffril, H.A, Samah, B. A et al (2013)	• To investigate the level of social adaptation to climate change among fishermen	• Survey questionnaire administered to a randomly (multistage) selected 300 registered fishermen in East Coast of Malaysia. • A total of 45 questions adopted from IUCN were developed; both in 5-point likert scale (1=disagree; 5=strongly agree). •	• The surveyed fishermen had high level of adaptation as regard 2 aspects: first, environmental awareness, attitude & belief; and 2nd. local environmental knowledge. • Low level adaptation as regards 3 aspects: first, attachment to place; second, formal & informal networks; third, attachment to occupation.
Yila, J. O &Ressurection, B. P (2013)	• To investigate factors determining smallholder farmers' adaptation strategies to climate change. • To provide an understanding of why and how hh chooses adaptation options. • The study is built on the theory of adoption of innovation developed by Rogers (1983).	• Primary and secondary data were used. Primary data was collected from a survey involving 250 randomly selected households in semi-arid region of Nigeria. • Key informant interviews and FGDs were also used. • Stepwise multiple regression (Multivariate linear regression) was used to identify key determinants. • •	• DV (adaptation strategies) identified: different crop variety, soil&water conservation, agroforestry, seedbank, diversification of crop types & varieties, diversification of livestock types &varieties, production intensification, switching from farm to non-farming, irrigation, mix cropping & change of timing of planting, income stabilization program, diversification of income sources, and wild food. • Determinants of adaptation strategies:

			agricultural labor force, education of Hh, land tenure arrangements, gender of Hh, extension service availability, out-migration of labor, years of farming experience, household size and availability of farmer to farmer extension.
Sanga, Moshi & Hella (2013)	The study aimed to achieve: • Investigate small scale farmers' perceptions to climate change; • Farm level adaptation efforts and limitation; • Determine factors influencing adoption adaptation mechanisms •	• The study was conducted in Pangani River Basin and Pemba of Tanzania. • Primary data was collected from 11 villages, an average of 35 randomly selected respondents were collected. • FGD was also used to collect data. • Secondary data was collected from TMA for temperature (37 years) & rainfall (51 years). • Estimation technique: multinomial logit model.	• Adopted strategies include: irrigation, grow crops with shorter maturity period. Mixing crop in the same plot, soil and water conservation mechanisms, planting drought resistant, plantinf, FDG and change prot date etc. • Farmers are making efforts to adapt to CC, but are constrained by shortage of water for irrigation, lack of necessary farm inputs, capital, lack of information on appropriate adaptation mechanisms, and shortage of farm lands. • Multinomial logit results: access to extension services; credit; education level, and location positively condition farmers' choices of climate change coping strategy.
Ajao and Ogunninyi (2011). Agrawal, A, Kononen, M &Perrin, N (2009)	• To examine farmers strategies to climate change in Ogbomoso agricultural zone of Oyo State in Nigeria. • To examine the relationships between climate-related vulnerabilities, adaptation practices, institutions, and external interventions so as to show the role and importance of local institutions in climate change. •	• Probit model • The study is theoretical. There is no clear methodology, except anecdote from institutional perspective applied at different levels of analysis.	• The long-term improvement investments commonly adapted by the study area were tree planting/ agro forestry, surface cover. • Effective local adaptation requires local institutions that are responsive, flexible and able to adapt to the uncertainties associated with climate change. • governments & other external stakeholders need to strengthen and take advantage of already existing strategies that many households and social groups

			use collectively or singly. • Local level community response is the most important factor enabling people to reduce and cope with climate risks especially in the most remote areas/marginalized groups.
Deressa et al., (2009).	• To identify the major methods used by farmers to adapt climate change in the Nile Basin of Ethiopia the factors that affect their choice of method, and the barriers to adaptation.	• Multinomial Logit (MNL) Model.	The level of education, gender, age, and wealth of household, access to extension and credit, information on climate, Agro-ecological settings and temperature all factors influence farmers' choice.
Bodin, O &Crona, B.I. (2009)	• To synthesize earlier literature in order to add more precision to initial insights and pending hypotheses about the impacts of social networks on natural resource governance processes and outcomes.	• This is a review of previous empirical works. • The paper use content analysis to synthesize the findings from empirical papers of several years.	• It has even been shown that social networks can be more important than the existence of formal institutions for effective enforcement and compliance with environmental regulations. • The paper shows that significant differences exist in governance processes and outcomes can be expected among networks experiencing structural differences in terms of density, degree of cohesiveness, subgroup interconnectivity, and degree of network centralization.