ASSESSING RESILIENT AGRICULTURE-BASED LIVELIHOODS: A CASE OF CONSERVATION AGRICULTURE IN KANTHONZWENI SUB-COUNTY

BY

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B63/70286/2011

THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF ARTS DEGREE IN PLANNING.

DEPARTMENT OF URBAN AND REGIONAL PLANNING

SCHOOL OF BUILT ENVIRONMENT

UNIVERSITY OF NAIROBI

2014

ABSTRACT

Exposure to climate variability and extremes, most particularly drought, poses a substantial risk to people living in ASALs. A number of interventions on sustainable land use, livelihood and environmental management have been promoted in Makueni County to enable households build resilience to stresses of drought and other climatic variations. With the increasing trend in drought occurrences, there is need for evidence on the characteristics of agriculture-dependent communities that have proven resilient to past climate variability which is lacking at the household and community levels.

This study identified characteristics of climate variability resilient farmers, land use approaches and practices that significantly contribute to increased livelihood resilience and examined factors influencing the capacity to develop and maintain resilient livelihoods. It also identified policy options for enhancing resilient livelihoods.

The study adopted a survey design. Literature review, face to face interviews, observation and photography were used to collect data. The target population consisted of all farming households in Kathonzweni and Mavindini Divisions and service providers from all relevant institutions. Using multiple sampling strategies that included census of CA farmers, systematic random sampling for TT farmers and simple random sampling for NT farmers. A total of 138 households consisting of 46 conservation agriculture farmers (CA), 46 trained but not practicing farmers (TT) and 46 not trained and not practicing farmers (NT) were sampled. Two focus group discussions were undertaken per category of farmers making a total of six. Local leaders and extension service providers were purposively identified and interviewed as key informants on farmer resilience. Households with resilient livelihoods were identified as those with food access, financial security, entitlements in term of assets and sufficient human capital.

Farmers in Makueni grow their own food which is supplemented through diversified income sources, not only in crops, but also in other livelihood sources such as remittances. T-tests for comparison of means indicated that CA farmers had significantly higher access to food than TT and NT farmers. They also had higher financial security, remittances and better human resource capital that contribute immensely to food production. Overall, CA was identified as a technique that has very high potential to improve yields, income, environmental conservation and in the long term lead to increased household livelihood resilience. Drought was ranked as the main factor limiting farmers' ability to develop and sustain resilient livelihoods.

The study recommends increased promotion of CA, diversified income sources through land use planning that allocates various enterprises optimally. Techniques such as sub-soiling, ripping, terracing and growing of drought tolerant crops that have proven to assist farmers to raise their agricultural output should be promoted through increased acreage under these techniques. The study also recommends construction of a dam at Thwake River to facilitate rain water harvesting for irrigation during drought.

Key word: *Resilient, Vulnerability, Land use, Sustainable livelihood, Poverty, Drought, Conservation Agriculture.*

DECLARATION

I hereby declare that this thesis is my own original work and effort and that it has not been submitted anywhere for any award. Where other sources of information have been used, they have been acknowledged

It is part of fulfilment of the requirement for the award of the Degree of Master of Arts in Planning of the Department of Urban and Regional Planning (DURP), University of Nairobi.

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ACKNOWLEDGEMENTS

This thesis is a product of part of the larger project focusing on “Resilient agriculture-based livelihoods and resilient agricultural landscapes” in the frame of “Adaptation to climate change in African agriculture, and funded by Swiss National Science Foundation’s Ambizione Initiative. This thesis therefore builds its theoretical and conceptual foundation from the overall frame of the Ambizione project. In this regard, I am very grateful to the project leader and the principal investigator Prof. Chinwe Ifejika Speranza for accepting me in the project and agreeing to finance my studies and the thesis. This thesis would not have been realized without this financial and topical support.

I would also want to express my profound gratitude to my three supervisors Dr. Fridah W. Mugo, Dr. Boniface P. Kiteme, and Dr. Chinwe S. Ifejika for their exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. Their collective and individual efforts in the entire process of this study combined to enable the production of this final product.

I also take this opportunity to express my gratitude to the Department of Urban and Regional Planning and various lecturers including Mr. Charles Osengo, Dr. Rose Musyoka and Mrs. Margaret Ng’ayu for their support during the inception of the process.

This thesis would not have come to a successful completion, without the help I received from the field Project Team that included Dickson Mukunga, Juliet Muia, Mercy Kariuki, Ruth Kioko, George Sila, Phyllis Ndanu, Benjamin Kyalo and Brian Muia who assisted in the data collection, cleaning and entry. Thanks to Dickson Mukunga who assisted me in data analysis and for the various fruitful discussions we had in regard to the data.

I also pass my special thanks to my employer, CETRAD for granting me leave and hosting me during my studies and development of this thesis. A special mention go to Grace Wambugu, Eliza Peter, Caroline Ouko and Evanson Njuguna for their encouragement and Jacinta Mucugu for encouraging me to proceed with higher education and ensuring that funds were availed to me during the entire period of my education.

Words cannot express how grateful I am to my wife Flora Kainyu and children Fion Kendi and Emmanuel Karani for their prayers and continous encouragement during my studies. Also grateful to my two mothers Evelyn Gaiti and Joyce Gakii for their immense support in

terms of finance and prayers during the study period and my sisters Fridah, Regina and Emily for the time spend together and encouragement during the entire period of my studies.

Finally, to my fellow students' Lawrence and Allan who supported me during my academic work and buildup of this thesis.

To you all who directly or indirectly contributed to the successful implementation of this study, I say a big THANK YOU.

TABLE OF CONTENTS

List of tables

List of figures

List of maps

List of Plates

ACRONYMS

ALFA: Agriculture, Livestock, Fisheries and Food Authority

ASALs: Arid and Semi Arid Lands

BIDII: Benevolent Institute of Development Initiative

CA: Conservation Agriculture

CAADP: Comprehensive Africa Agricultural Development Programme

CETRAD: Centre for Training and Integrated Research for ASALs Development

C.R.S: Catholic Relief Services

CSA: Climate Smart Agriculture

DFID: Department for International development

ERS: Economic Recovery Strategy for Wealth and Employment Creation

EU: European Union

FAO: Food and Agriculture Organization

GOK: Government of Kenya

IFPRI: International Food Policy Research Institute

ILRI: International Livestock Research Institute

IPCC: Intergovernmental Panel on Climate Change

IPRSP: Interim Poverty Reduction Strategy

KIHBS: Kenya Integrated Household and Budget Survey

KIPPRA: The Kenya Institute for Public Policy Research and Analysis

KNBS: Kenya National Bureau of Statistics

LDGs: Least Developed countries

MDGs: Millennium Development Goals

MOA: Ministry of Agriculture

NDMC: National drought mitigation centre

NEPAD: New Economic Partnership for African Development

NOAA: National Oceanic and Atmospheric Administration

NPEP: National Poverty Eradication Plan

NWP: Nairobi Work Program

PRSP: Poverty Reduction Strategy Paper

SES: Social ecological systems

SL: Sustainable Livelihood

SPSS: Statistical Package for Social Sciences

STI: Science, Technology and Innovation

THVC: Traditional High Value Crops

UN: United Nations

U.C.C.S: Ukambani Christian Community Services

UNFCCC: United Nations Framework Convention on Climate Change

USAID: United State Agency for International Development

USDA: United State Department of Agriculture

1 INTRODUCTION

Resilience has increasingly become a key concept in social science oriented environmental research exploring how to deal successfully with climate, economic or social change. Much has been written about ecosystem and socio-ecological resilience (Holling 1973; carpenter et al., 2002; Berkes et la., 2003) or about social and ecological resilience (Adger 2000), but few studies address resilience from a livelihoods perspective (e.g Sallu et al., 2010; Obrist et al., 2010). Issues on how much a livelihood practice maintains or increases farmers' capacity to increase and maintain its livelihood especially during period of crisis are weakly conceptualised and operationalized.

Though (Adger 2000) refers to livelihoods stability as an aspect of social resilience, operationalization and assessment of what livelihood resilience entails are lacking. Obrist et al., (2010) also note that social resilience remains neglected especially from agricultural production system perspective. Authors define social resilience "the capacity of actors to access capitals in order to –not only to cope with and adjust to adverse conditions (that is reactive capacity) – but also search for and create options (that is proactive capacity), and thus develop increased competence (that is positive outcomes) in dealing with threat" (Obrist et al. 2010: 289). They developed a multi-layered social resilience framework emphasising the interactions between enabling factors and capacities operating at different levels of society, thereby highlighting 'the interconnectedness of different dimensions and scale in livelihood systems' (Obrist et al. 2010: 287). Drawing from social and cultural theories such as Bourdieu's practice theory, capitals and social fields (1984; 1986) and Gidden's structuration theory (1979; 1984), the study explored resilience by examining indicators of resilient and household performance using 2009 year as the perceived drought year, approaches and techniques that have proved to promote resilient, factors affecting resilient building and the policy option. Its acknowledged that resilience thinking is implicit in Sustainable Livelihood (SL) approaches, e.g. the SL approach of the United Kingdom Department for International development (DFID), that focuses on how people's capabilities, assets and activities, as well as transforming structures and processes have positive outcomes like incomes, increased well being or improved food security (op. Cit. 286).

Therefore, linking livelihoods approaches to resilience thinking can enhance how livelihoods approaches address long term change, but the link is yet to be made (Scoones). The paper

thus aims at extending the operationalization of resilience concept to livelihoods by identifying criteria and variables that can measure or assess resilience for research and policy practice departing from the livelihoods perspective. Therefore results in this study will inform on research, development policy and practice on building and maintaining livelihoods resilience and reducing vulnerability to shock and stresses.

The paper does not only focus on general livelihoods resilience but also illustrate examples of techniques proven by farmers' that have proven resilience to climate risks of droughts.

1.1 Background to the research problem

According to Oxfarm, almost 80 per cent of the world's 925 million hungry people live in rural areas, and most depend on agriculture as their main source of income and employment. Approximately half of these are smallholder farmers. Overall, smallholder farmers constitute 1.5 billion of the three billion people living in rural areas and 87 per cent of all farmers in developing countries. Of the one billion poor people living in rural areas, most rely mainly on agriculture for their incomes (Oxfam GB, 2011). Global shocks and crises such as the 2008 3-F crisis (food, fuel, and financial), as well as more localized ones such as droughts, are changing and deepening the risks already faced by the poor and vulnerable people, particularly those involved in agriculture and other ecosystem-dependent livelihoods. Reliance on subsistence agriculture means that the impact of these stresses and shocks are felt more by rural poor people, who depend directly on food system outcomes for their survival. This has profound implications for the security of their livelihoods and welfare (Mark Davies et al, 2011).

According to the Government of Kenya, in 2011, one third of the total population of 39 million people in Kenya suffered from chronic food and nutrition insecurity. As Kenya's population continues to grow, producing enough food for all remains a challenge. Unpredictable weather patterns, poor planning and slow adoption of modern farming methods negatively influence food security. Data from the International Food Policy Research Institute (IFPRI, 1990, 1996, 2001, and 2012) show that food security has worsened in the last two decades, with the Global Hunger Index dropping from 24 points in 1992 to 20 points in 2009. Further, the Kenya Economic Report (KIPPRA, 2009) indicates that about half of Kenya's population is poor, and about 7.5 million people live in extreme poverty. Over 10

million suffer from chronic food insecurity and poor nutrition. The Millennium Development Goals (MDGs), to which Kenya is a signatory, place elimination of hunger at the top of the list of international goals. In recent years, it is estimated that at any one time, about 2 million Kenyans require food assistance. According to trends, during periods of drought, heavy rains and floods, the number of the needy would double (MOA, 2008).

Drought cycles in the country seem to have shortened to every 2-3 years instead of 5-7 years in the past (MOA, 2009). The effect of climate change and global warming is posing great danger to agricultural productivity. This has been aggravated by population pressure in high potential areas pushing human settlement to water catchment areas and also cultivation of the fragile ASALs (Nyariki, 2009). Small scale farmers in arid areas of Kenya have continued to face uncertainties on crop production thus increased vulnerability to climate changes and have continued to depend on basic essentials from relief provided by the government and other international organizations. Sixty percent of the 10 million people living in arid areas live below poverty line thus they are the most affected by food insecurity and poverty.

Though the situation calls for a reliable measure/ or coping strategy, these communities continue to face challenges from one year to another. The government has, through the new constitution and vision 2030 formulated policies that aim to alleviate poverty and hunger in the country. Thus Vision 2030, on social equity and poverty reduction strives to reduce poverty from the current level of 46 per cent of total population by between 3 and 9 per cent, which is where most industrializing countries in South East Asia currently are (GOK, 2007).

For the last five years, the Centre for Training and Integrated Research for ASALs Development (CETRAD) introduced and promoted a water and soil conservation technology (Conservation Agriculture) in Kanthonzweni District. The project aimed to improvement of food security situation, livelihoods and for the long term improvement of resilience livelihoods. This study result on resilience build by farmers practicing conservation agriculture in the district will go a long way to inform on the best practices, approaches, and opportunities that can build resilient communities.

Makueni communities generally derive their livelihoods from subsistence (small-scale) farming. The mastery of multiple livelihood skills is a source of resilience in times of uncertainty and change. Diversification by local farmers provides a buffer against environmental variability and change. To be able to bounce back during these shocks,

communities adopt and build various strategies and resilience to cushion themselves from shocks.

Thus, in the recent past resilience has increasingly become a key concept in human geography and development studies partly due to the seemingly insurmountable challenges posed by multiple stressors in a globalised world. However, operationalizing resilience for research and practice is still largely lacking. The aim of the study was to identify and characterise livelihood resilience to climate risks among farmers and determine key contributing factors.

1.2 The problem statement

The national wide survey carried out in 2006 by Kenya Integrated Household and Budget Survey (KIHBS), found that 46% of the total Kenyan population is absolutely poor, i.e. below the poverty line, whereas 49% of the rural population is absolutely poor (Kenya National Bureau of Statistics, 2007). The 1997 Welfare Monitoring Survey showed a poverty rate of 57% overall and 60% in the rural population. Therefore, there has been some reduction in poverty across the country and across rural areas over the last decade but the challenge remains to reduce poverty levels in the Kenyan rural areas to enable rural people to build resilient livelihoods.

Makueni is a food insecure county with a history of low food production and a marked fluctuation due to unreliable rainfall. The county food security situation has been severely compromised by five consecutive partial to total crop failures. In 2005, Makueni produced only 9% of its estimated annual cereal demand of 127,720 metric tons (MOA, 2005). This has been disastrous for the largely peasant households due to loss of their livelihood. In general, food insecurity in the district is linked to inadequate rainfall, use of poor agricultural technologies, low purchasing power, poor infrastructure and environmental degradation (MOA, 2010). The county has relied on food and non-food aid continuously for several years because of vulnerable livelihood systems which are not resilient to adverse effects of weather (World Vision, 2006). This has created dependency syndrome within the community, hindering innovativeness and participation in development initiatives (World Vision, 2006). The poor and women are the most vulnerable, with over 64% of households being female-headed. They are often left by the male youth in search of employment opportunities in towns

especially in Nairobi. According to constituency well being report, up to 50.5% of Makueni County population lives below poverty line (KNBS, 2005/2006).

The government introduced new legislative and policy reforms to coordinate ecosystem management and the sustainable use of natural resources which includes; *Agricultural Sector Development Strategy*, which gives agriculture priority importance within Kenya's economy, as a means of livelihood for most of the rural population, and as the key to food security and poverty reduction; *Legal Notice No. 166*, which offers guidelines for agricultural farm forestry and requires that 10 per cent of all agricultural land be planted with trees. But regardless of these envisioned strategies, Kenyan households' have continued to face challenges and the situation is more pronounced in ASALs where, they have continued to rely on relief for survival. Makueni County is faced with adverse effects of climate and weather; therefore farmers are faced with shocks year in and year out and continue to receive donations as relief from the government and other international bodies such as Kenya Red Cross, Catholic relief services and World Food Program. The key strides are for specific households to generate sustainable livelihood strategies in order to build sustainable resilience to ensure households bounce back after times of shock.

Resilience research is still largely lacking in the country. Thus there is need to characterise livelihood resilience among farmers and to analyse how resilient the livelihoods are to climatic risks and the determinant factors. Previous research has focused on agro-pastoral production system contribution to resilient livelihoods thus need for study on adaptation on farming system to understand the dynamics and contribution of such systems in the country (Chinwe, 2010).

Empirical evidence on the characteristics of agriculture-dependent communities that have proven resilient to past climate-related problems is lacking at the household and community levels in Kenya. Generating information to fill this gap will increase the understanding of how communities cope with the impacts of climate-related problems, providing useful insights into the structure, and drivers of resilience and useful lessons for ensuring sustainable livelihoods in the face of climate variability.

1.3 Research questions

This research sought to answer the following questions in order to achieve the set objectives:

a. What are the indicators of resilient agriculture-based livelihoods to seasonal climatic variations?
b. Which farmers' and local actors' approaches and practices contribute to resilient livelihoods in the face of seasonal climatic variation?
c. What factors influence farmers' capacity to develop and maintain resilient livelihoods in the face of climatic risks?
d. What are the policy options for improving resilient livelihoods?

1.4 Research objectives

The following objectives were pursued in order to carry out investigation of the stated problem.

a. To identify and examine indicators of resilient agriculture-based livelihoods to seasonal climatic variations.
b. To identify farmers' and local actors' approaches and practices that contribute to resilient livelihoods in the face of seasonal climatic variation.
c. To examine factors influencing farmers' capacity to develop and maintain resilient livelihoods in the face of climatic risks.
d. To identify policy options for enhancing of resilient livelihoods.

1.5 Research hypothesis

Hypothesis II:

H_0: Farmers practicing Conservation agriculture technology are less resilient or equal to those who are not practising the technology.

H_1: Farmers practising conservation agriculture technology are more resilient than those who are not practising the technology.

1.6 Geographical and theoretical scope of the study

This study was carried out in two divisions; Mavindini and Kathonzweni of Kathonzweni sub county in Makueni County. The area is 187km away from Nairobi and its geographical coordinates are 1° 48' 0" South and 37° 37' 0" East. The sub County was curved from the larger and former Makueni district. Kathonzweni sub county, is located in the southern end of Eastern Province and covers an area of 7,965.8 sq Km with a projected population of 1,037,266 (2009 population projections) with an annual growth rate of 2.8% (KNBS, 2009). There are three main livelihood zones in the county. They include marginal mixed farming, mixed farming (dairy/irrigation), and mixed farming (food crops/cotton/livestock).

The study used the case of conservation agriculture farmers within Kathonzweni Sub County in Kenya and examined how conservation agriculture (CA) practices contribute to improvement of resilience and buffer capacity.

The cluster of practices that characterizes buffer capacity in conservation agriculture was identified. All practices in conservation agriculture that increase resilience capacity were evaluated from farmer's point of view on; economic, social, and ecological. Also factors that influence farmer capacity to maintain resilience and the principles underlying resilience were identified.

1.7 Justification and significance of the study

With a population of 39 million people (about ten percent of which is classified as food insecure) and growing at an annual rate of about three percent, Kenya remain the largest importer of food and agricultural products in east Africa (USDA, 2009). The Government of Kenya (GOK) recognized the seriousness of the evolving food shortage (precipitated by the white corn shortfall) in 2009 and food state of emergency was declared stating that about 10 million Kenyans, or about 25 percent of the population, were at risk of food shortage. In 2009, the GOK requested potential donor countries to provide Kenya Shillings 32 billion (approximately $401 million) to help with the hunger eradication effort. Thus this study can help to save the country income used to eradicate poverty in the country. E.g. the 1998-2000 drought events were estimated to have economic costs of $2.8 billion from the loss of crops and livestock (Stockholm Environment Institute, Project Report 2009)

According to trends, periods of drought, heavy rains and floods, the number of food needy doubles during such occurrences (MOA, 2008) and 60% of 10 million people living in arid areas live below poverty line and are the most affected by food insecurity and poverty. Analyses on climate trend during 1960 to 2009 indicate consistent patterns of climate change on rainfall and temperature data. When analysis is extended to2025, it indicates that large parts of Kenya will have experienced more than a 100 millimeter (mm) decline in long-season rainfall by that date (Williams and Funk, 2010).

Food insecurity in Kenya has been a major challenge that has faced the country for many years plunging majority of Kenyans especially low income earners into abject poverty. The latest index indicates that the national poverty levels stand at 47 per cent and it might increase if inflation rates, shilling volatility and poor farming methods are not curbed early. In Kenya food insecurity is concentrated in the rural areas. In April, 2008, about 3.5 million people in the country were reported to be in need of emergency food aid (USAID, 2009). The food security problem spreads to regional levels worsening as the agricultural potential declines, and develops into famines in the dry lands with low agricultural productivity and purchasing power, as livelihoods are based on extensive crop farming and herding (Muyanga, 2004).

Evidence on the generic characteristics of agriculture-dependent communities that have proven resilient or vulnerable to past climate-related problems is lacking at the household and community levels in Kenya.

1.8 Assumptions of the study

a) The study assumes that farmers respond to shocks by adopting various strategies to enable them cope and bounce back.

1.9 Definition of terms and variables

1.9.1 Resilience

The term "resilience" and "adaptive capacity" are sometimes used interchangeably. For resilience, I will adopt capenter's (2001), Folke (2006), FAO's (2011) and Garmezy, (1994) in Saleebey, (1996). In this sense, resilience refers to,

The capacity of individuals, social groups or social-ecological systems to absorb (withstand, live with, accommodate) disturbances (e.g. climate change impacts) while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to learn and adapt to change (cf. Carpenter et al. 2001; Berkes et al. 2003; Folke 2006; IPCC 2007[+]).

In a food security context, resilience is defined as "the ability of a household to keep with a certain level of well-being (i.e. being food secure) by withstanding shocks and stresses." This depends on available livelihood options and on how well households are able to handle risks. This definition implicitly considers both (ex-ante) actions that reduce the risk of households becoming food insecure, and (ex-post) actions that help households cope after a crisis occurs (FAO, 2011).

Resilience means the skills, abilities, knowledge, and insight that accumulate over time as people struggle to surmount adversity and meet challenges. It is an ongoing and developing of energy and skill that can be used in current struggles (Garmezy, (1994), in Saleebey, (1996).

The study will also adapt to the following definitions

1.9.2 Livelihood

The concept of livelihood is about individuals, households, or groups making a living, attempting to meet their various consumption and economic necessities, coping with uncertainties, and responding to new opportunities (de Haan and Zoomers, 2003).

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living.

1.9.3 Sustainable livelihood

A livelihood is sustainable when it can cope with and recover from stresses and shocks and manage to enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Chambers & Conway, 1991).

1.9.4 Vulnerability

Likelihood of being harmed by a given adverse event, and has an external side consisting of risks, shocks, and stresses to which individuals or households are subjected, and an internal defenseless side characterized by a lack of means to cope without a damaging loss (Chambers 1989).

Degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." (IPCC, 2001: 995).

1.9.5 Adaptive capacity

The ability of a system [human or natural] to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

2 LITERATURE REVIEW

2.1 Introduction

2.1.1 **Origin of resilience**

The term resilience was introduced into the English language in the early 17th Century from the Latin verb resilire, meaning to rebound or recoil (Concise Oxford Dictionary, Tenth Edition). There is no evidence of resilience being used in any scholarly work until Tredgold (1818) introduced the term to describe a property of timber, and to explain why some types of wood were able to accommodate sudden and severe loads without breaking.

In less than a decade the term resilience evolved from the disciplines of materials science and environmental studies to become a concept used liberally and enthusiastically by policy makers, practitioners and academics.

2.1.2 Resilience

Resilience is the capacity of individual, social groups or social ecological system to absorb withstand, live with, accommodate disturbances e.g. climate change impacts while retaining some basic structure and ways of functioning, the capacity to self organization and capacity to learn and adopt to change.

High dependence on natural resources and rain-fed agriculture in a context of a changing climate, socio-economic pressures and low adaptive capacities make Africa's smallholder crop production farmer vulnerable to climate change (IPCC 2007a, McIntyre et al. 2009). High rainfall variability in amount, time and location is common in African dry lands (Ogallo 1989) and poses a risk to maintaining and increasing agricultural production (Ifejika Speranza et al. 2008). The likely increase in rainfall variability projected for African's dry lands, a projected decrease in reliable growing days and an increase in season failure rates up to 2050 (IPCC 37 2007a; Jones and Thornton 2009) will exacerbate the already precarious climatic conditions for agricultural production. Thus, building resilience offers a pathway to reduce the vulnerability of agricultural production to climate variability. However, few studies have characterized resilience in the context of livelihoods-related environmental research. Resilience has three characteristic features, namely, buffer capacity, self-organization and

capacity for learning, which also influence one another. The study will focus on the contribution of Conservation Agriculture to building of agriculture resilient livelihood.

The way a household copes with and withstand climate change impacts depends on options available in terms of capabilities, assets (both material and social resources) and activities. Livelihood strategy for a household is the way those options are arranged and selected for such household to withstand shocks during extreme effects of climate change.

Households belonging to different socio-economic groups have different strategies to earn their own living thus different levels of resilience to climate change. E.g. farmer household verses a household whose major income is from public sector employment- Each requiring different type of interventions. Different communities and households have adopted various livelihood strategies in order to cope with extreme climatic effect. In Makueni, the occupation activities of most households can be classified as homogeneous groups of agro pastoralists and small holder farmers. The district has for many years been involved in farming as a means of economic activity and for survival.

2.1.3 **Characteristics of resilience**

A strawman paper by Alastair McAslan on “the concept of resilient” discuses at length a number of characteristics of resilience. They include:

i) Threats and events- All definitions of resilience refer to threats and events which are abnormal in terms of their scale, form or timing. Resilience is seen as the ability to accommodate abnormal threats and events, be they enemy actions (Fairbairn, 1865), or perturbations from climate change (Stockholm Resilience Centre, 2009), or natural disasters such as earthquakes or floods (Bruneau et.al. 2003), or economic shocks (Hamel and Välikangas, 2003). Most definitions, particularly those involving individuals, communities and organisations also refer to identifying, assessing and communicating the risk from such threats and events.

ii) Positive outcomes- All definitions refer to a positive outcome, be it the ability of a material to absorb and release energy and return to its original state (Gere and Goodman, 2009), or the ability of an individual, group or organisation to continue in existence in the face of some sort of surprise event (Longstaff, 2005), or the ability to recover from or adjust easily to misfortune or sustained life stress, or the capacity of a system to

absorb disturbance and still retain essentially the same function (Resilience Alliance, 2006). In some cases a positive outcome means returning to the state or condition that existed before the disturbance occurred. In other cases a positive outcome means returning to an improved state or condition.

iii) Being prepared- Resilience involves the ability or capacity to absorb, and then recover from an abnormal event. This capacity may be built formally and deliberately by developing plans, standards and operational procedures, or by developing physical, economic and/or human capital (Mayunga, 2007). It may also evolve informally through the development of social capital (Tierney, 2006), or it may exist naturally through the properties of the material being used (Mallet, 1856). Individuals, communities, organisations and, indeed, nations which are prepared and ready for an abnormal event, tend to be more resilient.

iv) Desire/ commitment to survive- Survival is a basic human instinct, and individuals who demonstrate the strongest will to remain alive are able to accept extreme and abnormal conditions and recover from traumatic events.

v) Adaptability- We live in a world which is constantly evolving, in some cases through natural processes and in other cases through the intervention of mankind. There is common agreement in the literature that systems, organisations and people who are able and willing to adapt tend to be more resilient.

vi) Gaining experience- The ability and willingness to learn is often linked to adaptability and being prepared. The learning may come from personal experience or by studying the lessons of others in a formal manner.

vii) Collective and coordinated response – interdependency- As society becomes more complex and interconnected, and the impact of global factors become more immediate and apparent, we find ourselves more vulnerable to disruptive events. In facing such interconnected threats, resilient households, communities and organisations and indeed nations tend to be those which are well coordinated and share common values and beliefs. But researchers such as Durodie (2004) suggest that shared community values and beliefs in the modern world have been replaced by self interest and personal gain, resulting invulnerable societies which are less able and willing to plan for, and react to, disruptive events.

2.1.4 **Resilient livelihood approach**

The concept of resilience, originally proposed in the ecological literature (Holling, 1973) was successively proposed to explore the relative persistence of different states of nature in complex dynamic systems such as socio-economic systems (Levin et al. 1998). The concept of resilience has two main variants (Holling, 1996). One, called “engineering” resilience by Gunderson et al. (1997), is the ability of the system to return to the steady-state after a perturbation (Pimm, 1984; O’Neill et al., 1986; Tilman et al. 1994). It focuses on efficiency, constancy, and predictability, and it is the concept which engineers turn to in their attempt to develop optimal designs (“fail-safe” designs). The other definition, we can refer to as “ecological” resilience, is the magnitude of disturbance that can be absorbed before the system re-defines its structure by changing the variables and processes that control behaviour (Walker et al., 1969; Holling, 1973). It focuses on conditions away from any stable steady-state, where instabilities can flip the system into another regime of behaviour (i.e., to another stability domain).

Both variants deal with aspects of the stability of system equilibria, offering alternative measures of the capacity of a system to retain their functions following disturbance. However, each definition emphasises different aspects of stability that “can become alternative paradigms whose devotees reflect traditions of a discipline or of an attitude more than of a reality of nature” (Gunderson et al., 1997: 3). Also the two definitions reflect two different views of the world: engineers want to make things work, while ecologists acknowledge that things can break down and change their behaviour. Traditionally, economists have primarily tended to consider conditions close to a single stable state However, the issue of ecological resilience has also begun to emerge in economics with the identification of multi-stable states due to path-dependency (Arthur, 1987), “chreodic” development (Clark and Juma,1987) and production non- convexities such as increasing return to scale (David, 1985). Levin et al., (1998) argue that resilience offers a helpful way of thinking about the evolution of social systems, partly because it provides a means of analysing, measuring and implementing the sustainability of such systems. This is largely because resilience shifts attention away from long-term equilibria and towards the system’s capacity to respond to short-term shocks and stresses in a constructive and creative way.

2.1.5 Sources of resilience within a system

Key sources of resilience lie in the requisite variety within functional groups. Examples include biodiversity in critical ecosystem functions, flexible options for management, norms and rules in human organizations, cultural and political diversity in social groups. Resilience also comes from accumulated capital that provides sources for renewal. In ecological systems, these include mechanisms for regeneration, such as seeds and spatial re-colonization, or in soil properties. In social systems, it is the social capital of trust, networks, memory, and developed relationships, or, in the cultural capital of ethics, values, and systems of knowledge. Moreover, the kindred discipline of system ecology acknowledges that critical ecosystem organising processes, or "keystone" (Paine, 1974) processes, create feedback that re-enforces the persistence of system temporal and spatial patterns over specific scale domains. These processes interact across a range of spatial and temporal bounds. In social-ecological systems, there are many factors which contribute to this, including institutions, property rights, and the completeness and effectiveness of markets.

Households are components of food systems and can be conceived as (sub-) systems themselves. The household definition is, in fact, consistent with the Spedding (1988) definition of system as "a group of interacting components, operating together for a common purpose, capable of reacting as a whole to external stimuli: It is affected directly by its own outputs and has a specified boundary based on the inclusion of all significant feedback". Moreover, as decision-making unit, it is the unit within which the most important decisions to manage uncertain events, both ex ante and ex post, including the ones affecting food security, are made (European report, 2008). For example, what income generating activities to engage in, how to allocate food and non-food consumption among household members, what strategies to implement in order to manage and cope with risks, etc.

The multi-dimensionality of the food security and poverty concept(s), and the complexity of the conduit mechanisms to food insecurity, qualifies the household as a system which faces largely unpredictable exogenous shocks. This also implies that it is necessary to consider a household as a complex adaptive system. The survival of a household as a system depends less on the stability of its individual components than on the household's ability to maintain its self-organisation in the face of stress and shock; in other words, on its resilience. In a resilient household, change has the potential to create opportunity for development, novelty and innovation. As resilience declines, it takes a progressively smaller external event to cause

a catastrophe. A household with low resilience may still maintain its functions and generate resources and services – i.e., may seem to be in good shape – but when subject to disturbances and stochastic events, it may exceed a critical threshold and change to a less desirable state.

For all these reasons, the concept of resilience as applied to household food security seems to be promising (EU, 2008): It aims to measure the capability of households to absorb the negative effects of unpredictable shocks, rather than to predict the occurrence of a crisis (as in the case of most vulnerability literature).

2.2 Indicators of resilience agriculture base livelihood

Under the arid and semi-arid areas of study (Makueni County), agro-pastoralism forms the fundamental basis of livelihoods. Livestock and crop farming forms the basic livelihood source and at the same time act as the main source of food, income and savings. Generally as an adaption to climate change and other hazards, agro-pastoralists in Makueni have developed complex and diverse strategies including the rearing and growing of various livestock and crops, diversification, and grassroots institutions to management natural resources, and assuring social safety nets. Much evidence still indicates that that agro pastoralism is economically viable, ecologically sound and a socially accepted agricultural system under the dry land environment (Scoones I. 1995, Hesse & MacGregor 2006, Devereux, 2006, Rodriguez, 2008).

Today, many of the agro-pastoralists are exposed to different challenges of ecological and human crisis such as drought, famine, environmental degradation and dependency on food aid. There is a general consensus in the literature that the vulnerability that characterizes many pastoral and agro-pastoral groups in Africa is not drought, but the increasing marginalisation of their drought-response mechanisms. Therefore the indicators identified and examined are that form the household buffer capacity. They are: food security situation of households, financial security, physical capital, natural capital and human capital.

2.3 Approaches and practices to build resilience

The declaration of the World Summit on Food Security (2009) announced that food production has to increase by 70% and in order to feed an exponentially increasing population (FAO 2009). It will require adopting measures, approaches and practices that guarantee access to food in rural and in cities (United Nations, 2009). Additionally, climate change implies severe risks for food security and the agricultural sector, which will have particular incidence on vulnerable fractions of the population (IPCC, 2001). Climate-smart agriculture (CSA) (which includes the agriculture, forestry and fisheries sectors) at the local level contributes to meeting global objectives. CSA is built on three pillars (FAO, 2010), which focus on:

- Sustainably increasing farm productivity and income, Productivity must increase in order to secure access to enough food for the growing population.
- Strengthening resilience to climate change and variability. Climate change requires adaption of food production systems for resilience both at the livelihood level and at the ecosystem level.
- Mitigating the contribution of agricultural practices to climate change through a reduction or removal of greenhouse gas emissions. A reduction in greenhouse gas emissions and the agricultural carbon footprint is essential, which calls for changes of practices, including more resource efficiency, use of clean energy, conservation technologies and carbon sequestration.

Traditionally, a number of approaches have been used by farmers through indigenous knowledge that have proven to build resilience. These approaches have been directed to conservation measures. According to the Ministry of agriculture, a numbers of agricultural practices in the district span from agricultural crop production to livestock keeping. Historically, the County has depended on agricultural production. The District has also been ranked number one in the entire country on soil erosion conservation. These are techniques plus livestock keeping that farmers have for years perfected to conquer food insecurity.

Other approaches and practices that have been generated recently are mangoes production which currently stands out as key income generating enterprise in the district and County.

2.3.1 Conservation agriculture (CA) to improve resilience livelihood to climate change

Conservation is a technique that entails three principles (permanent soil cover, minimum soil disturbance and crop rotation) with overall role of soil and water conservation in-order to increase production and minimize weather base risks. Conservation agriculture has for many years been used to build resilient livelihoods in various parts of the world. Farmers in Kathonzweni have practiced CA for a number of years-traditionally (Terraces) and post modern society through the application of the three principles.

Kanthonzweni District is faced with adverse effect of climate and weather, thus farmers face shocks year in and year out. And the key issue is for specific households to generate specific livelihood strategies in-order to build sustainable resilience to enable the household to bounce back in times of shock. Such strategies are; diversification of crops especially growing of drought tolerant crops, and adopting better farming techniques that conserve moisture such as conservation agriculture (terracing, zai pits, minimum tillage, mulching and crop rotation).

FAO identifies four integrated thematic pillars as core of disaster risk reduction; enable the environment, watch to safeguard (early warning), prepare to respond and building resilience (building resilience with technologies, approaches and practices across all agricultural sectors).

The study is based on the premise that CA is a form of coping strategy and approach that enables practicing farmers to adapt to changing climate. Thus the study used the experience of CA farmers in this region that have practiced it for four years and comparing their performance to those not practicing.

2.4 Factors influencing capacity to build resilience

2.4.1 Drought

There is no common definition of drought because it is unlike other types of hazards which make it difficult to define. Since impacts are specific to the affected region as well as the affected communities, a universal definition is difficult to develop. However, drought can be defined in a simple conceptual way that it is a prolonged and abnormally dry and hot period when there is scarcity of water for the normal needs of the affected community or ecosystem (EEN, 2004).

Droughts are now receiving more attention due to the recent increase in their frequency and intensity. It is a slow onset disaster that is believed to be the primary cause of famine due to crop failure. The general definition can be modified to further develop definitions of specific types of droughts such as meteorological droughts, agricultural droughts, hydrological droughts and socio-economic droughts. It's one of the main causes of vulnerability thus affecting resilience building.

2.4.1.1 Agricultural drought

Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focusing on precipitation shortages. The definitions of agricultural drought attempt to explain the susceptibility of crops to water deficiencies during different stages of crop development. It does not only affect the farming sector in agriculture but also the pastoral sector where it forces pastoralists to migrate from their land with their animals in order to look for pasture and water. Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. National drought mitigation centre (NDMC, 2006) states that rainfall patterns, especially rain failure or erratic rainfall are frequently the cause of natural disasters in Kenya where rural livelihoods have evolved to adapt to water availability.

Folke, Elinor & Co. in their 2002 seminar paper on sustainable development argued that 'management that builds resilience can sustain socio-ecological systems in the face of surprise'. As a result, there is a rising interest in understanding elements that enhance coping capacity or that build resilience (Daskon, 2010). In the event of a livelihood shock, farm households do not remain passive but adopt a number of strategies to cope with the shock and to manage subsequent risks.

This study looked in in-depth to identify practices by farmers that have proved to build resilient livelihood using the base year of 2009 and 2010 which were believed to be drought years within the study area.

2.4.1.2 Impacts of drought on food security in Kenya

Persistent incidences of drought in Kenya have continued to threaten the food security situation and subjected millions of Kenyans to starvation. In January 2009, the President of

Kenya declared a state of food emergency and appealed for humanitarian assistance from the international community to save approximately 10 million Kenyans from the risk of starvation. The effect of drought on the production of maize is of considerable concern in Kenya where over 80 percent of land area is arid or semi-arid. Most of these areas receive low and uncertain rainfall distribution patterns averaging 500-800mm per annum. A chronology of drought in the last one decade indicates that Kenya is now a drought-prone country (USAID, 2009).

Chronology of droughts 1997–2009 (Source *Source: Kandji, 2006.)*

The high frequency of drought implies that the vulnerable populations have a very short recovery phase. According to the Intergovernmental Panel on Climate Change, Kenya will suffer more intense and frequent droughts in the 21st Century.

January 1997: the Kenyan Government declared a state of national disaster after a severe drought threatened the livelihoods of 2 million people.

December 2000: 4 million people were in need of food aid after Kenya was hit by its worst drought in 37 years. (Whole country)
March-June 2004: the long rains failed and the subsequent crop failure left more than 2.3 million people in need of assistance. (North Eastern, Lower Eastern, Coast, & part of rift valley)
December 2005: President Kibaki declared a 'national catastrophe' in reference to the famine that affected 2.5 million people in northern Kenya.
January 2009: President Kibaki declared drought and famine in the country a national disaster and announced that 10 million people are food insecure and in need of emergency support. The study uses 2009 as the drought base year.

The country's dependence on rainfall and poor farming technologies are the main root causes of the country's vulnerability to drought. Agriculture, which is the mainstay of the economy, is almost entirely rain-fed.

2.4.2 Historic experience

Regions with high historic climatic variability can be particularly important examples of adaptive capacity and climate resilience (or lack thereof). Polsky and Easterly (2001), for example, studied agricultural adaptation to climate variability in the U.S. great plains using a

Ricardian approach that included an index of historic climatic variability. They concluded that farmers and institutions in districts with high historic climate variability had adapted and were more resilient to climate variability, but that the underlying reasons and sustainability of these adaptations were unclear, varied spatially and needed to be investigated with field-level study of individual farms, farmers and the institutions affecting agriculture.

2.4.3 Other factors affecting adoptive capacity and resilience building

According to Smit *et al.* (2001), the following determines resilience and adoptive capacity of an actor (e.g. farmers, groups, household): first is the economic resources where greater economic resources increase adaptive capacity while lack of financial resources limits adaptation options and resilient building, secondly technology –where lack of technology limits the range of potential adaptation options while less technologically advanced regions/households are less likely to develop adaptive capacity and to build resilience, thirdly information and skills where lack of informed, skilled and trained personnel reduces adaptive capacity while greater access to information increases likelihood of timely and appropriate adaptation, fourthly is the infrastructure greater variety of infrastructure can enhance adaptive capacity since it provides more options. Also characteristics and location of infrastructure affects adaptive capacity, fifth is institutions where well developed social institutions help to reduce impacts of climate related risks and therefore increase farmers' capacity to develop resilient and adaptive capacity. Policies and regulations may constrain or enhance adaptive capacity and farmer's ability to build sustainable livelihoods, and lastly equity where equitable distribution of resources increases adaptive capacity and also resilient building. Both availability of entitlement to resources are important.

2.5 Policy review

After 50 years of Independence, Kenya remains a dual economy with wide disparities in economic, social and infra-structural development across regions. The late 1990s and early 2000s saw the development of the National Poverty Eradication Plan (NPEP) and the Poverty Reduction Strategy Paper (PRSP), both of which were produced under the umbrella of the United Nations' Millennium Development Goals. Though the PRSP resulted in a better understanding of poverty in Kenya, due to broad-based consultation among key stakeholders, it was not implemented in full due in part to reluctance to change by those in governance. In particular, the national budget was not changed to accommodate the poverty reduction plans,

and key political and economic governance measures such as fighting corruption were also not implemented as anticipated.

From 2003 to 2007 an Economic Recovery Action Plan (ERC) was a blueprint that guided the Government's economic policies for a period of 5 years. The Action Plan harmonized strategies for accelerated economic growth with the country's poverty reduction strategies and the ideals outlined by the government. The central focus of the Plan was to create jobs through sound macroeconomic policies, improved governance, efficient public service delivery, an enabling environment for the private sector to do business, and through public investments and policies that reduce the cost of doing business. It further paid particular attention to promoting actions leading to the sustainable management of natural commons such as land, water, forests to which the very poor depend on. Its implementation was meant to translate into sustained economic growth, wealth creation and poverty reduction, and a broad improvement in the well-being of Kenyans.

The comprehensive Africa Agricultural Development Programme (CAADP) is at the heart of efforts by African governments to accelerate growth and eliminate poverty across the continent under the New Economic Partnership for African Development (NEPAD) initiative. The main goal of CAADP is to help African countries reach a higher path ofeconomic growth through agricultural led development that eliminates hunger, reduces poverty and food insecurity and insurance environmental resilience. This is a programme by the African union of which Kenya is a signatory, and it's fully owned and led by African governments. Though the programme is continental in scope, this programme is an integral part of Kenyan government efforts to promote agricultural sector growth and economic development. The key intermediate targets of CAADP that the government is aiming to achieve are; the pursuit to achieve 6% average annual agricultural sector growth rate at the national level and allocation of 10% of the national budgets to the agricultural sector. These targets are yet to be realised in the country.

The unveiling of Kenya Vision 2030 marked an important milestone in the country’s development as it came soon after the successful implementation of the “Economic Recovery Strategy for Wealth and Employment Creation” (ERS). The Vision is the national long-term development blue-print that aims to transform Kenya into a newly industrializing, middle income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment.

The Vision comprises of three key pillars: Economic; Social; and Political. The Economic Pillar aims to achieve an average economic growth rate of 10 per cent per annum and sustaining the same until 2030 generate more resources to address the MDGs. The vision has identified a number of flagship projects in every sector to be implemented over the vision period to facilitate the desired growth that can support the implementation of the MDGs on a sustainable basis. In addition the vision has flagged out projects addressing the MDGs directly in key sectors such as agriculture, education, health, water and environment.

The social pillar seeks to create just, cohesive and equitable social development in a clean and secure environment. The Social Pillar seeks to engender just, cohesive and equitable social development in a clean and secure environment, while the Political Pillar aims to realise an issue-based, people-centred, result-oriented and accountable democratic system. The three pillars are anchored on the foundations of macroeconomic stability; infrastructural development; Science, Technology and Innovation (STI); Land Reforms; Human Resources Development; Security and Public Sector Reforms.

In order to ensure agricultural sector reforms, the Agriculture, Livestock, Fisheries and Food Authority (ALFA) Bill was passed in 2012 following a series of new agricultural research, livestock, fisheries and crops legislation passed throughout the year. The purpose of the new legislation was to transform Kenya's agricultural sector into a commercially-oriented and internationally competitive industry. The new structure will help Kenya modernize agricultural production, improve service delivery, and harmonize the regulatory and legal framework of government programs.

2.6 Conceptual and analytical framework criteria and indicators

Characterizing resilience will provide a framework for understanding the most effective combinations of short and long term strategies for lifting farming families out of poverty and hunger cycles. The research was based on the principle that factors that make farming households resilient to food security and other shocks must first be identified, understood, and strengthened.

To understand resilience, factors that make households resilient to food security shocks and stresses were analyzed and they form the study variables assessed. From the adopted definition of resilience, three attributes which further can be decomposed into various proxy

indicators are usually identified (cf. Carpenter et al., 2001, Milestad and Darnhofer, 2003; Milestad, 2003), namely buffer capacity, self organization and capacity for learning.

2.6.1 Buffer capacity

Buffer capacity has been described as the amount of change (disturbance) a system can undergo (absorb) and still retain the same structure, function, identity, and feedback on function and structure (carpenter et al, 2001; Resilient alliance, 2010). From livelihood perspective, it remains difficult to capture this change or disturbance and characterise the magnitude of change. We thus operationalize buffer capacity as the capacity to cushion change and to use the emerging opportunities to achieve better livelihood outcomes such as reduced poverty (Ifejika Speranza, 2012). This capacity enables the maintenance and improvement of essential basic structures and ways of functioning and has been analysed in details in Ifejika Speranza (2012). The indicators are:

a) *Endowments* refer to the resources available to the actors and in the case of this study to the farmers and can cushion actors/farmers to change. The higher the endowment to the farmer/ household the more likely to be more food secure and long run resilient than those with lesser or none. For the purpose of this study, endowment will be captured with livelihood capitals/ assets, which can be human (existing knowledge and skills), financial (incomes, yields, savings), physical (technological innovations), social (benefits through group memberships) or and natural (soil organic carbon content[1]) (cf. DFID, 2000). The guiding question is what ways and how much a livelihood practice contributes to maintaining, improving or increasing these assets.

Livelihood capital	**Indicators**
Human capital –	Literacy level, Knowledge and skills.
Financial capital	Household incomes, yields and expenditure
Social capital	Membership and participation in social networks
Physical capital	Machinery, building, equipment, water ponds, granary
Physical capital	Services and infrastructure
Natural capital[1]	

[1]*To be carried out in a different study_ Resilient livelihood mapping*

b) *Entitlements*: these are sets of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces (sen, 1984: 497). Therefore, entitlement is about access to resources, and the more entitlements a household, group or individual command, the likely it can buffer adverse impact such as adverse weather. Drawing from Sen (1984), Devereux (2001), describes a person's entitlement set as a full range of goods and services that he or she can acquire by converting his or her endowments (assets and resources, including labour power) through exchange entitlements mappings (e.g. Production, trade, social security provision and subsidies). Therefore, entitlements determine capabilities (what people can do with their entitlements (Sen, 1984).

   Endowments and Access to the above variables will be assessed

c) *Diversity* refers to differences in livelihood characteristics and processes and their multiple ways of functioning. Livelihood that comprises different components with different characteristics and different functions are likely to be more robust to disturbances. Diversity also provides flexibility in that a livelihoods system or an individual farmer/household can draw on different farm resources. Diversity is expected to increase resilience as droughts or floods do not affect all crops in a mixed cropping or agro-forestry system to the same degree, hence diversity reduces the risk of crop loss or widespread disease infestation.

   Livelihood diversification will be assessed- No of diversity in terms of Crops (type and variety), agro-forestry, and no of different livelihoods

d) *Site specific knowledge* is an actor or farmers' knowledge of the social ecological system (SES) within which livelihood activities is undertaken. Studies show that migrant farmers often do not have adequate knowledge of agro-ecosystem to which they have migrated. They tend to carry the same seeds and same farming techniques, which are often, not fit the new locations ecological conditions. Therefore, the study will capture how practices derive from actor's knowledge through the level of experience a land user has in that specific environment (cf. Altran et al., 2002).

   Local knowledge relevant for the livelihood will be assessed. - No of years in agriculture and years in the region.

2.6.2 Self organization

Self organization as an attribute of resilience highlights how human agency, adaptive capacities, power and social interactions shape social resilience (cf. Obrist et al., 2010). An emerging common feature is that endogenous interactions and processes are the core for self organization (cf. Di Marzo Seugendo et al., 2003). The indicators are:

a) *Institution* refers to societal norms and rules (Ostrom, 1990) as well as formal institutions like groups, organizations and government agencies/bodies. They can limit or enhance households/actors adaptive capacities and are very crucial in resilience building.
   Existing institutions (policies, rules, and services), governing resources use and their enforcement.

b) *Opportunity for self organization* addresses the question of whether the SES offers opportunities for actors (farmers and other resource users) to organize themselves. The extent to which policies and regulations foster or hinder group organizations can be used as proxy to measure this criterion;
   Number and type of group in which actor is a member, degree of participation

2.6.3 Conceptual framework

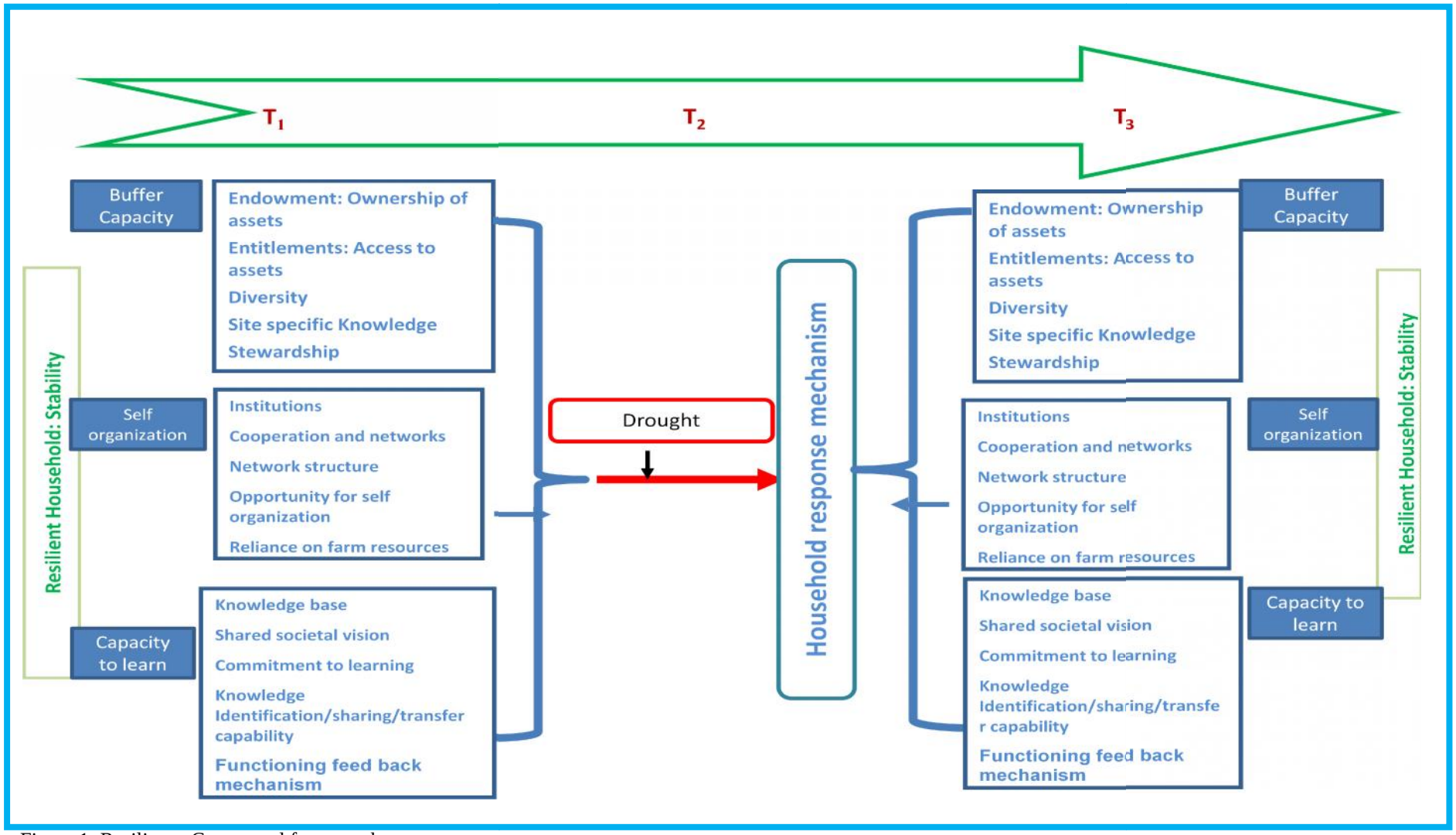
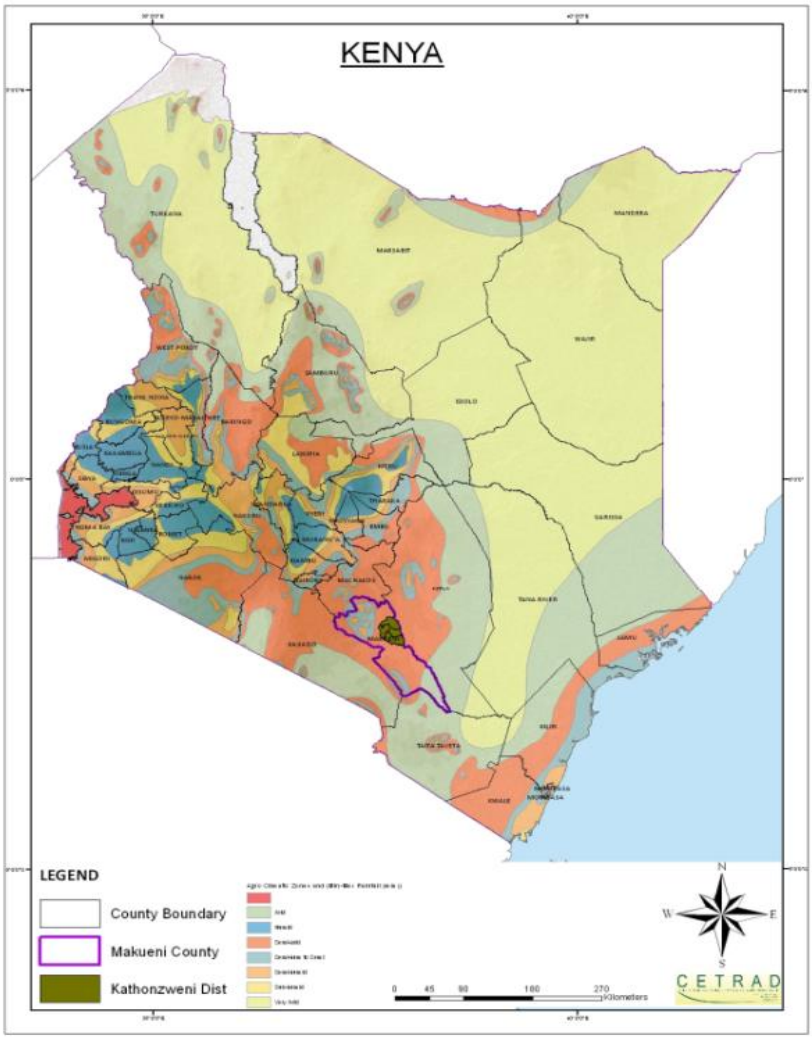


Figure 1: Resilience Conceptual framework

3 STUDY AREA

3.1 Location and size of the study area

Makueni County is one of the eight counties that form the former Eastern province and one of the three that comprise Ukambani region. The county borders Kajiado County to the west, Taita Taveta to the south, Kitui to the East and Machakos to the North (See Map 1). Makueni County comprises eight sub counties. The County lies between latitude $1^0$35'South and longitude 37^0 10'East and 38^0 30' East. It covers an area of 7,965.8 km^2 out of which 474.1 km^2 is Tsavo West National Park and 724.3 km^2 is Chyullu Game Reserve. The study was carried out in Kathonzweni sub County in Makueni County and covered two divisions in the sub County. These are Mavindini and Kathonzweni Divisions.



Map 1: Study area in the National context

3.2 Physical and topography

The county lies in the arid and semi arid zones of the eastern region of the country. The major land formation in Makueni County includes the volcanic Chyulu Hills, which lie along the southwest border of the County with Kibwezi sub County. The Mbooni and Kilungu Hills rise to a height of 1,900 metres above sea level. The county terrain is generally low-lying from 600m above sea level in Tsavo at the southern end of the county. The southern part of the County is low lying grassland, which receives little rainfall but has an enormous potential for ranching. The northern part of the county is hilly with medium average rainfall of 1000 mm and has potential for food crop production, dairy, horticulture and coffee production.

The main river in the county is Athi River, which is perennial and fed by tributaries such as Kambu, Kiboko, Kaiti, Thwake and Mtito Andei, which drain from various parts of the county. A few other streams flow from the Mbooni and Kilungu Hills but their flow becomes irregular as they move to the low-lying areas. These rivers provide a high potential for both large and small-scale irrigation (See Map 2).

Map 2: Makueni County topography
(Source CETRAD)

3.3 Climate and rainfall

The County is characterized by extreme rainfall variability. Typically good seasons are interspersed with extremely dry seasons and variations in the onset of rainy seasons add to the difficulty of ensuring adequate food production. The County has two rainy seasons with two peaks in March / April (long rains) and November/December (short rains). From June to October is a long dry period, while January to March is a short one. The hilly parts of the County receive 800 to 1200 mm of rainfall per year. The rest of the County receives less rainfall estimated at about 500 mm per annum. Mean temperatures in the County range from 20.2 to 24.6 degrees centigrade. To the north, it is usually cool while in the low lying area of the south, it is usually hot. During the dry periods, i.e. between May and October, the lower parts of the County experience severe heat. The high temperatures experienced in the low lying areas cause high evaporation.

Climate variations and extreme differences in temperatures can be explained by change in altitude. The areas to the North such as Kilungu and Mbooni hills are usually cool with temperatures ranging from 20.2º C to 24.6º C, while the low-lying areas of the South such as Kitise and Mavindini are usually hot. Generally, the county experiences high temperatures during the day and low temperatures at night. During the dry periods between May and October the lower parts of the county experience severe heat. The Northern part of the county is hilly with medium rainfall ranging from 800mm to 1200mm and has high potential for food crop production. This part of the County, covering mainly in Kilungu and Kaiti has few natural and planted forests the area is therefore suitable for horticulture and dairy farming.

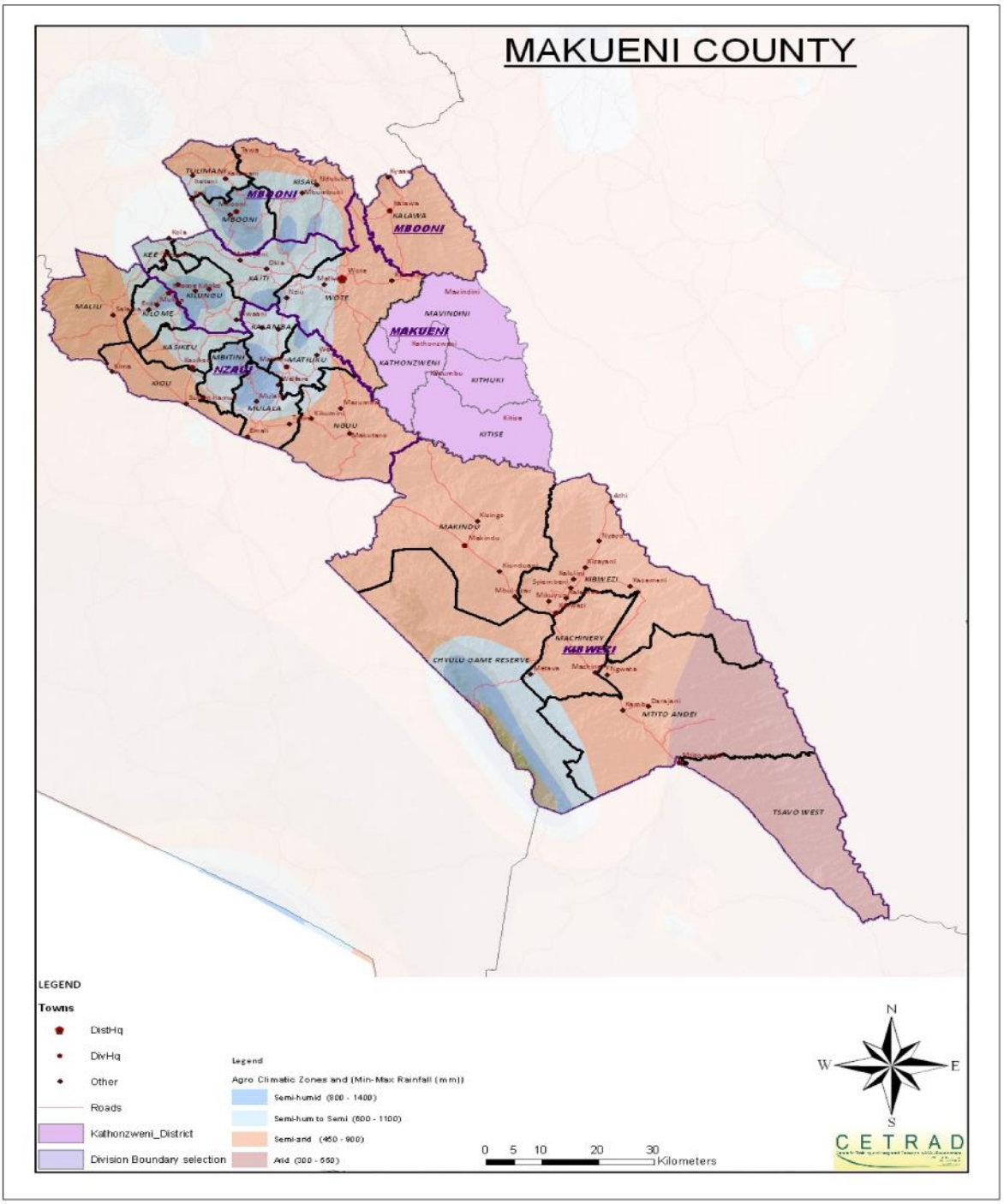
Over time, the county has experienced climate change and variability which includes insufficient rain and prolonged dry spells among others. Human activities such as farming on hill tops, charcoal burning, and sand harvesting have contributed to this scenario. As a result there has been crop failure affecting the food security and thus economic activities. Water scarcity has also become worse due to this condition. Increase in population puts a lot of pressure on land and other resources. To mitigate the effects of water scarcity, the community has resulted into construction of sand dams which are capable of retaining water. Soil erosion control measures are also being undertaken

3.4 Agro-ecological zones

Makueni County is categorized as arid and semi arid zone. It falls within three agro-ecological zones, the high potential zone (LM2), medium potential zone (LM3, UM4, LM5) and low potential zone (LM5, LM6, UM6, UM5). The area of study falls on the lower potential agro-ecological zone characterised by livestock rearing, and growing of maize, sorghum,, pigeon & cow peas and cotton among others. These are the main enterprises that farmers in the study area depend on to build their livelihoods (See Table 1).

Agro-ecological zone	**Percentage of district**	**Description of area**	**Main land use activity**
High potential LM2	19.3	Hill masses of Mbooni East & West and Kilungu	Coffee, maize, peas, citrus, fruits, trees.
Medium potential LM3,UM3,LM4,UM4	2.4	Lower slopes of hills and adjacent areas of Nziu	Coffee, maize, cotton, beans, pigeon peas, sunflower, sorghum and fruits.
Lower potential LM5, LM6, UM6	56.7	Kathonzweni, Makueni, Kibwezi, Makindu	Livestock rearing, maize, sorghum, pigeon peas, beans, cotton, sunflower and forests
	21.6%	Tsavo Game park & Chyullu Game reserve	World animals and vegetation

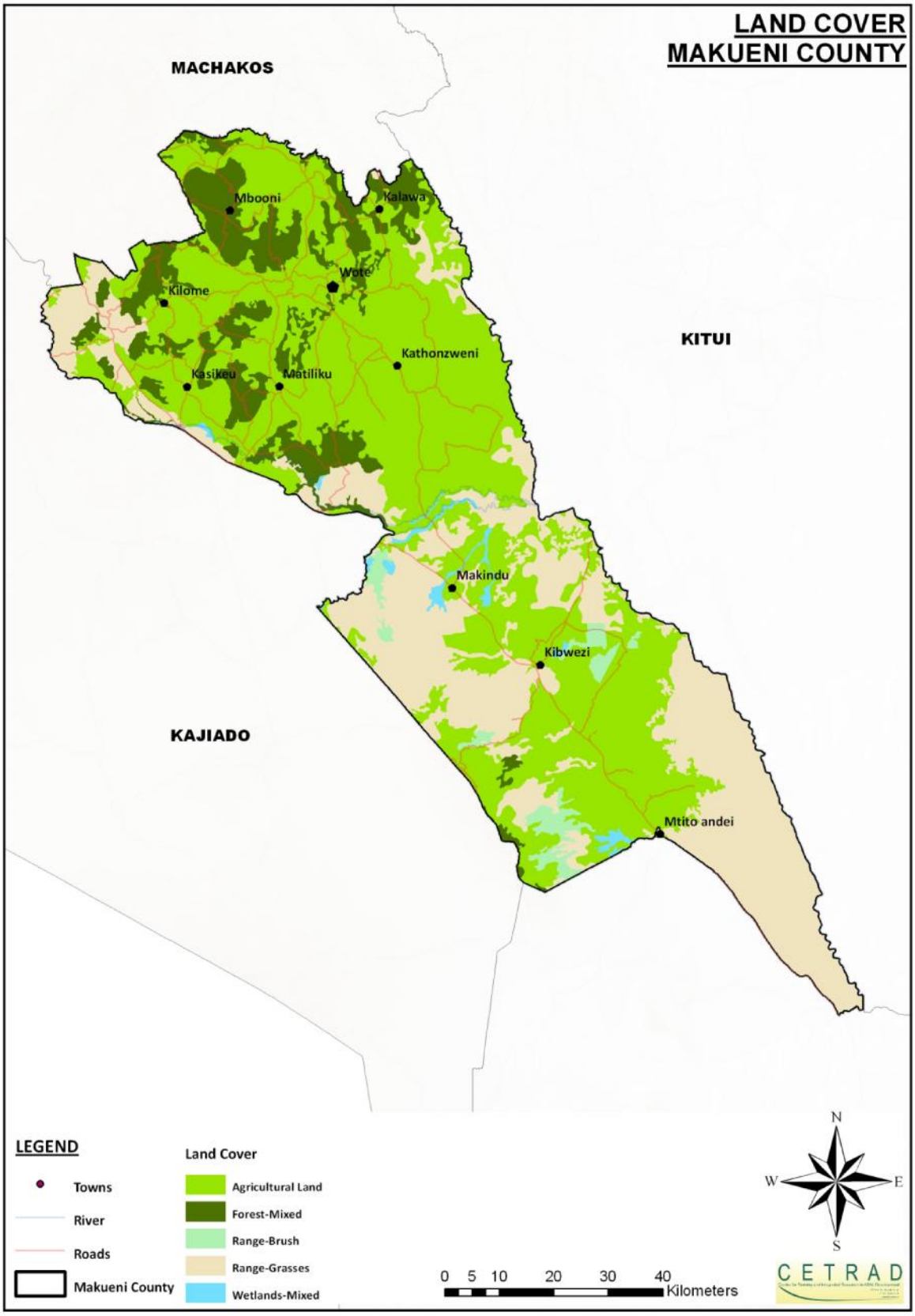
Table 1: Makueni agro-ecological zones



Map 3: Agro ecological zone
(Source CETRAD)

3.5 Vegetation and wildlife

Vegetation of the County can be categorised into 4 groups including forest, closed shrubs, open shrubs and closed herbaceous. Shrubs cover 50 percent while forests cover only 4% of the County.



Map 4: Vegetation and land cover

3.6 Socio-economic and cultural dynamics

3.6.1 Population and demographic characteristics

According to the population census of 2009, the **C**ounty had a population of 884,527. The males were 49 %, while females were 51 %. The population density then was 110.4 people per sq km. The county had an annual population growth rate of 2.8 % which is above the national growth rate of 2.69%. (KNBS, 2010).

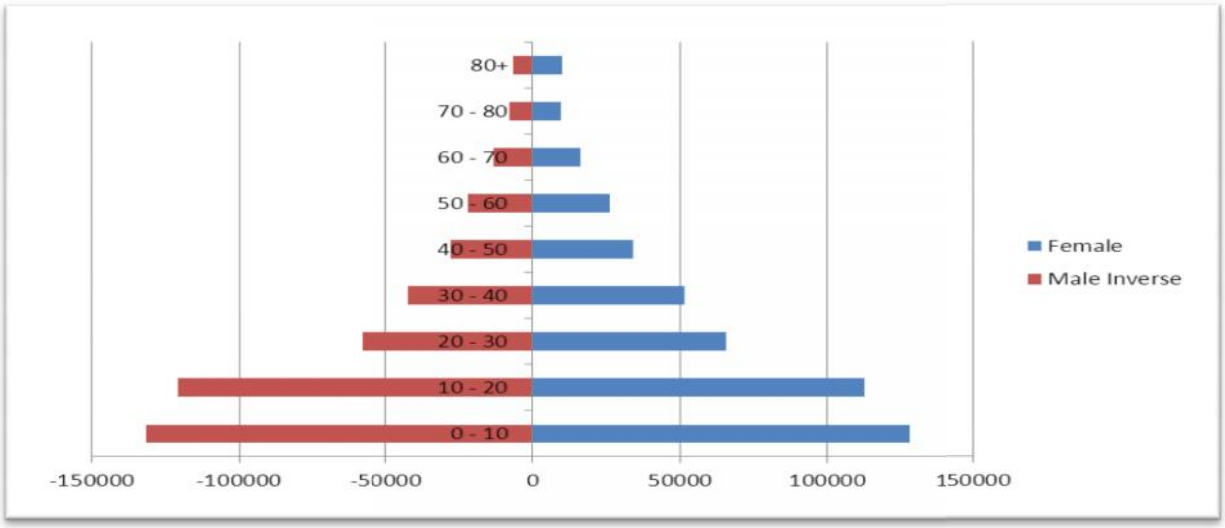


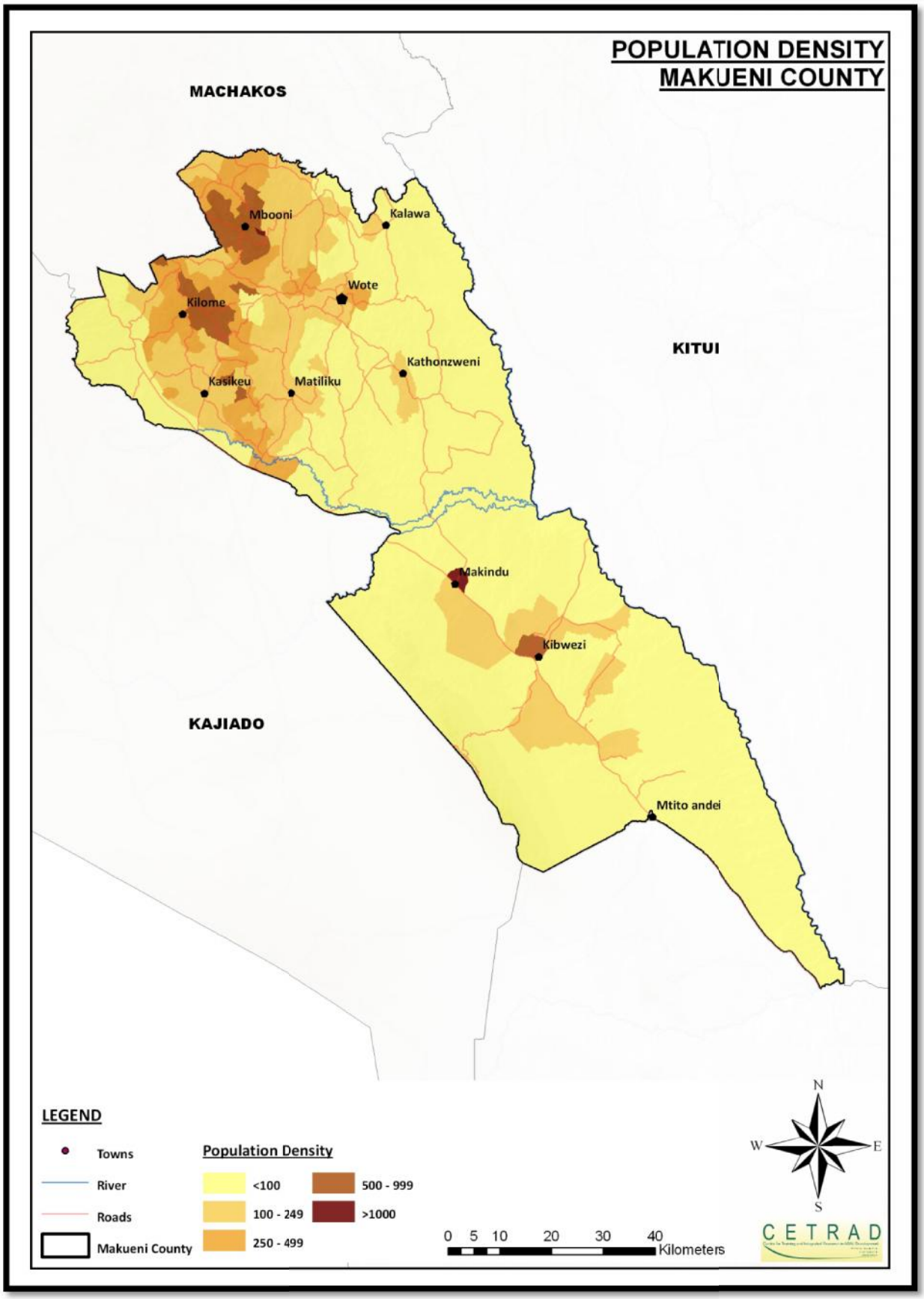
Figure 2: Population Pyramid for Makueni county 2009 census
(KNBS 2009)

3.6.2 Characteristics of study area

Kathonzweni Division is 195.1km2 in size and hosts a population of 22,732 people (KNBS 2009), and has 2986 households. The division has two locations and four sub locations. Mavindini Division is 157.5Km2 in size and host a population of 17856 and has 1785 households. The division has two locations and four sub locations. (See Table 2).

Division	Size in km^2	Population	No of households	Farm families	Locations	Sub-locations
Kathonzweni	195.1	22732	2986	2273	Kathonzweni	Ituka
						Thavu
					Kwa kavisi	Kwa kavisi
						Kavingoni
Mavindini	157.5	17856	2010	1785	Mavindini	Mavindini
						Katithi
					Muusini	Muusini
						Kiumoni

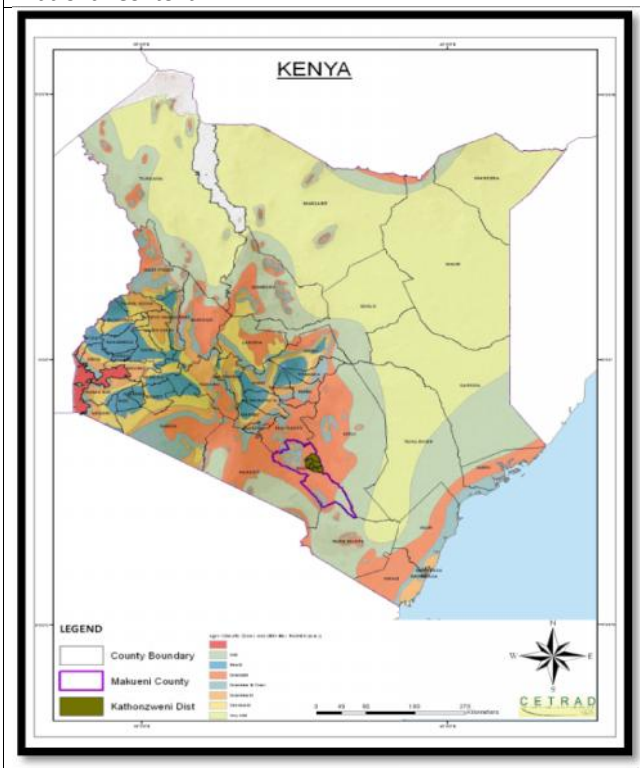
Table 2: Characteristics of Study area



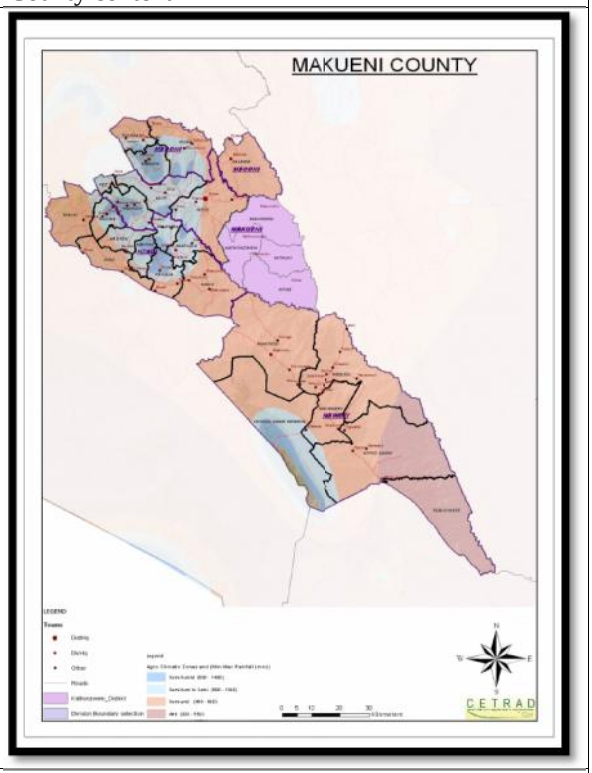
Map 5: Population density of Makueni County
(Source CETRAD)

3.7 Summary of study area

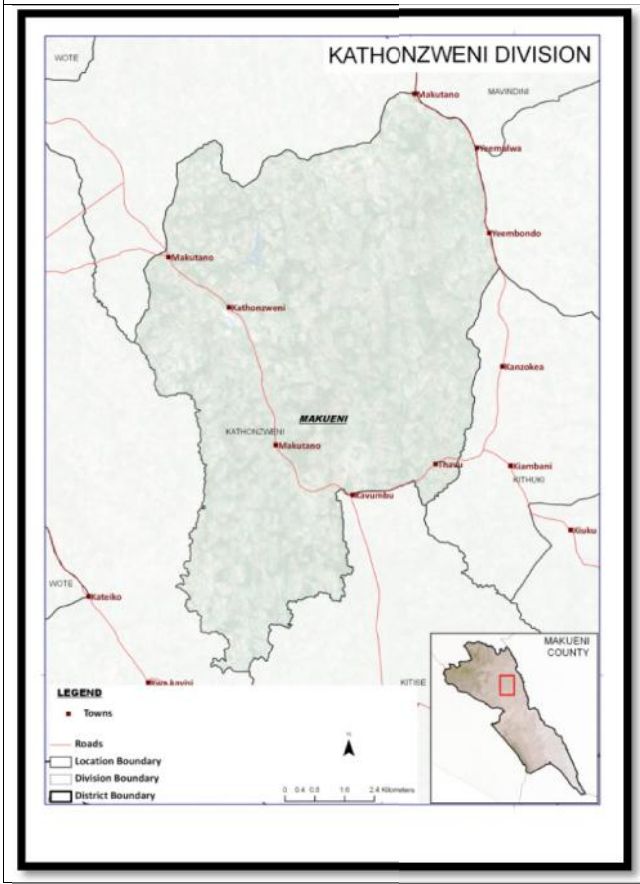
National context



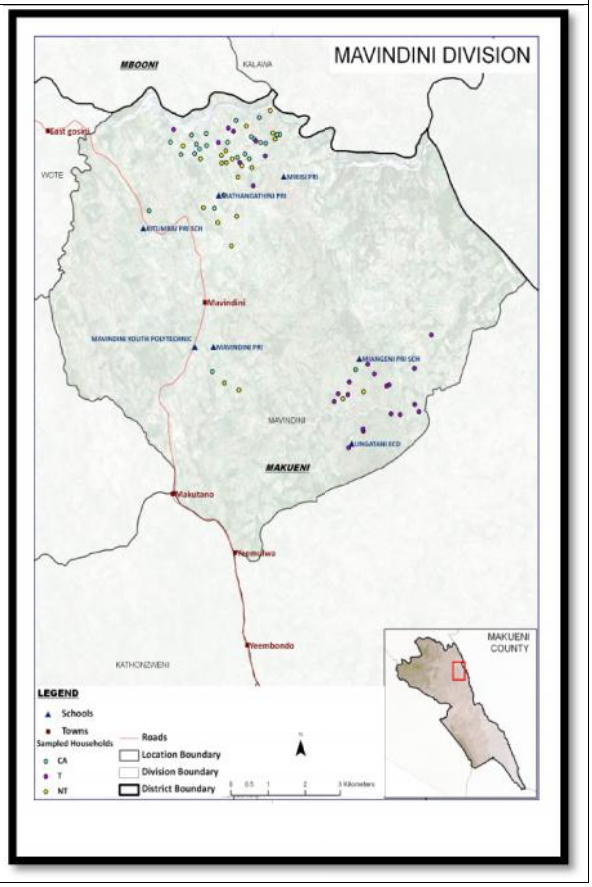
County context



Kathonzweni Division



Mavindini Division



Map 6: Summary of study area

4 RESEARCH METHODOLOGY

4.1 Research design

In order to understand and gain in-depth results on the subject under investigation, the researcher carried out a field survey in order to collect primary and secondary data on the field under study. To adequately respond to the research questions, a survey was carried out using research approaches involving exploratory and descriptive research designs. Exploratory research was to provide open information on the subject matter of the research while descriptive research was to give a logical description of the different groups under investigation according to specified criteria.

The research design had two parts. The first part involved carrying out exploratory research and it constituted the theoretical foundation of this research. This informed the context of resilient livelihoods, household food insecurity/poverty, and the rationale for intervention, in Kenya's dry-land in particular. The outcome of the theoretical review was the formulation of the research objectives, and hypothesis.

The second part involved sampling and collection of relevant primary data. Farmers practicing conservation agriculture within the twelve groups covered by the project were identified. Farmers covered by the project and had received training on CA were grouped into two categories of those that are practicing $CA^{(1)}$ and those that are not practicing $CA^{(2)}$. In addition, another category of farmers that were not trained and not practicing $^{(3)}$ were identified. Purposive samples of forty six farmers who had practiced CA for over three years were identified and formed category one. Category two was sampled from the list of trained farmers but not practicing CA. A systematic random sample was carried out to come up with this category. A purposive sample of another forty six farmers was taken by picking immediate neighbor to the CA farmer to represent the third category. Categories were: Trained CA practicing farmers (CA); Trained, Non practicing farmers (NT); and Not trained, not practicing (TT).

4.2 Research population

The research population consisted of all farmers in the study area. The study however focused on conservation agriculture practising farmers and those that are not practising.

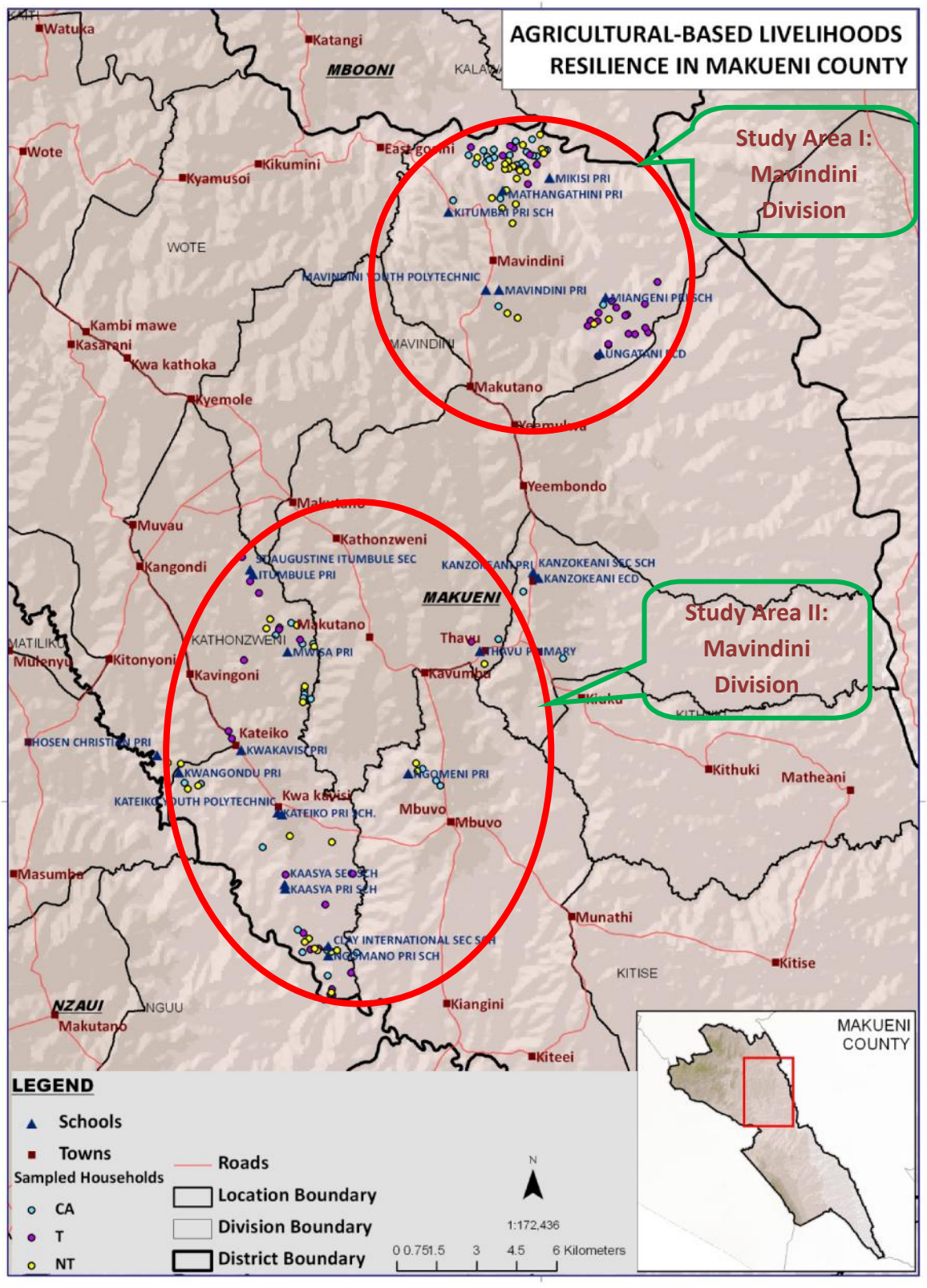
4.3 Sampling frame and size

4.3.1 Sampling frame

The sampling frame was a list of all farmers trained and has practised CA in the past three years in the two divisions and a separate list of 475 farmers trained on CA but not practicing CA. The third group of the untrained and not practising was picked from neighbours of trained and practising farmers.

4.3.2 Sample size and sampling

As recommended by Mugenda and Mugenda (1999) that a sample should be 30 or more, for statistical analysis, the research used a sample of 138 farmers derived from the three categories as follows: A census of CA farmers was carried out to identify those that have practised for over three years. A total of forty six farmers identified were purposively selected to represent this category of CA farmers; forty six farmers selected through systematic random sample from conservation agriculture trained farmers but not practising CA where every 10^{th} name in the list were picked to represent this category. The third category of forty six non trained and not practising farmers randomly selected from immediate neighbourhood of the CA farmers. This is to give room for the resilient landscape study scheduled in the same area. Map 6 shows the two divisions where sample was collected indicating the 46 CA farmers, 46 trained but not practicing farmers and the 46 non trained and not practicing.



Map 8: Study area

Purposive sampling was applied to identify key stakeholders who have information related to the study topic such as the relevant government representatives, local actors and opinion

leaders. For this study, the stakeholders interviewed were the Agricultural Extension Officer and the Ukambani Christian Community Services (UCCS).

4.4 Data collection methods and analysis

Three methods were used to collect data. They included interviews, observations and document examination.

4.4.1 Interviews

Interviews were conducted for household heads or spouses, key informants and purposively selected individuals with information on the study topic.

4.4.1.1 Household questionnaire

A detailed questionnaire capturing all the variables was developed and tested prior to data collection to minimize errors in administering questions as well as omitting any ambiguity of questions. Household questionnaire was administered to household heads or their spouses. (See map 7 and appendices 8.1.1)

4.4.1.2 Key informant questionnaire

Key informant questionnaire (See appendices 8.1.2) was administered to the key stakeholders who were perceived to have information related to the study topic (Agricultural Extension Officer and Ukambani Christian Community Services staff).

4.4.1.3 Focus group discussion

The group leadership of groups in the three categories formed the focus groups. Two focus group discussions per category were carried out making a total of six focus groups. The groups were subjected to similar questions. Groups were made up of six to twelve persons and interviews were conducted separately. The goal of this exercise was to ensure greater involvement by locals, particularly within the three categories under study. Greater focus on participants' knowledge of the region and skills acquired over a long period of time that have enabled them acquire and keep sustainable livelihoods was emphasised. To obtain in-depth understanding of the inclusion of cross-cutting issues e.g. gender dimension into agricultural production, women, and men groups were engaged separately in the participatory exercise if

and when necessary to separate albeit in view and appreciation of the cultural backgrounds from the study areas.

4.4.1.4 Implementing the survey tools

During data collection the services of eight field enumerators were engaged. These were recruited from among the community members from the respective study sites but with a degree as minimum qualification. This ensured enhanced community participation in data production by engaging their own. In addition, the enumerators (understood and spoke the local language/dialect fluently) were instrumental to helping interpret the questions in the local language. The enumerators were trained prior to data collection in order to understand and internalize the questions. Where necessary, the questions were translated to Kamba language during training to ensure that enumerators fully understood questions in order to ease the administration of questions, as well as avoid any ambiguity in translation during household data surveys. The whole team formed also undertook a pilot survey/pre-test and later re-trained using the pilot questionnaires to ensure all variables are acquired appropriately.

4.4.2 Observation and photography

An observation checklist was used to record types of settlement and human activities within households and the region while a photo checklist was used to generate photos of physical structures, ecological and economic features to show the existing situation in the study area.

4.4.3 Data analysis

A custom made MS Excel database with inbuilt range and consistency checks was designed to eliminate data entry errors. Identification numbers for survey respondents were used to ensure anonymity of survey participants. All data from the household survey was edited, coded, entered into the database and transferred to SPSS (Version 20) for data cleaning and analysis. The analysis was conducted using descriptive statistical methods where continuous data was summarized using appropriate measures of central tendency and dispersion. The data collected was analyzed using Statistical Package for Social Sciences (SPSS) and the results are presented using frequency tables, percentages and histograms. To understand institutional network, UCINET software was used to develop the network matrix to depict relationship of institutions with community and the activities they are involved in.

5 STUDY FINDINGS

5.1 Introduction

This chapter elaborates on the results from the household survey, key informants and focus group discussions. The first part captures how farmers/households perform using various indicators of livelihood resilience. The second part captures approaches and practices that are perceived to assist farmers to build livelihood resilience from the farmers' and key informants' point of view and the last part focuses on the factors that affect famers' capacity to maintain livelihood resilience..

5.2 Indicators of agriculture based resilient livelihood

The first objective of this study was to identify and examine indicators of agriculture based resilient livelihood. Key indicators of agriculture based resilient households were analysed using data from agricultural households. These indicators are divided in three different categories that include buffer capacities of the household, self organisation and the capacity to learn. Under buffer capacity a number of indicators were identified and examined. They include household food access, financial security, household assets and human capital as discussed below.

i. Household food access shows the food security status of a specific household. A household with no or low food access is food insecure. This means that the livelihoods that support the particular household are not resilient. Under food access are household food production, other food sources and coping strategy by households to ensure availability of food throughout the year. Crop diversity for own production also has a role to play in food security. A food secure household should have a nutritious diet which the household production should provide. Therefore a household with diverse crop farming as opposed to household with mono production will have higher security in ensuring that the household has access to food not only in right quantities but also in quality.

ii. Another indicator is financial security of the household. From the sources, amount and diversity of incomes available to the household indicate how resilient households are to drought. A household with diversified and reliable sources of income is less vulnerable to climate variation. Sources of income are affected differently by drought risk. An example is a household depending entirely on farm income as its source of income. During time of

drought such household will not be food secure rather will end up depending on relief for survival. Therefore, diversity in sources of income indicates how well a household copes with drought.

iii. Entitlements such as assets are also an indicator of resilience. Households in the study area hold and keep various assets that assist them during drought. Assets are in form of household goods, livestock and trees which farmers acquire for their security. Assets such as livestock are kept by farmers for income and food and at the same time can be disposed/sold off during drought to supplement household food access by using earnings to buy food (see figure 14). Also household goods such as phones, television sets among others are sold during drought (see figure 13). At the same time trees grown by farmers are sold during drought time to raise funds that are used for food. Therefore the amount of assets a household holds indicates how well prepared a household is to climate variation. A household with no or low asset base is less resilient since their coping strategies are narrow.

iv. Human capital is another indicator of resilience. This refers to individual capacity, training, skills and knowledge. Emery and Flora (2006) also include health status and leadership capabilities. Importantly, human capital is utilized by households to develop and access resources for the welfare of the household or the community (Chaskin et al., 2001; C. Flora & Fora, 2004; Harris et al., 2000). Human capital also plays an important role in enabling the household to increase its efficiency of financial and built capital.

5.2.1 Examination of indicators of resilient livelihood

5.2.1.1 Food access

A household with resilient livelihood should be food secure meaning that it should have access to food needed for a healthy life for all its members (adequate in terms of quantity, quality and culturally accepted) and it's not at undue risk of losing such access. Therefore food access is a dimension of food security which encompasses income, expenditure and buying capacity of the household. Resilience to food insecurity (Alinovi et al., 2008), that is the ability of the household to maintain a certain level of well-being such being food secure, withstanding shocks and stresses, depending on the options available to the household to make a living and its ability to handle risks. Most important mission of every household in the study area during emergency situation such as drought is to secure food supply for survival.

Farming being the main income source for the households in the study area, substantially contributes in the incomes of the households and plays a role as an indicator of resilient households that are food secure. A higher crop yield means more food secure and resilient households as opposed to low crop yield households. Plate 1 below shows comparison of crops in the field from the CA farmers' field and the non CA farmers during the time of data collection. From these photos it's very clear that CA farmers received a good harvest during this season compared to their non CA counterparts whose crops looked unhealthy and fully covered by weed. Note that these farmers are neighbours. The left side is the CA farmers while the right side depicts non CA farms.

Conservation agriculture (march _august season)	Traditional farming (march _august season)
	
CA farmer in his maize field	Conventional farmer in his maize farm
	
CA farmer in his amaranthus farm	Conventional maize farm covered with weeds
	
CA farmer in his pigeon peas farm	Withering maize conventional

Plate 1: Crops of CA and Non CA farms in Makueni

5.2.1.1.1 Household food production

Households in the study area grow food for their consumption and at the same time generate income from the produce. A number of crops grown are: maize, cow peas, pigeon peas, Dolichos, beans, green grams and fruit trees. According to the county agricultural officer, the county produces the highest pigeon peas in the country. It also has a high number of livestock. The county has an elaborate livestock market that sees traders from far counties visiting the area on weekly bases for livestock and farm produce. Below is a summary of the two main crops for the year 2009 to 2012.

a) Maize

Farmers' maize production shows a steady increase from the drought year of 2009 to 2012. Maize yield decreased in 2010 with (9.1%), then increased with 7.4% in 2011 then shot up by 112% in 2012 for CA farmers. The drop in 2010 can be explained by the prolonged dry spell in the last quarter of 2009 and the first two months of 2010. Table 3, Figure 3 and 4 indicate that CA farmers produced an average of 303 kgs of maize grain per acre in 2009, 276 kgs in 2010, 326 kgs in 2011 and 642 kgs in 2012 while during the same period 2009 to 2012, TT farmers managed to produce only 114, 110, 108, 274 kgs and NT farmers 125, 94,129, 349 kgs respectively.

Category of Farmers/year	2009	2010	2011	2012
Conservation Agriculture	303	276	326	642
Trained farmer not practicing	114	110	108	274
Not Trained Farmer	125	94	129	343

Table 3: Average household maize yield per household/acre

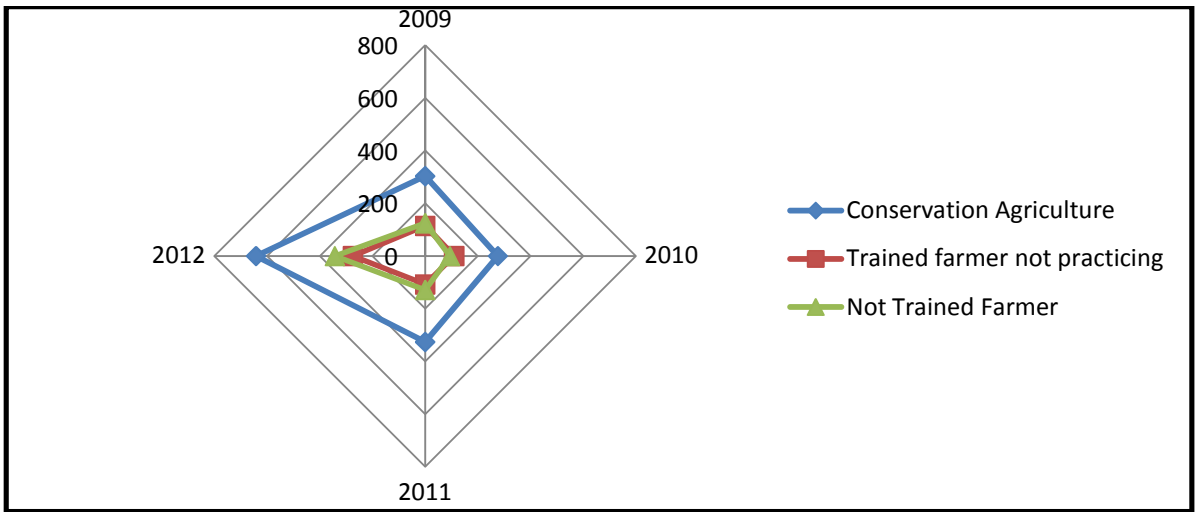


Figure 3: Radar chart on average household maize yield/acre

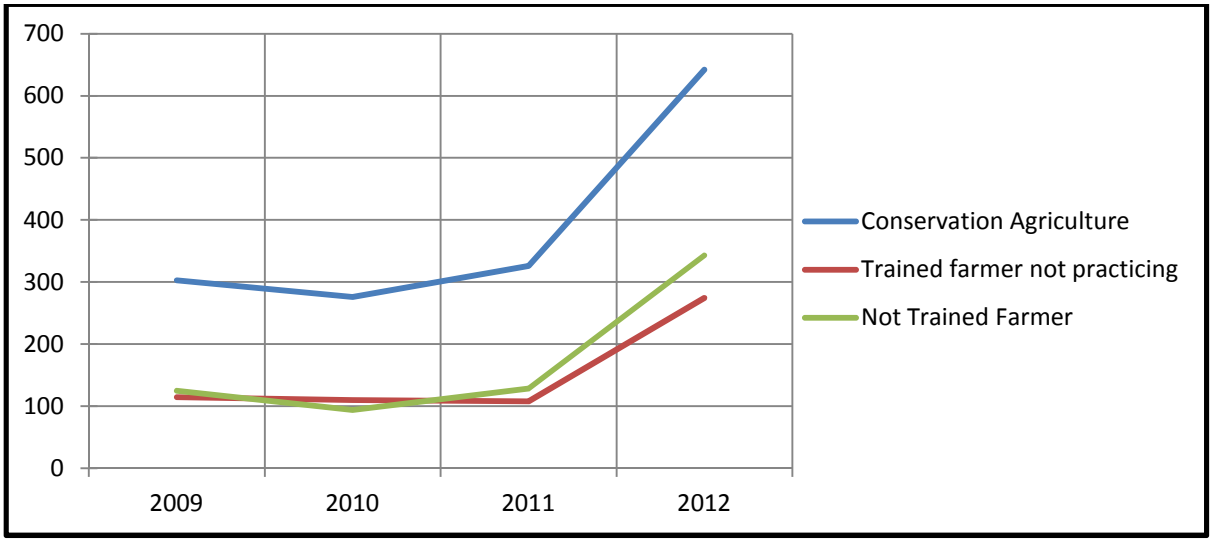


Figure 4: Average household maize yield/acre per household

Figure 10 above showing maize production trend from 2009 to 2012 in the entire category under study. Reduction in production was basically due to drought in the last half of 2009 thus affecting the January 2010 harvest by the farmers. CA production increased sharply and more than doubled from the year 2011 to 2012.

b) Hypothesis test on yield

A t-test was carried out in order to determine if there is a significant difference between CA farmers maize produce per acre during the four year period (2009 to 2012) with the other two categories.

H_0: Farmers practicing Conservation Agriculture (CA) technology produces less or equal maize per acre compared to those who are not practising the technology.

H_1: Farmers practising Conservation Agriculture (CA) technology produce more than those who are not practising the technology.

The following formular was used

$$t = \frac{M1 - M2}{\sqrt{\frac{Var1}{n} + \frac{Var2}{n}}}$$

Where:

t = t value

M1 = Mean kgs of maize of CA farmers = 386.75

M2 = Mean income of TT = 151.67

Var1 = SD^2_1 = 29374.25

Var2 = SD^2_2 = 6707.41

a) **CA vs. TT Farmers**

t = 2.475: α=0.05, critical value = 2.1318

t calculated> critical value= 2.475> 2.1318

b) **CA vs. NT Farmers**

t= 2.0772

α=0.05, critical value = 2.01504

t calculated > critical value= 2.0772 > 2.01504

Conclusion

From the calculation, the t-value for both categories is higher than the critical value (t value > CV). The null hypothesis was rejected and the alternate hypothesis accepted. Therefore, CA farmers produce more than non CA farmers. At 95% confidence level, the yields of CA farmers are significantly higher than the yield of those that don't practice CA. This depicts need to promote CA technology to ensure farmers increase the amount of acreage under the technology. It also suggests that the CA technology can contribute positively to increasing agriculture based livelihood resilience.

a) Green grams

The same trend was displayed with the green-gram crop where produce slightly reduced in 2010 and increased to higher levels in 2011 and 2012 (see Table 4 and Figure 5). CA farmers still led in green grams production of 177 kgs in 2009 and improved to 366 kgs in 2012 compared to TT from 132 kgs to 246 kgs in 2012 and NT from 114 kgs to 280 Kgs in 2012.

Category of farmers/year	2009	2010	2011	2012
Conservation Agriculture	295	265	318	610
Trained Farmer not practicing	147	119	168	273
Not rained Farmer	127	154	154	311

Table 4: Average greengrams yields/acre/household

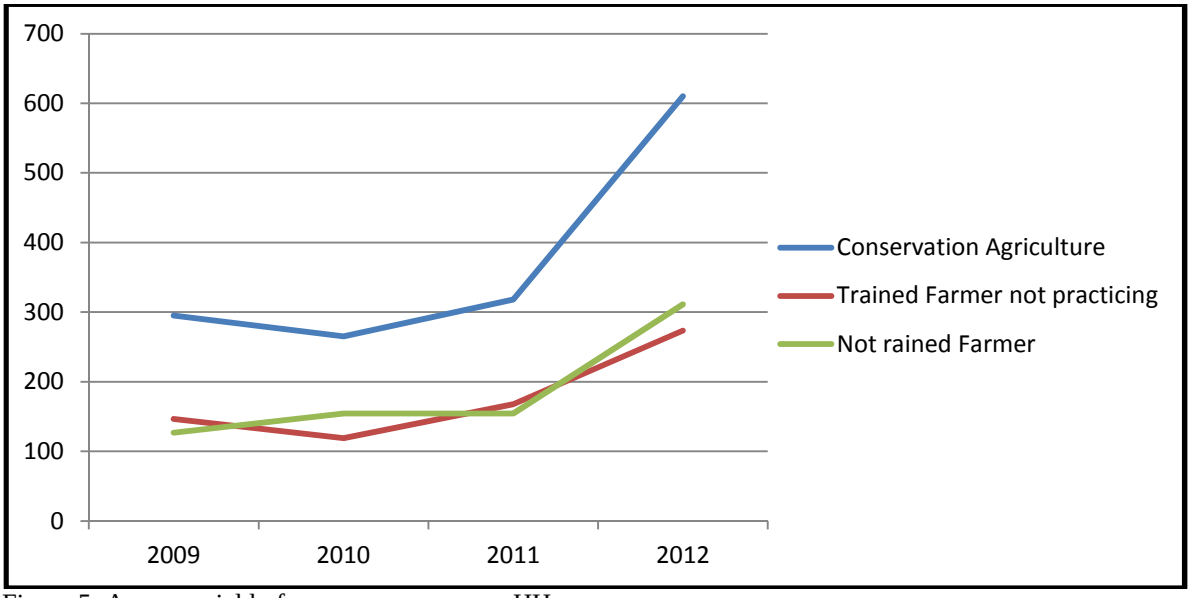


Figure 5: Average yield of green-gram per acre HH


Plate 2: Green grams and black beans (Dolíchos) on a CA farm

5.2.1.1.2 Coping strategies during drought

Farmers in the study area grow diverse crops that are used to ensure each household has nutritious meals. Commonly grown food crops are maize, beans, dolichos, green-grams, pigeon peas and sorghum. Farmers' crop harvests are used for the household food consumption as well as to generate income for the households. The main source of food for all respondents in the three categories is locally produced food. Households sell the surplus at the local markets. Another source of food is buying from the local markets (See Table 5). The main expenditure is on maize and vegetables for household consumption.

Category of farmer	Food expenditure/ household/ month (Ksh)	
	2012	Year after drought (2010)
CA	4,842	10,865
TT	5,143	9,240
NT	4,504	6,452

Table 5: Food expenditure/household/month

During time of food deficiency, farmers not only obtain food from their other income sources ranging from casual jobs, businesses, remittances, pensions, but also acquire through relief food from the government and poverty relief allowances. Information from the focus groups discussions show that a number of institutions provide relief food to communities in the region to enable households to feed themselves during these famine times. Figure 6 shows the number of farm households depending on relief food and poverty relief during drought periods. TT farmers and NT farmers have the highest number of households benefiting from the poverty relief. Relief is distributed once every month during non drought years compared to once per week during the drought years such as the 2010, 2011 seasons.

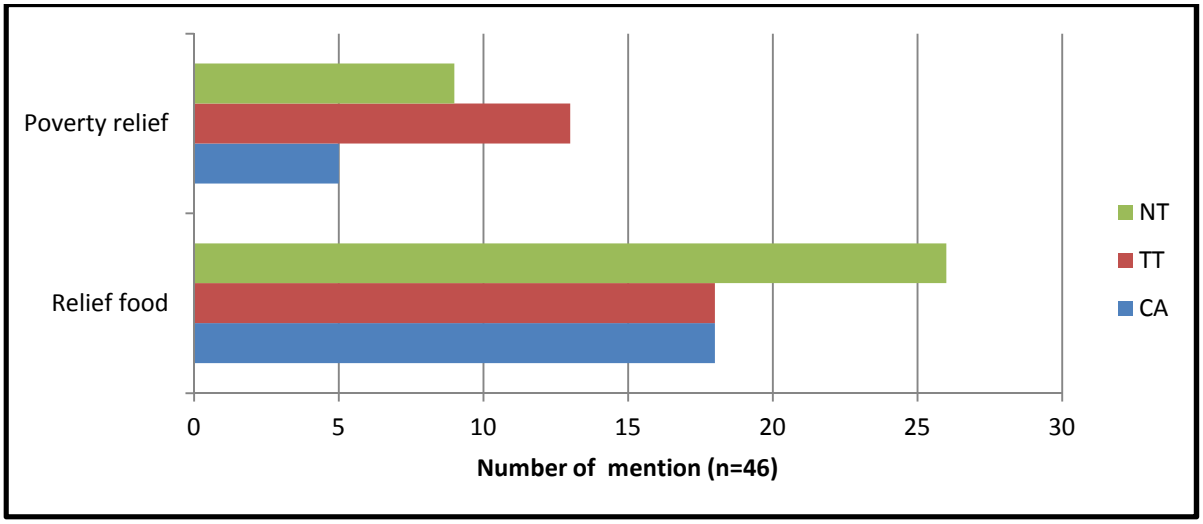


Figure 6: Sources of food during drought

5.2.1.2 Financial security

Financial capital refers to the financial resources available to invest in community capacity-building, to underwrite the development of businesses, to support civic and social entrepreneurship, and to accumulate wealth for future community development (Lorenz, 1999). Households with higher financial resources are more food secure than households with low financial resources. The main expenditures for households were reported as food purchases, education, medical and clothing (See table 5). Thus financial capability of the respondent plays a major role in the achievement of food security with those with higher

incomes having higher purchasing capability as opposed to those with lower income. Various indicators of financial security are discussed below.

5.2.1.2.1 Income sources

The main source of income for the target population was farm related incomes with 100% of the respondents depending on agriculture as their main source. Fourteen sources of income were identified with farming taking a centre role as the main source of income for the households. The major off-farm income sources were reported as; remittances [R] (48% of the population), businesses [B] (46%) and casual labour [CL] (50%). (See Table 6 and Figure 7).

Category	F	CL	R	B	SE	FT	P	WS	VS	OT	GA	BB	RE	WM
CA	100	48	50	48	28	28	20	4	0	7	0	2	0	0
TT	91	46	48	46	20	13	2	4	2	0	0	2	2	4
NT	98	57	46	43	24	17	0	2	0	4	2	4	0	0
Average	96	50	48	46	24	20	7	4	1	4	1	3	1	1

Table 6: Sources of income

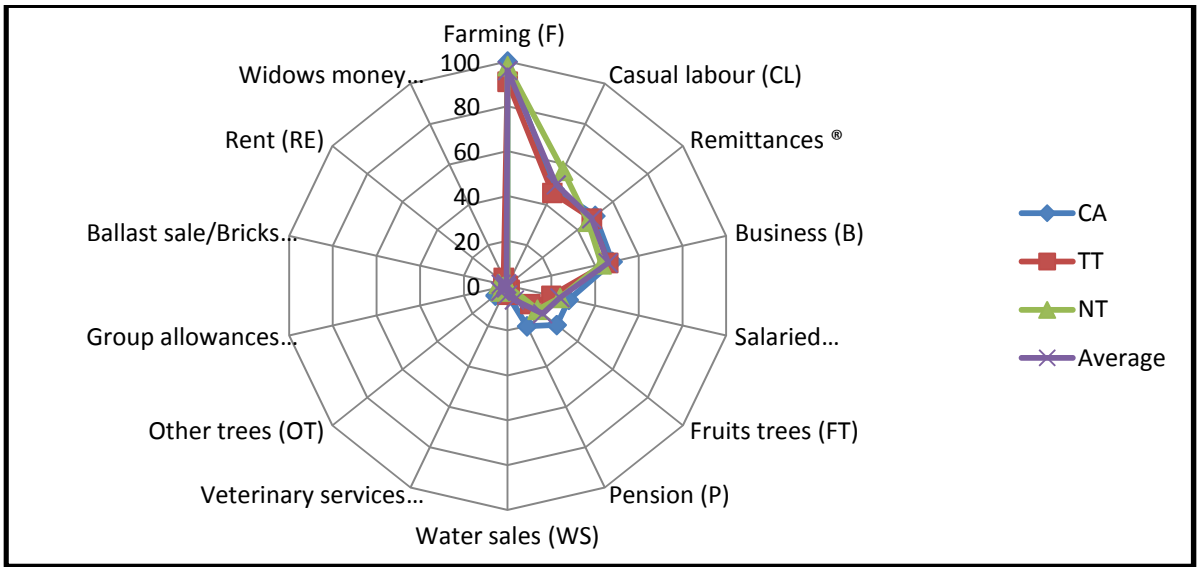


Figure 7: Radar chart on livelihood sources
(Author, 2013)

Figure 8 shows a steady increase in income from the year of 2009 (drought year), to 2012. On category basis, cross tabulation shows that CA farmers had their farm incomes increase from ksh 3,127 in 2009 to ksh 9,968 in 2012. he total average income per household for CA farmers stands at Ksh. 150,719 in 2011 and increased to Ksh. 171, 528 in 2012 per Household; This translates to 14, 294 per month/ household and 13.81% increase.

Farmer category	Ave Income 2011	Monthly ave/HH 2011	Ave Income 2012	Monthly ave/hh 2012
CA	150,719	12,560	171,528	14,294
TT	138,627	11,552	140,904	11,742
NT	98,775	8,231	133,901	11,158

Table 7: Average annual household income

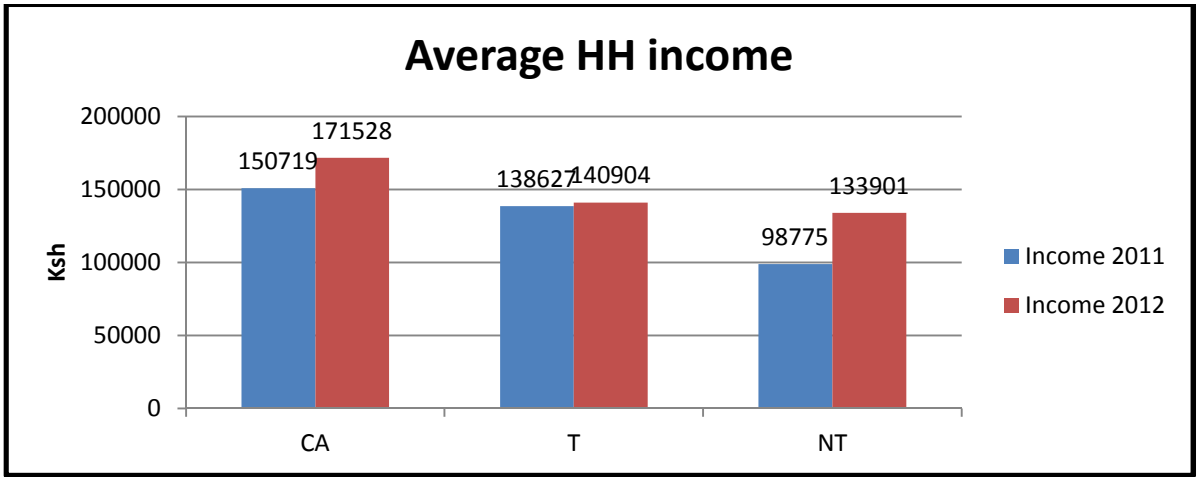


Figure 8: Average annual household income

5.2.1.2.2 Poverty line

Table 8 and Figure 9 (radar chart) below show the number of respondents in percentage of each category that their total incomes are below and above absolute poverty line of 1.25$ per day in 2011 and 2012. In 2011, 28% of CA farmers' incomes were below poverty line compared to 41% of TT and 35% of the NT farmers.

	2011	2011	2011	2012	2012	2012
	A=≤109/=dy	109≤C≥220/=/dy	D≥220/=/dy	A=≤109/=dy	109≤C≥220/=/dy	D≥220/=/dy
CA	***28***	***33***	***39***	***23***	***38***	***39***
TT	***41***	***26***	***33***	***37***	***28***	***35***
NT	***35***	***35***	***30***	***31***	***36***	***33***
Ave	***35***	***31***	***34***	***30***	***34***	***36***

Table 8: Respondents' income levels

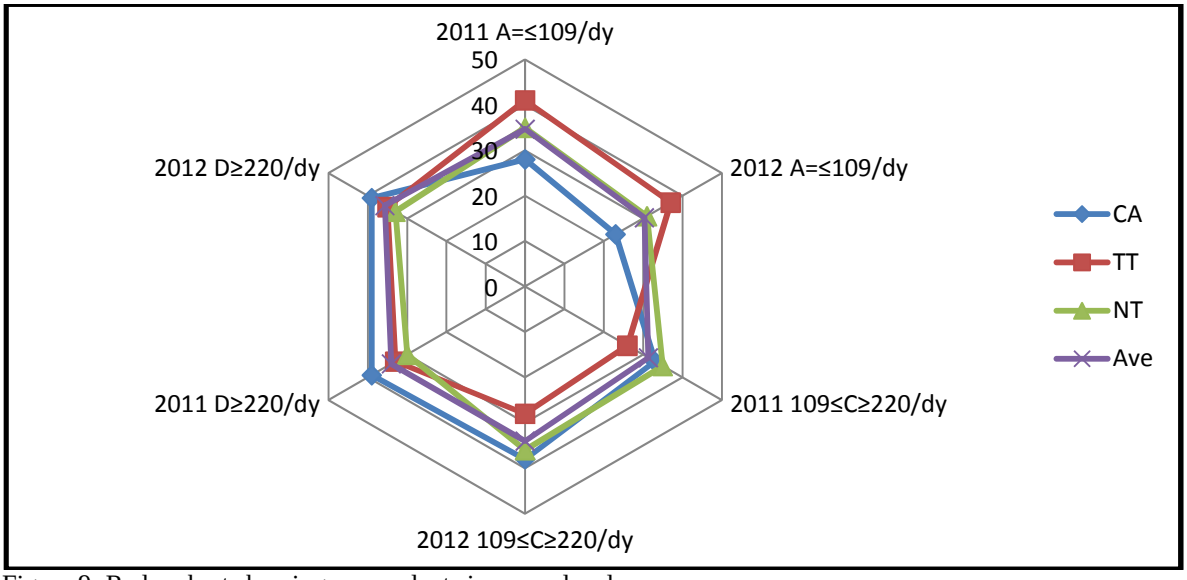


Figure 9: Radar chart showing respondents incomes level

5.2.1.2.3 Income reliability

Of the 96% of the respondents depending on farming as a source of livelihood, 33% had the source contributing less than 10% to the household total income. This means that farming is not very reliable for those households. Further, farming is a reliable source and contributes 10 -50% of total income to 47% of the households whereas 20% of households receive more than 50% of their income from farming. Other than farming, remittance is a key income source for households where 67% (25% very reliable & 42% reliable) receive remittances that contribute substantially to household income.

Source of income	Not very reliable<10	Reliable10 - 50%	Very reliable>50%
Farming	33	47	20
Casual labour	8	25	67
Remittances	33	42	25
Business	21	48	30
Salaried employment	3	29	68

Table 9: Income source reliability

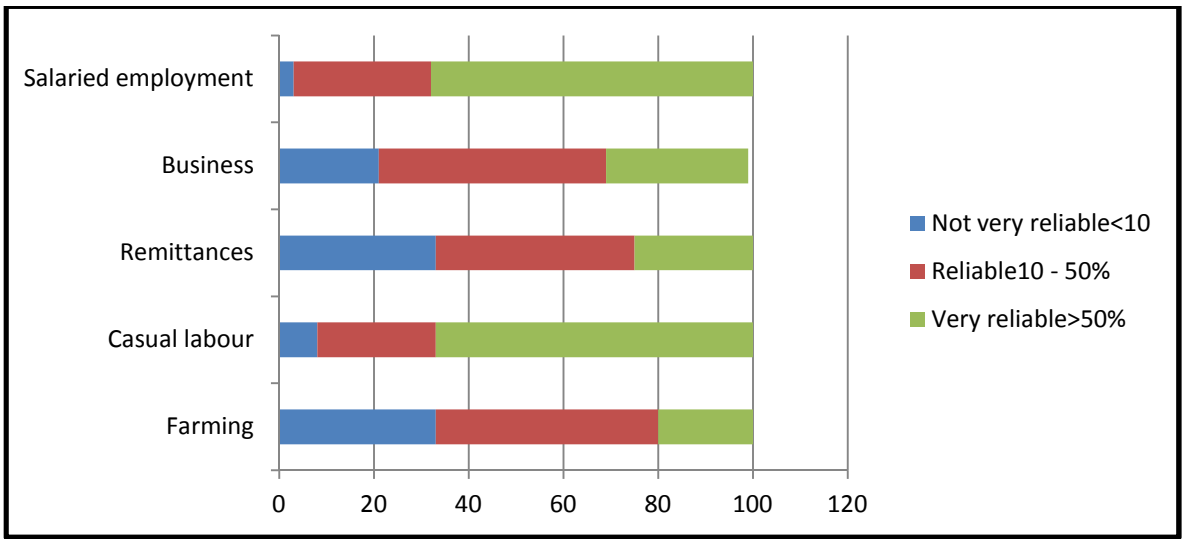


Figure 10: Incomes source reliability

5.2.1.2.4 Income sustainability

Another characteristic of income is its sustainability and its availability to households on regular basis. Farming being the main income source is only available to farmers after the end of every season. Other sources such as casual labour are also seasonal in nature. But the main income that has shown reliability is the remittances. Remittance is a source that is received by an average of 50% of all households and is received on monthly basis by 75% of those that get it. Remittance is an income exclusively coming from close family members working in distant towns from the rural areas. This income assists farmers in supplementing food for their own consumption by purchasing food.

5.2.1.3 Diversity

Diversity is another indicator that helps households to build resilience by ensuring security during drought. It plays an important role in building resilience as it extends multiple options for dealing with perturbations, reducing risks by spreading them. Diversity can be nurtured ecologically through high biodiversity, both economically through livelihood diversification and through the inclusion of diverse points of view in policymaking processes. Diversity spans around a number of variables such as agricultural diversity (species and variety of crops grown), diversity in agro-forestry, diversity in livelihood sources (income) and household enterprises.

5.2.1.3.1 Agricultural biodiversity

Biodiversity forms the nexus between the health of an ecosystem and that of a community. It includes species used for food, fodder, fiber, fuel, and the large number of non-harvested

species in the wider landscape directly used by or benefiting households and the communities through the services they provide such as pollinators, soil biota and regulators of pests and diseases. Agricultural biodiversity provides material for experimentation, innovation and adaptation. The genetic diversity found in local crop varieties and animal breeds, expressed in important traits such as drought tolerance as in the case of the study area, and resistance to pests and diseases, helps them adapt to various soil and climate conditions. The loss in diversity of these traits reduces options for risk management and adaptation. Local food systems and landscape diversification, on the other hand, encourages the maintenance of agricultural biodiversity and contributes to food security and self-sufficiency.

Crop diversity provides a typical landscape diversity that indicates the aesthetic value of a diverse agricultural landscape from a social point of view[2]. On the other hand, in the literature on risk management in agriculture, crop diversity has been attributed a private value as an option for risk-averse farmers to hedge against uncertainty (Di Falco and Perrings, 2005). On these grounds, the trade-off between market output (crop yield) and non-market ecological by-product (crop diversity) can be considered relevant for farmers' decision making. In this study concentration was on private value as an option to averse risks by farmers.

Twenty two different crops were grown in the study area but four crops took up 69% of the total crop area and are depended on by the households for food and income. Their order of importance was green grams at 20%, cowpeas at 18%, maize at 18% and pigeon peas at 13%. Other than maize, all the others are drought escaping crops that the community and the Ministry officers believe play a big role in ensuring farmers are resilient to poor weather conditions. All the respondents grow diverse crop varieties averaging four different crops per household. The main reason given for the mix of crops was spread of risk due to unfavorable weather conditions. Unreliable rainfall was the most frequent reason given by 58% (See Figure 11) of the respondents. Most farmers were aware that mixing of different crops - though a tradition in the region, enables them to spread risk and increase chances of getting a harvest even during the dry spell. This is because rainfall in the region is unpredictable.

[1] Landscape will be dealt with in the larger project but this study will focus on diversity in sense of risk management in crops

Growing a mix of drought escaping crops plus other hybrid crops enables farmers to gain in-case of low rainfall or high rainfall.

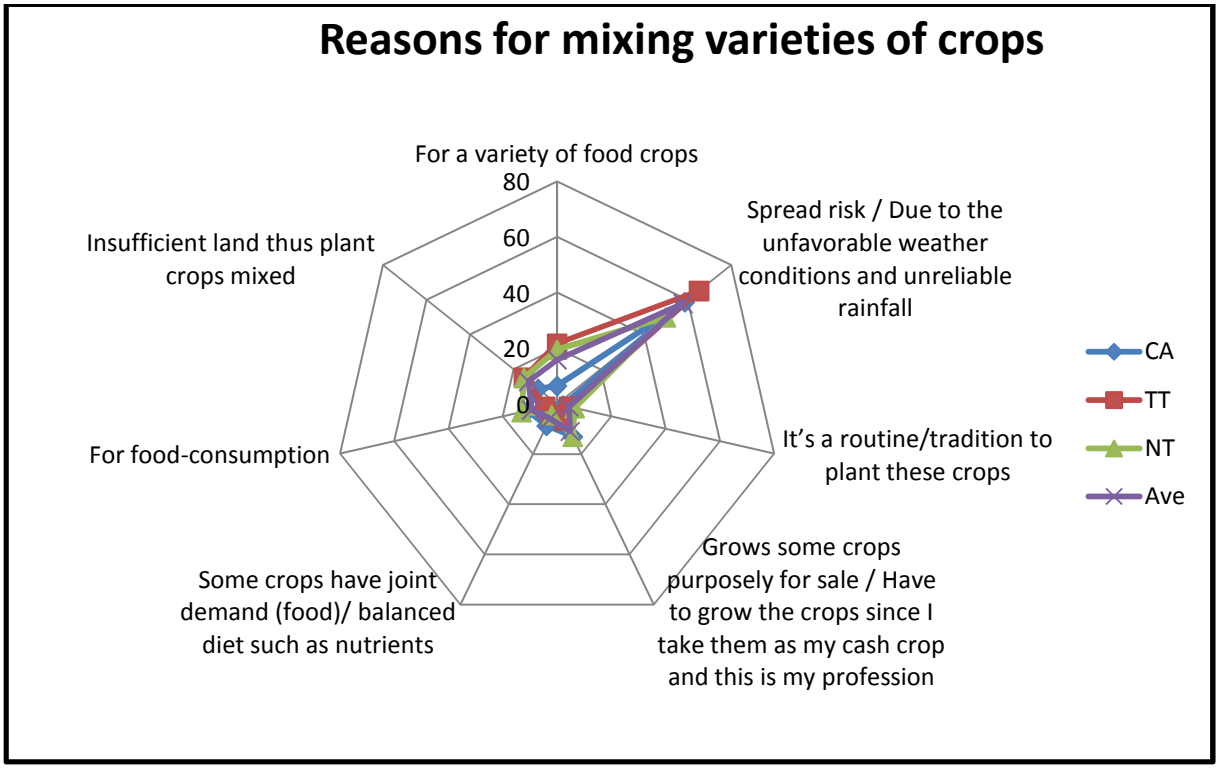


Figure 11: Radar chart showing the main reason for mixing crops

5.2.1.3.2 Income diversity

Fourteen sources of income were identified with household average of four income sources. As in the past where farming formed the main source of income in the rural areas, non-agricultural activities provide a significant source of income to farm households in the study area. Other than farming, other sources that indicated reliability are from business, remittances, casual labour, salaried employment and from agro-forestry such as fruit trees (Figure 12). Though this study did not look at the changes in income shares over the years, the high number of diverse income sources is a reflection of the rapidly changing structure of the rural economy in the study area. In 2011, farming only contributed 31% to the total CA household income, 20 % to the TT households and only 19.4% to the NT households while in 2012, farming contributed 32.4% to CA income, 25.4 to TT and finally only 26.9% to NT households. Dependence on a single source exposes households to risks during drought. thus need to promote diversity in income sources to cushion farmers during climatic variation.

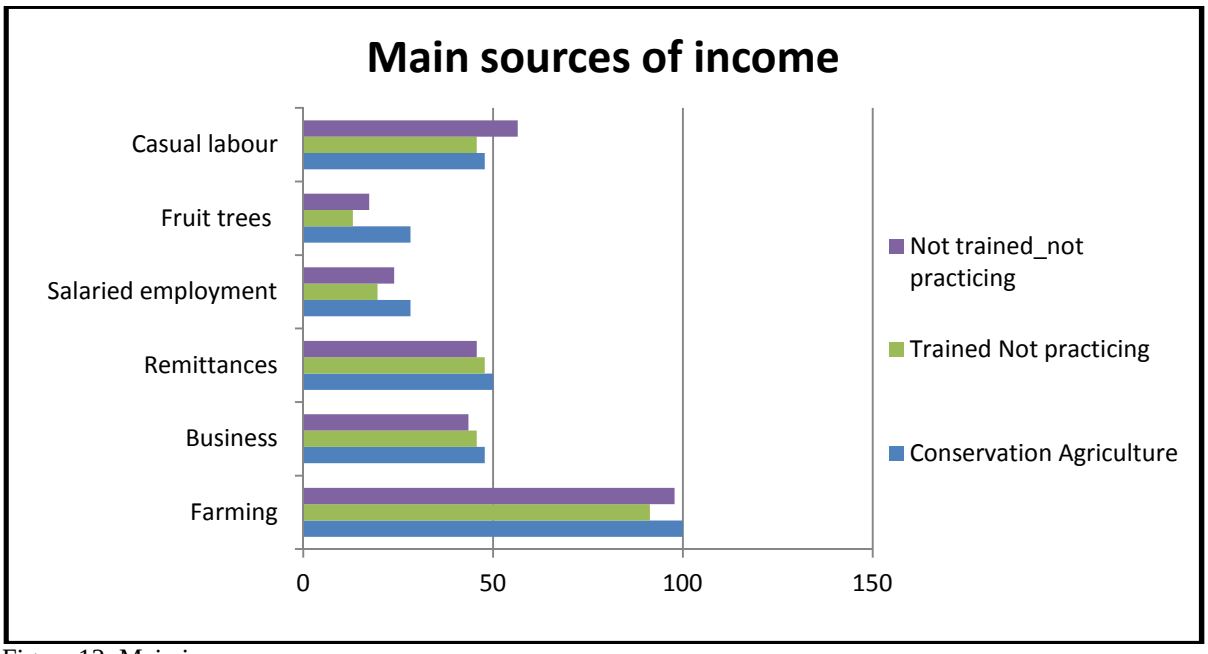


Figure 12: Main income sources

5.2.1.4 Entitlement

These are sets of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces (sen, 1984: 497).

5.2.1.4.1 Physical household assets

According to Dercon 2006, households and individuals have assets such as labour, human capital, physical capital, commons and public goods at their disposal to make a living. These assets are used to generate income in various forms, including earnings and return to assets, sale of assets, transfer and remittances. Households actively build up assets as an alternative to spending. Therefore assets are part of a household's capital and their availability is an important coping mechanism during periods of hardship.

The major household assets owned by the farmers were mobile phones, ploughs, bicycles, wheelbarrows and jembes among others. Figure 13 shows that in the last four years, only 4% of the respondent households had disposed off their assets with 29% to raise money for school fees, 29% to purchase food and 14% for other family needs.

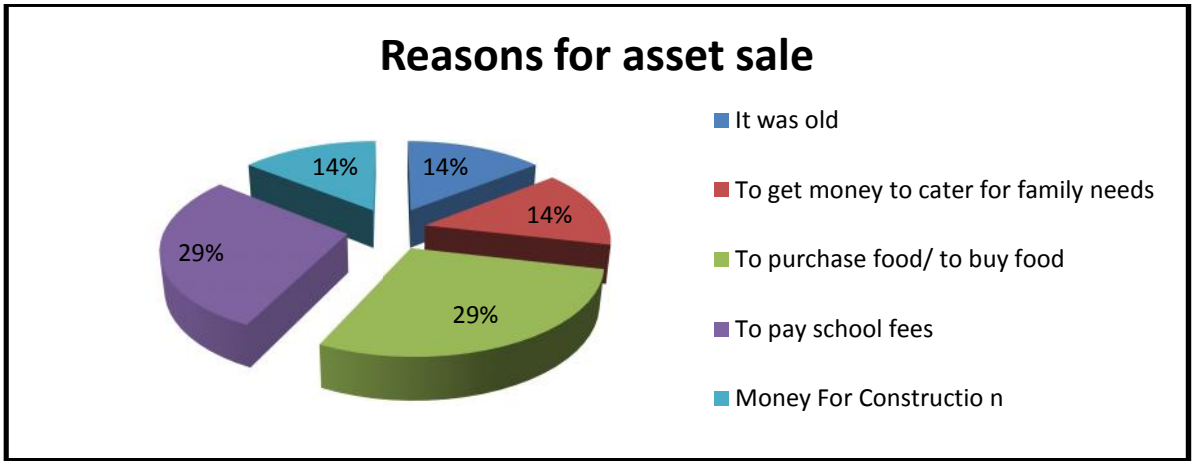


Figure 13: Reason for selling assets

5.2.1.4.2 Natural household assets

a) Livestock

Other assets that help during drought periods are the various livestock kept and can be disposed to generate income for households. In the study area a number of livestock are kept: They include cows (dairy and beef), shoats, poultry and bees (see table 10 and figure 14). Livestock unit are calculated using (*TLU = 1 milk cow; distributed as follows for others: 0.7 for other cattle, 0.5 for heifers, 0.25 for calves, 0.52 for donkeys, 0.15 for dairy goats, 0.1 for goats and sheep, 0.02 for other small stock like poultry-chicken).*

Category of farmer	2009	2010	2011	2012
CA	4.385	4.032	4.563	5.214
TT	3.745	3.213	4.145	4.645
NT	2.674	2.142	2.578	3.754

Table 10: Average livestock units per household

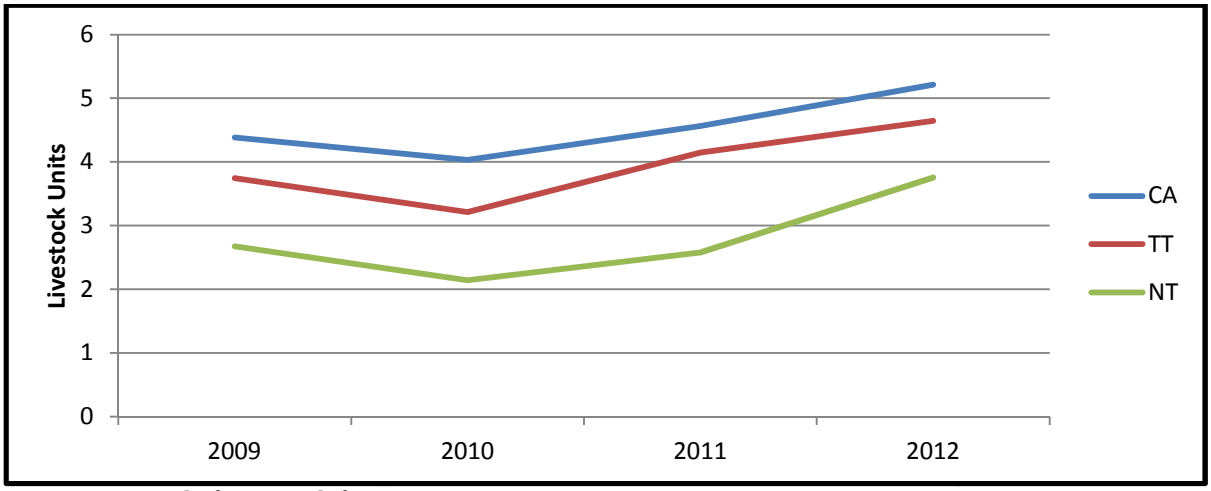


Figure 14: Trend of Livestock from 2009 to 2012

Table 9 and figure 14 shows the trend of livestock from 2009 to 2012. Number of livestock decreased in 2010 after the drought year and increased in 2011 and 2012. The decrease is attributed to disposal of animals to generate income for the household after the drought. The main reason given by the farmers for selling of animals was in order to generate fund to cater for production deficit by buying food as well as pay household bills which include school fees, medical costs among others.

b) Trees

Another asset that was identified to have a benefit in ensuring farmers capability in coping with drought was the high presence of trees within the farms. Most of them were fruit trees such as mangoes and citrus for income generation which occurs mainly in the month of January and February. Others are either hard wood that farmers can either sell during the dry periods or produce charcoal from wood to generate fuel as well as income. A total of 91 different tree species in the three categories were found on the farms. These trees are either naturally growing or artificially planted by the farmers for various economic and ecological benefits. The most common trees were the mango, pawpaw as summarized in Table 11.

Common Name/Local name	Botanical name/Latin name	Category	% HH with 0 trees	% HH with 1-40 trees	% HH with >40 trees
Mango	*Mangifera indica*	**CA**	22	61	17
		TT	37	54	9
		NT	37	61	2
Pawpaw	*Carica Papaya*	**CA**	39	61	0
		TT	33	65	2
		NT	39	57	4
Mukengeta	*Senna spectabilis*	**CA**	57	41	2
		TT	52	48	0
		NT	48	50	2
Umbrella thorn acacia	*Acacia tortilis*	**CA**	48	35	17
		TT	43	37	20
		NT	43	41	15
Mukau tree	*Melia volkensii*	**CA**	61	35	4
		TT	63	35	2
		NT	67	33	0
Neem tree	*Azadirachta indica*	**CA**	67	33	0
		TT	65	35	0
		NT	83	17	0

Table 11: Common trees grown by households

The study found that 78% of the CA households grow mangoes with an average of 21 trees per household compared to 63% of TT only with an average of 11 trees and 63% of NT with an average of 10 trees. Although households have trees in their compound, the agro-forestry coverage in the area still remain low and ranges from 0.1 for NT farmers to 2.3% for CA farmers.

A correlation of number of trees grown by the household income shows a -0.00593 showing a weak relationship. This implies that the number of trees a household has does not necessarily mean a higher income for that particular household. At the same time, a correlation between education level to the number of trees grown by households show a + 0.0348 correlation. This is a clear indication that education plays a role in a household decision making.

5.2.1.5 Human capital

Human capital is another indicator of resilience since it is utilized by households in the production process. A household with higher number of productive persons has shown to be more secure in terms of production as well as the total household earnings. All categories had an average household size of 7 with 5 to 6 productive members in every household most of who reside within the household compound (See Table 12).

	Average HH size	Average number HH members below 18years	Average productive HH members	Average members permanently on the plot
CA	7	2	5	5
TT	7	2	6	4
NT	7	2	5	5

Table 12: Household characteristic

At the same time, human resource available to the household has been found to show diverse productivity depending on the education level. Table 13 and figure 15 show that the average farm income per household increases with the level of education. A correlation between education level and average household income shows a strong correlation of +0.4325 showing a positive relationship between education level and incomes from farming. This is a clear indication that those with higher education level are more able to obtain and utilize information to increase productivity. This makes their households more resilient.

Education level	Income from farming drought year
University	4,800.00
College graduate	134,814.50
Completed Secondary	63,810.50
Not completed secondary	27,258.00
Completed primary	16,415.60
Not completed primary	21,301.70
Adult education	19,325.00
No education background	7,885.00

Table 13: Education level vs average farm income

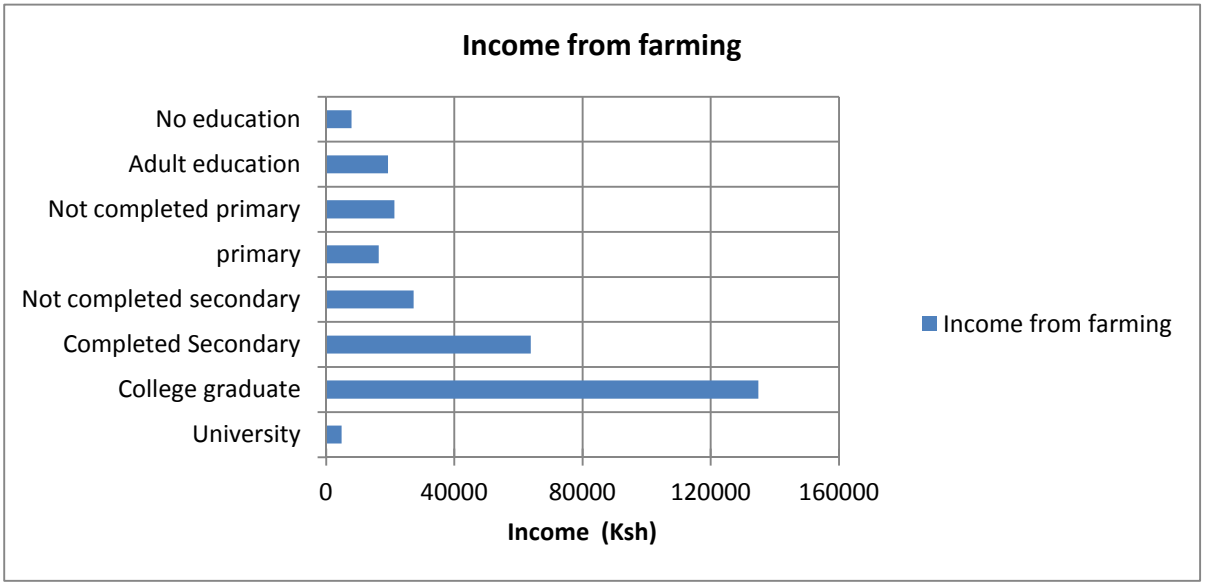


Figure 15: Education level vs income from farming

Level of skills and knowledge the household possesses is summarised in Table 14 and figure 16 which shows that 72% of the CA farmer respondents have formal education from primary level education and higher and only 28% who are primary school dropouts or had no formal education. Up to 46% of TT farmers and 57% of NT farmers have primary education and higher.

Category of farmer	Tertiary Education	Secondary Education	Primary Education	Not Completed Pry Education	Adult Education	No Education
CA	***9***	***17***	***46***	***15***	***2***	***11***
TT	***7***	***15***	***24***	***37***	***2***	***15***
NT	***2***	***20***	***35***	***33***	***2***	***9***

Table 14: Respondents education level

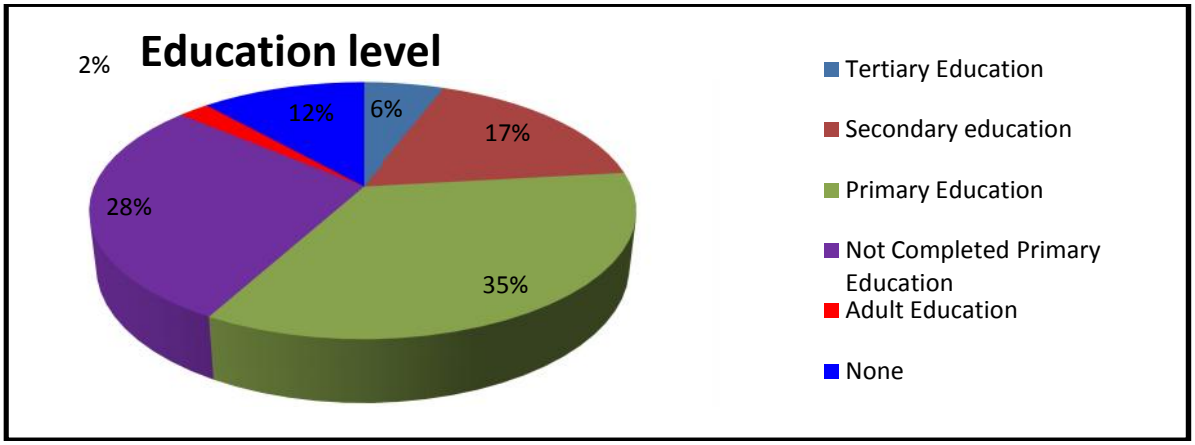


Figure 16: Respondents education level

Kikamba, Kiswahili and English were the three languages spoken while English, Kikuyu and Kiswahili were understood in the study area. For CA farmers, 63% understand English language, 17% understand Kikuyu and 100% understand Kiswahili, while 54%, 15% and 89% of TT farmers and 60%, 26%, 52% of NT farmers understands English, Kikuyu and Kiswahili respectively (See table 15 and figure 17).

	Language Spoken			Language Understood		
	Kikamba	**Kiswahili**	**English**	**English**	**Kikuyu**	**Kiswahili**
Conservation Agriculture	***100***	***80***	***28***	***63***	***17***	***100***
Trained Not practicing	***100***	***72***	***24***	***54***	***15***	***89***
Not trained_ not practicing	***100***	***32***	***30***	***60***	***26***	***52***

Table 15: Languages spoken and understood

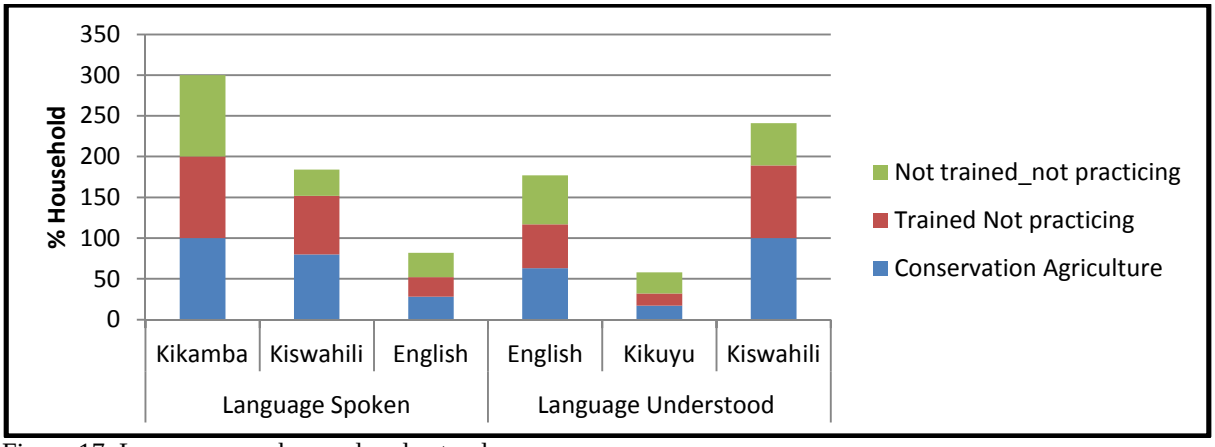


Figure 17: Languages spoken and understood

Farmers, who have higher education level, can speak and understand various languages stand a higher chance of sourcing and getting information than those with low understanding of commonly spoken languages. According to focus group discussion, most farmers training in the area use Kiswahili. Kikamba language is rarely used. Further training is always open to

all farmers but attendance depends on individual farmers to decide if to or not. This can explain the higher number of farmers who are more educated and could understand national languages attended the trainings offered. Therefore human capital is very critical to building of resilient livelihoods in that it enables households to make productive decisions that are translated to improved productivity.

5.2.1.6 Summary of category performance on each indicator

	Financial well being (FWB)			Food security (FS)			HH assets (HHPA)			Natural assets (HHNA)			Human resource (HR)		
	Not resilient	Resilient	V. resilient	Not resilient	Resilient	V. resilient	Not resilient	Resilient	V. resilient	Not resilient	Resilient	V. resilient	Not resilient	Resilient	V. resilient
CA	0.26	0.35	0.4	0.15	0.32	0.54	0.31	0.65	0.04	0.31	0.44	0.25	0.13	0.61	0.26
TT	0.4	0.27	0.35	0.35	0.26	0.39	0.43	0.54	0.03	0.46	0.39	0.15	0.17	0.61	0.22
NT	0.33	0.33	0.35	0.33	0.4	0.27	0.54	0.43	0.03	0.47	0.4	0.13	0.11	0.68	0.22

Table 16: Summary of performance on each indicator

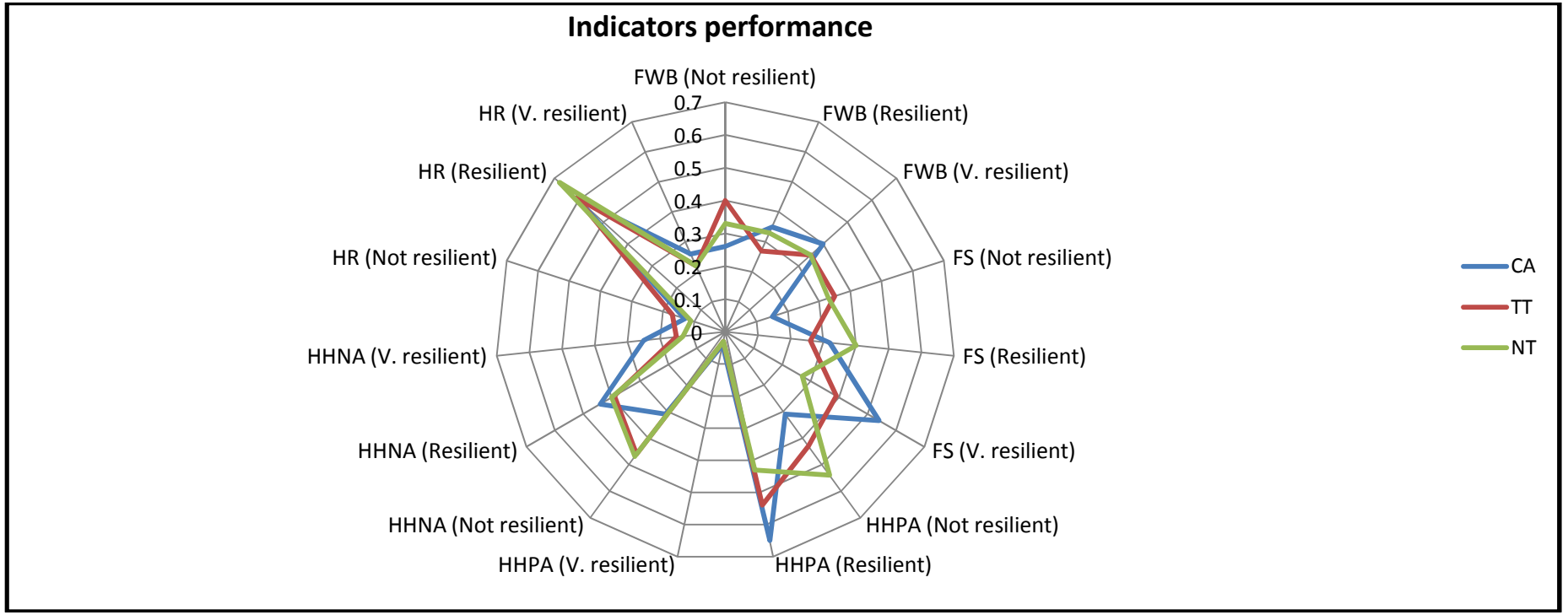


Figure 18: Performance of each category to indicators

5.2.1.7 Other drivers of resilient agricultural livelihoods

5.2.1.7.1 Natural capital

a) Land and land Use

According to Abson et al., 2013, land-use diversity may have an important role in ensuring resilient agricultural returns in the face of uncertainty and environmental conditions, and land-holding size plays a pivotal role in determining the relationships between resilience and returns at a landscape scale. Creating finer-grained land-use patterns based on pre-existing local land uses may increase the resilience of individual farms, while maintaining aggregate yield across landscapes (Ibid.: 14). This study analysed various land uses in the three categories under study.

	Count	Mean CA (acre)	Mean TT (Acre)	Mean NT (Acre)
Area under crops	46	**4.6**	**5.5**	**4.5**
Maize		**1**	1.8	1.4
Cow peas		**1.3**	1.2	1
Pigeon peas		**0.6**	0.9	0.9
Green gram		**1**	1.1	0.7
Others		**0.7**	0.5	0.5
Area under grazing	46	**3.2**	4.8	3.5
Area under forestry	46	**0.2**	0.2	0.1
Area under grass fodder	46	**0.4**	0.2	0.1
Area under home compound	46	**0.3**	0.2	0.2

Table 17: Land uses at household level

The overall average household farm size was 9.3 acres of land with CA farmers having 8.7 acres, TT with 10.9 acres while NT farmers had 8.4 acres. From Table 18, 39% of the CA farmers acquired their farm through inheritance but is good to note that 44% have acquired through their own effort by purchasing land. With TT and NT farmers' inheritance and purchase of land increases and decreases respectively. On tenure system, 74% (Figure 19) of the respondents had titled farms meaning that the area enjoys secure land tenure and can utilize their farm to obtain financial assistance from financial institutions.

	Inherited	Purchased	Self allocation	Hired/rented	Gift (by GOK)	Gift (relative)
CA	***39***	***44***	***6***	***9***	***2***	***0***
TT	***41***	***42***	***8***	***3***	***3***	***2***
NT	***56***	***22***	***13***	***9***	***0***	***0***

Table 18: Land acquisition method

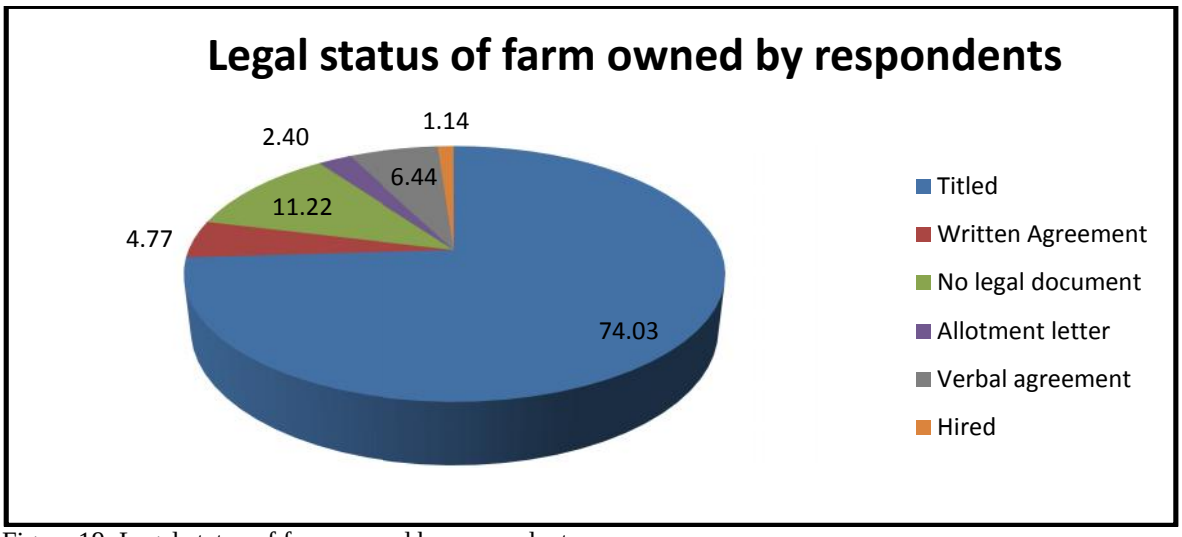


Figure 19: Legal status of farm owned by respondents

5.2.1.7.2 Physical capital

Resilience is also dependent on availability of efficient and functioning social infrastructure such as communication, health, education and markets and also household assets to meet various needs and aspirations of communities and those households. In this study, physical capital refers to the built environment, which comprises of shelters, electricity, water, telephone and critical infrastructure such as hospitals, schools and markets. Physical capital is one of the most important resources in building capacity of the community to cope with risk situations. For example, physical infrastructure such as roads, bridge as well as communication and transportation systems are essential for proper functioning of community, as with the Kathonzweni especially during harvesting and marketing of their produce. In general, lack of physical infrastructure or services facilities may have direct negative impact on community capacity to cope with production process. Physical capital was measured by their number, quality, shelters, distances, lifelines, and service infrastructures.

a) Infrastructure and Services

Resilience is also dependent on the availability of efficient and functioning social infrastructure, such as communication, health, education and markets to meet various needs and aspirations of the household and the communities.

i) Infrastructure

Better services and infrastructure, plays a major role to a resilient community and as such, farming community do require robust services not only from the government but also from private sector and better road condition. In Kenya arid areas are the most challenged in term

of services and infrastructure due to poor policies and bad politics that marginalised these regions which led to poor development. Road are the most affected and are usually impassable during dry spell and wet seasons. According to focus group discussion and the ministry of agriculture office, the area lacks public transport and when available are very expensive thus making farmers uncompetitive during produce selling and increased production costs. This has led to exploitation of small scale farmers by middle men especially during periods of harvesting.

Plate 3: Poor state of roads in the study area

By improving roads in this region can go a long way to enable farmers' competitiveness and minimize transaction cost in production and marketing. Development of centres as shown plate 4) it's a clear indication that physical planning regulation are not adhered to since shops at shopping centres are constructed without taking into consideration of regulations. Thus need to enforce these regulations especially after improvement of infrastructure.

Plate 4: Construction just two meters to the main road

According to the survey, other than the 8% of the respondents who have access to tarmac road in less than forty five minutes, 92% of the respondents take between one and eight hours to access the tarmac. Though 95% of the respondents confirmed that there exists public transport, it's unreliable with 16% of respondents confirming that it's only available once per day, 41% twice per day and 32% thrice per day (See Figure 20).

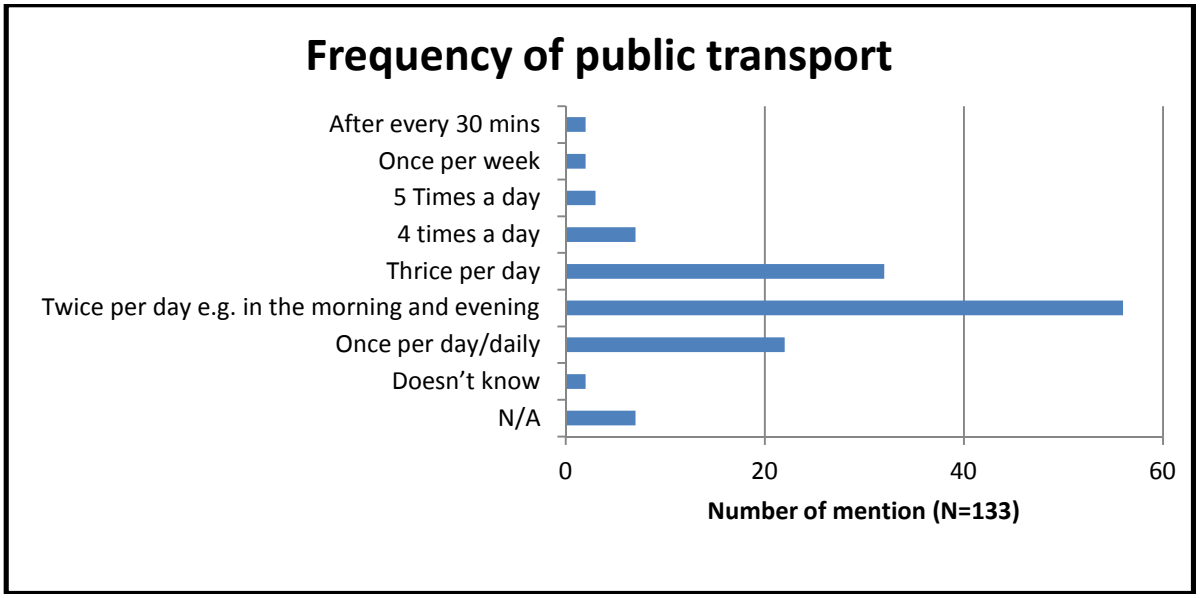


Figure 20: Frequency of public transport

Availability of market also is a major challenge affecting farmers in their production process. In the study area, only 24% of farmers with an access to the formal market within 3 kms from their farms while whereas 76% of the households have to travel a distance ranging from 3 kms away. Doubled by the poor roads and lack of transport, farmers continue to suffer especially during produce marketing whey are exploited by brokers.

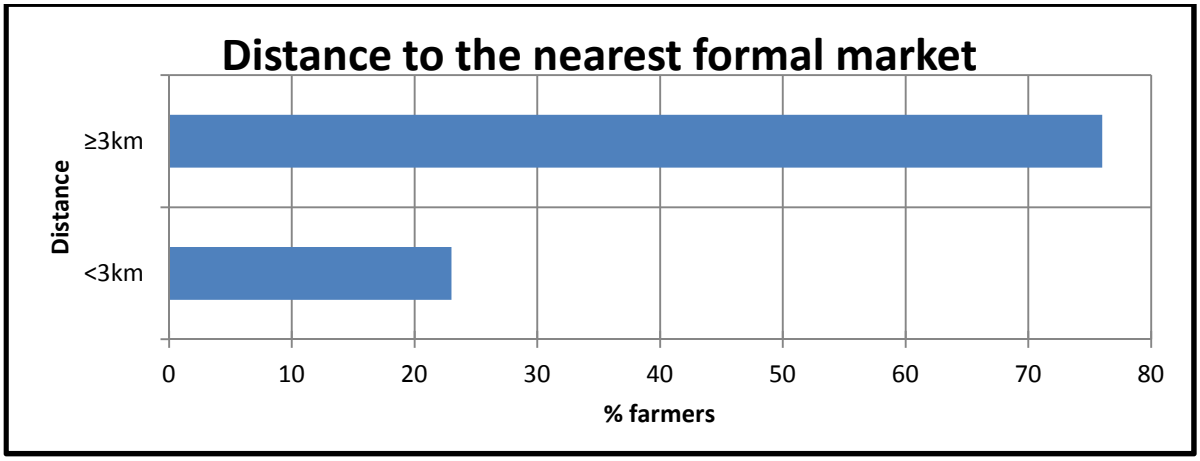


Figure 21: Distance to the nearest formal market

ii) Services

All respondents under this study had access to primary education with all primary schools mentioned being public schools. The time taken to various primary schools range from one minute to one hour but most respondents take less than 30 minutes to school (Figure 22). This is a clear indication that schools are within the community reach with all primary students walking to school. Secondary schools are further with over 40% taking more than thirty minutes to reach school. Up to 85% of secondary schools are public while only 13% were owned by private individuals.

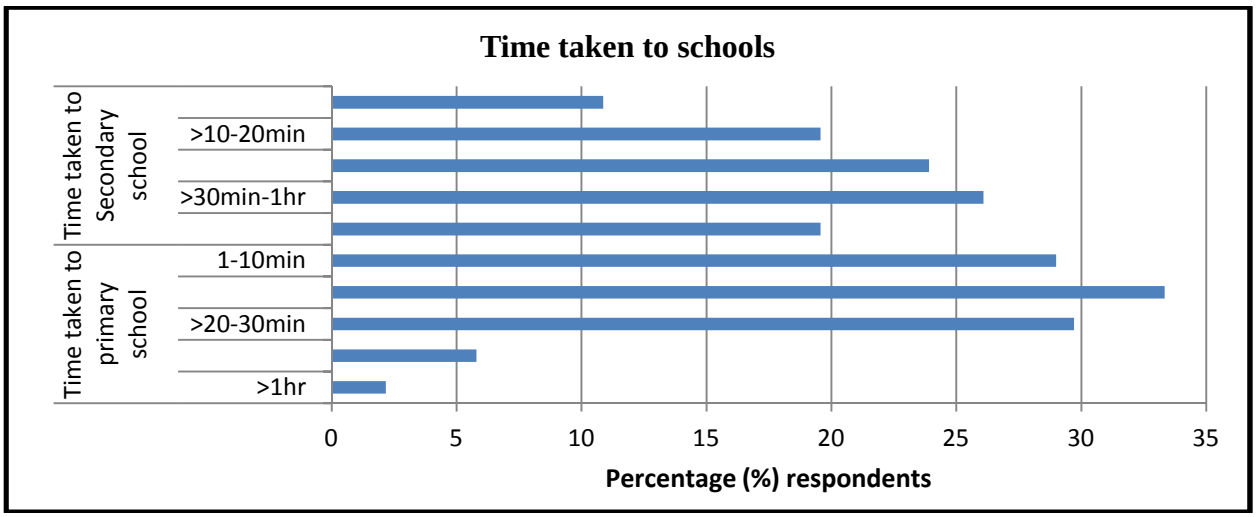


Figure 22: Time taken to schools

5.2.2 Site specific knowledge

Resilience thinking requires an acknowledgement of the fact that systems must learn to live with uncertainty and that change is inevitable (Berkes 2007). '"Expecting the unexpected" is said to be an oxymoron, but it means having the tools and the codes of conduct to fall back on when an unexpected event happens' (ibid.: 288); these tools and codes can spring from memories held by societies of similar events in the past.

Household knowledge of social ecological system was identified through the farmers experience from the number of years within Kathonzweni district and also experience gained from the number of years in agriculture practice. Most of the respondents in the three categories have a very high knowledge of the region, most having been born within Kathonzweni District. Figure 23 indicates that over 80% have been residents of the region for over 20 years with less than 10% having stayed for less than 10 years.

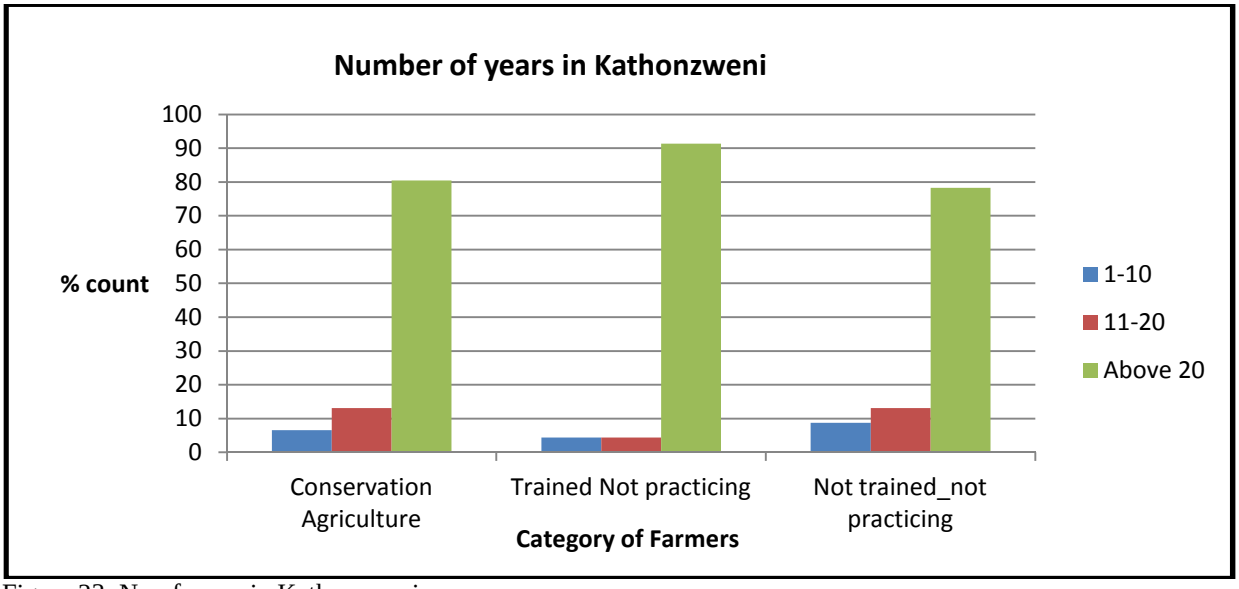


Figure 23: No of years in Kathonzweni

On agricultural practice knowledge, over 60% of the respondents had an experience of over 20 years in agriculture and less than 20% of respondents with less than 20 years of experience in agriculture practice (See Figure 24).

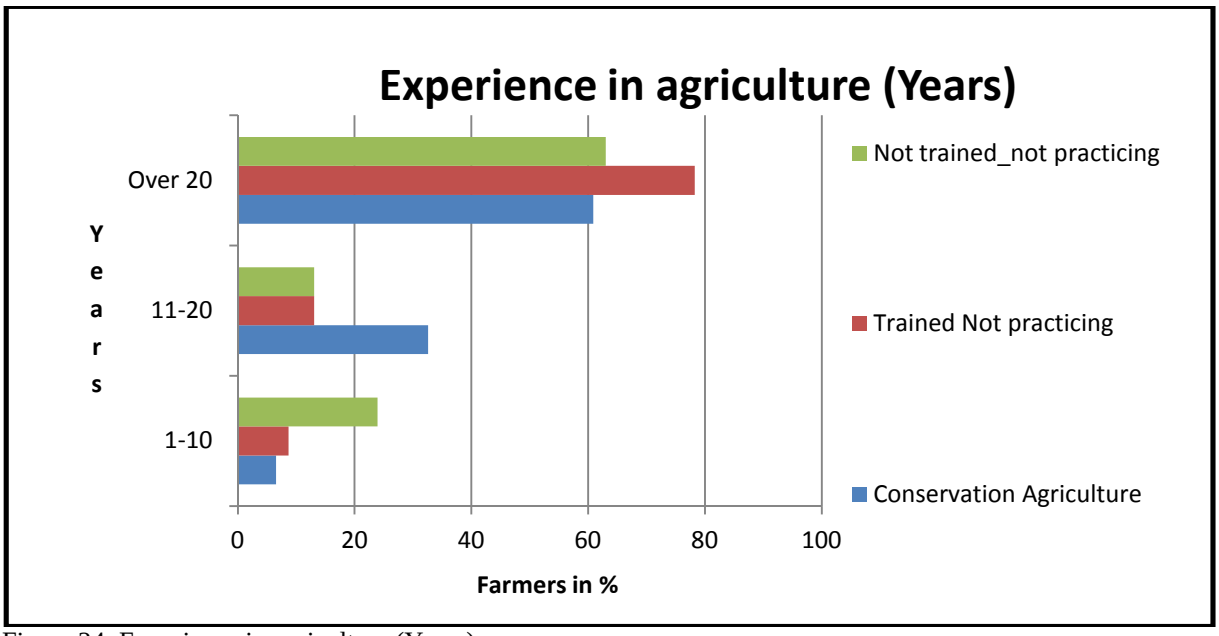


Figure 24: Experience in agriculture (Years)

Cross tabulation between number of years to the average maize production per household, shows that the less the years in experience of the Kathonzweni social ecological system the lower the production/yield (see Figure 25). The same is true with the experience in agriculture activity. In 2009, the drought year, those with fewer than 10 years of experience/knowledge of the region o contributed only 16 % to the average maize production as compared to 42% for those with 11 to 20 and above 20 years experience.

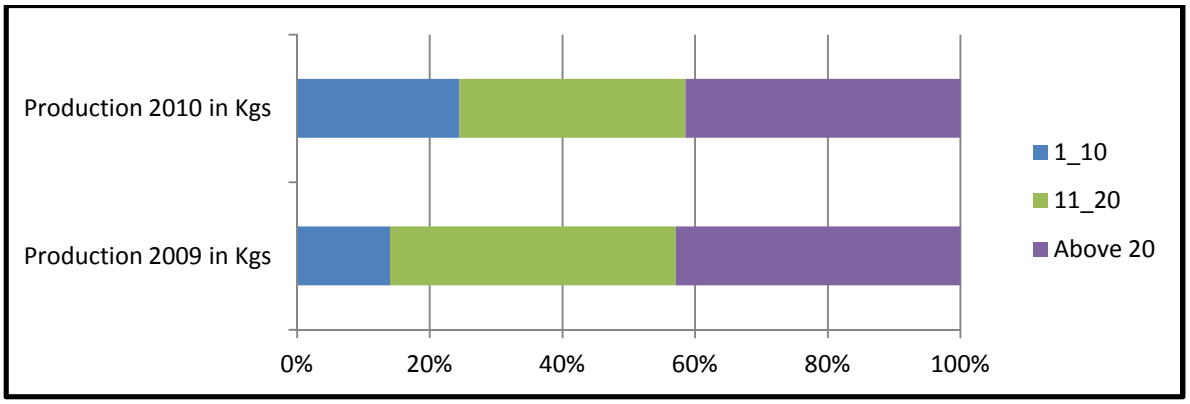


Figure 25: Experience versus maize yield

5.2.3 Self organization, cooperation and networks

Ability of users (in the case of the study farmers) within a system to self organise and reorganise to sustainably manage resources (Ostrom 2009). For self organization to take place there should be a certain amount of availability and scarcity in the resource system to provide incentives for self organization basically for better management. Therefore the ability of farmers to reorganise themselves is very critical in determining their resilience. Within the

local set up, creation of governance with multilevel partnerships is fundamental shift from usual top-down approach to management (ibid.: 291).

5.2.3.1 Institutions collaboration

In the study area, a number of institutions identified by the respondents as having been operating and providing services to the farming community were;

- Ministry of agriculture, livestock and fisheries development providing extension services to farmers through field days and open days,
- KARI has for years promoted certified drought tolerant seed to the community and also contracting farmers to grow clean seed and selling to them at a predetermined price.
- World Vision has been providing relief food to the farmers as well as promotes dry land farming technology in the region.
- CETRAD was identified to have promoted conservation agriculture in the region.
- Red cross also provides relief food
- K-rep (FSA) and equity bank providing credit to farmers. and
- BIDII group promoting dry land farming.

To understand the main activities carried out by organization in the region, UCINET software was used to analyse institution activity network. Figure 26 below showing institution activity networks shows that 11 institutions have been involved in promotion of conservation agriculture through training of farmers, 9 institutions providing farm inputs, 9 institutions providing relief food, and 5 institution providing food for work among other activities.

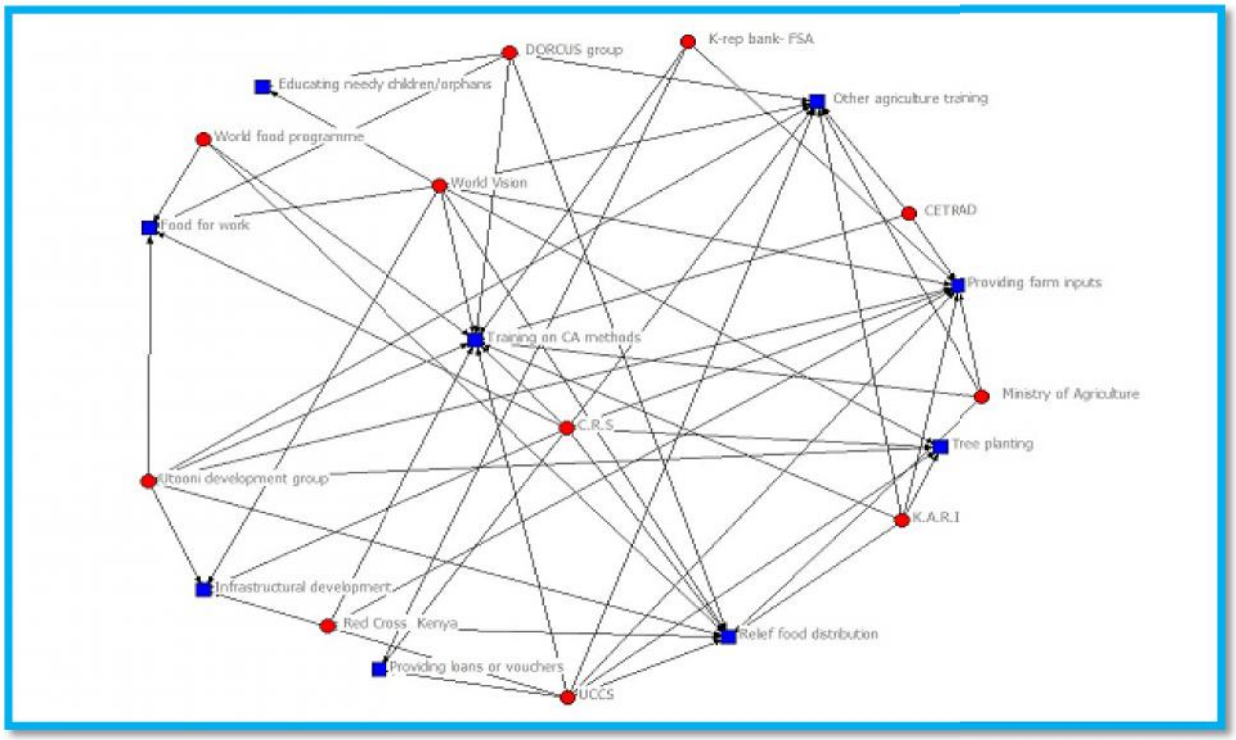


Figure 26: Institution and their activity network

According to focus group discussions, the following were identified as the man institutions working and collaborating with the community towards achievements of food security in the study area:

Organization	Activity
World Vision	• Trains farmers about the suitable farming techniques for the region • Promotes terracing of farms via a food for work programme • Promotes poultry keeping by offering training on the same
INADES-Kenya	• Promotes tree planting • Advocates for terracing of farms in the region
DORCUS	• Promotes poultry and goat keeping. Has mobilized farmers into groups where they learn about the two practices. Additionally, they help farmers to mobilize funds for purchasing goats/poultry and assist where necessary. • They have a food for work programme that seeks to promote terracing of farms
CETRAD	• Training farmers on conservation agriculture • Provides certified seed to the farmers
Catholic Relief Service	• They have a food for work programme-they issue vouchers to farmers involved in digging terraces • They assist farmers to get quality seeds. This is done in two ways namely subsidizing the price of seeds or giving farmers money for purchasing crop seeds.
Utooni Development Group	• Gabion construction • Tree planting • Gives relief food
Government	• Providing farm inputs such as seeds and fertilizer • Provides relief food • Training farmers on better farming techniques • Vaccinating livestock • Water harvesting e.g. through construction of dams
BIDII(Benevolent Institute of Development Initiative)	• Community capacity building
U.C.C.S (Ukambani Christian Community Services)	• Construction of weirs • Construction of dams

Table 19: Instituions interacting with farmers and activities

5.2.3.2 Cooperation and networks

Other than organization, farmers are members of groups which range from farming groups to financial groups. In Kenya, self help groups have a long tradition (Wacker 1996:135). All the

households interviewed at least belong to an average of two self help groups which vary in activities and membership. The perceived advantages and benefits to household members in self help groups are indicated in Figure 27. As in group activities where savings and lending is very key, table banking and allowing members to receive loans from group is perceived to be the most important to the members. This is a group product that enables members to borrow any time they are in need of cash and comes in handy to help farmers during drought situation in buying food. This is followed by the groups playing a major role to provide information to farmers on various emerging issues on agriculture and other topics, thus enabling farmers to make informed decisions in their production activities. Other than these two benefits, other benefits in order of importance are: common farming tools and labour assistance; generating incomes through selling of products; stocking livestock; for individual households; buying and sharing food for members during drought 'relief food from group; social assistance where members contribute for occasions such as burials and dowry payment; co-existence through social cohesion; marketing of produce; and buying inputs as groups.

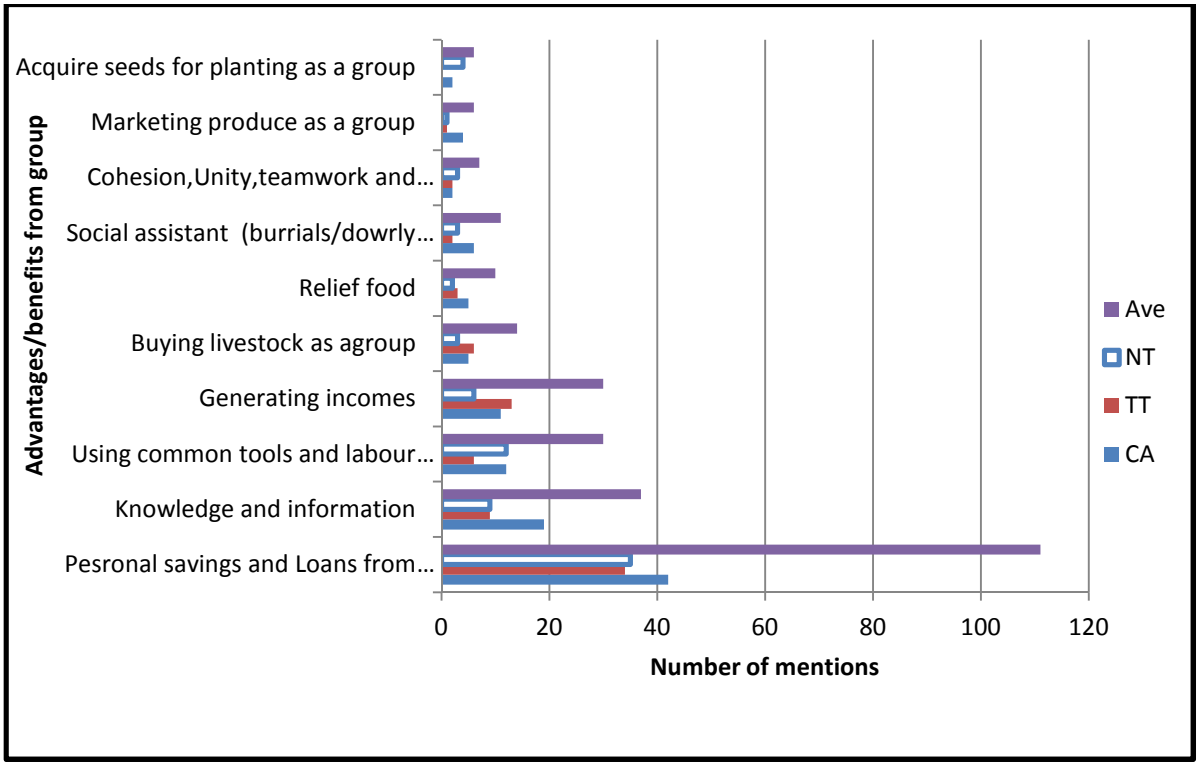


Figure 27: Perceived benefit in being in a group

Other than groups, farmers derive assistant through other cooperation. Figure 28 below shows form of assistant that farmers derive from other farmers especially the neighbours, friend

within the same village. Kind of assistant includes receiving farm inputs, various advices, free labour during land preparation and finance among others.

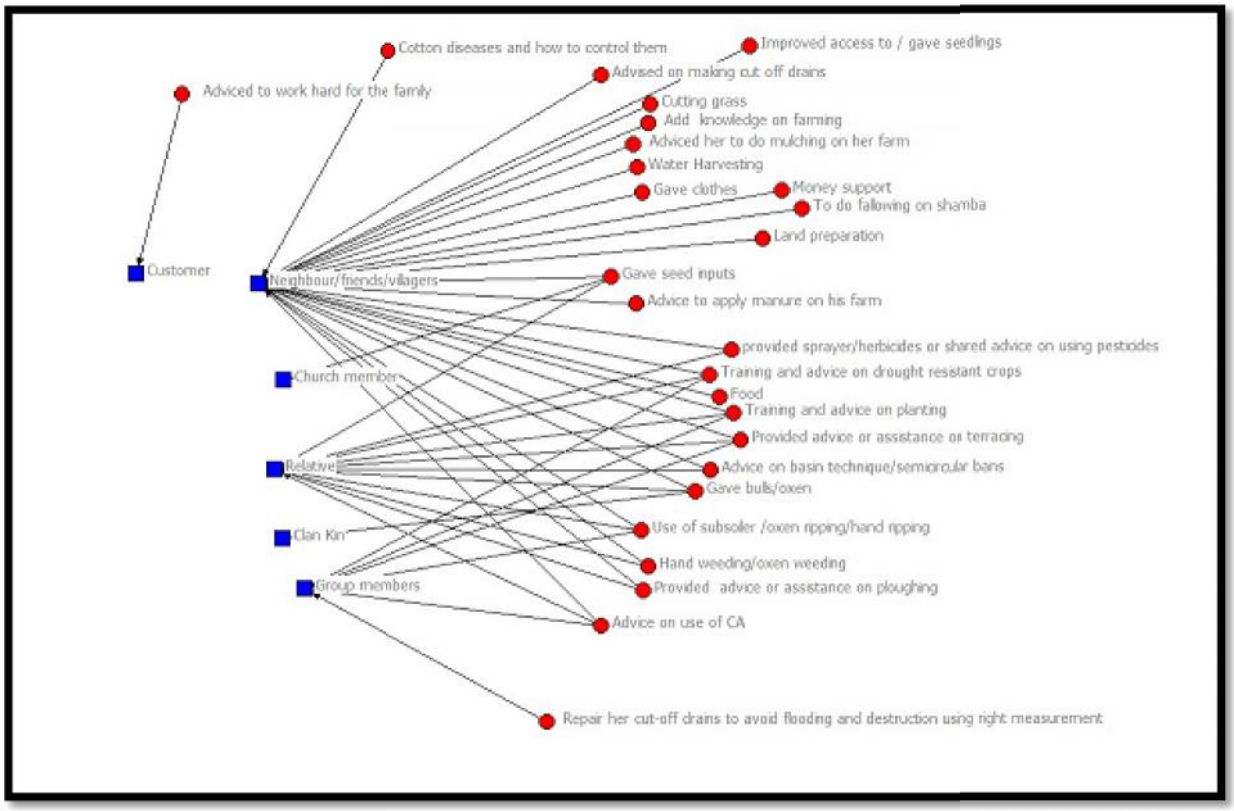


Figure 28: Cooperation and network

5.3 Approaches and practices that promote resilient livelihood development

5.3.1 Practice

From the perspective of the farmers, 21% of the respondents identified oxen ripping as a practice and technique that promotes resilient livelihood. Terracing, which is a practice that has been used for decades by the residents, was identified by 10.8% of the respondents to build resilient livelihood. Other techniques mentioned in order of importance are water harvesting, hand ripping, hand sub soiling, growing of drought tolerant crops and cover crops. All techniques mentioned are conservation techniques in farming and they have been practised and tested by farmers on their performance.

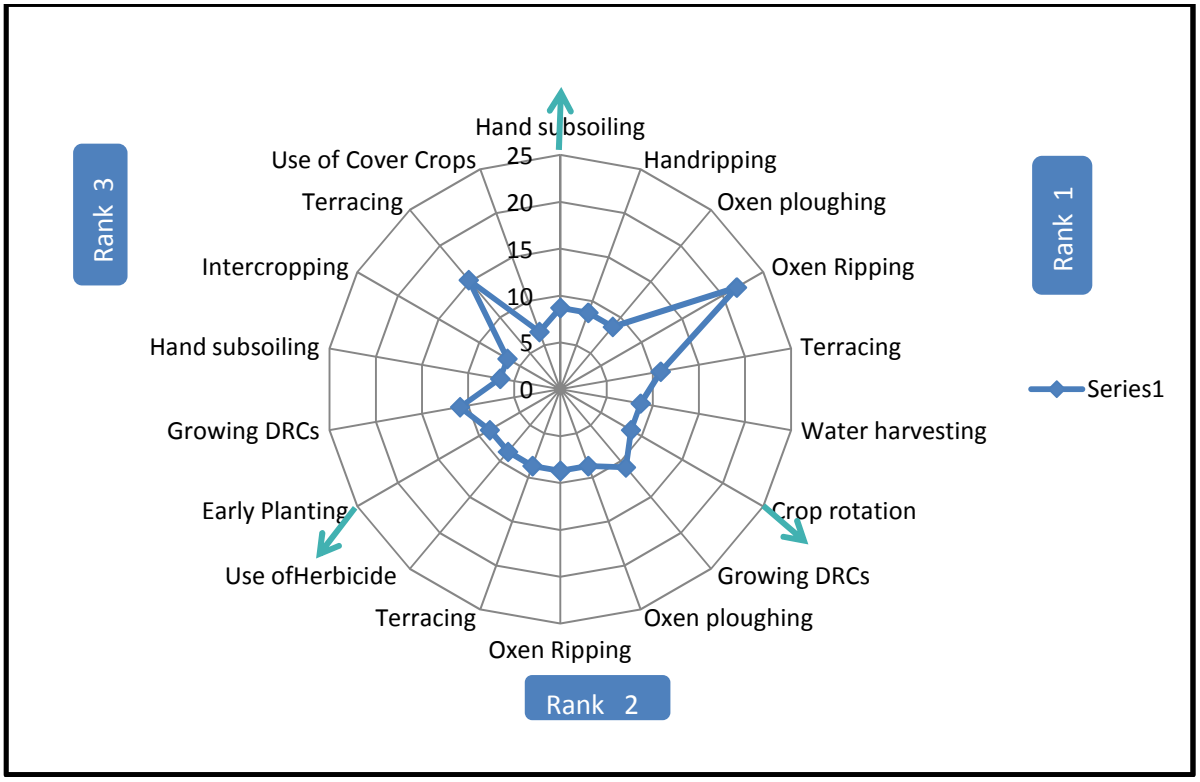


Figure 29: Most preferred technique by respondents

Interview with the key informant and focus groups, confirmed that oxen ripping has proved to cushion farmers' farms from adverse effect of weather and they have seen CA farmers harvest during the 2009 drought where non CA farmers did not harvest. Other than ripping, they also ranked terracing, water harvesting, drought tolerant crops and early timing in descending order as the main techniques that have proven to promote resilient livelihood in the past in the region. The MoA, gave an example of the high number of institution in the entire lower eastern that are promoting these technology.

Further, focus groups discussion identified a number of a collective action that can assist farmers to achieve sustainable livelihood. These are: i) social assistance where farmers can organise themselves to assist each other to implement conservation measures. Studies carried out have found that reciprocity in societies in sub-Saharan Africa has been declining and, although it is still part and parcel of social norms, it is not strong as it was about two decades ago (Campell et al. 2002: 34). The six focus groups held seemed to support Campell findings where, they had a feeling that the traditional history in the region where farmers have assisted each other is no longer there hence felt it's an important capital that can build resilient communities thus needed to be promoted and adopted in-order to enable households to be food secure and in the long run maintain livelihoods that are resilient to drought; carrying out conservation measures of planting trees to ensure social ecological systems are conserved; ii)

farmers to embrace rain water harvesting and storage to supplement rain-fed agriculture to irrigated during drought seasons; iii) formation of common farmers marketing and produce source to minimise costs and remove brokers in the sector at the same time ensuring higher income from the profession; and iv) policies from national government and county government that encourage adoption of technologies such as CA and agro-forestry. An example is the agriculture act cap 318 on farm forestry rule 2008, stipulate 10% forest cover on the farms while sectional paper no 1 of 2007 on forest policy emphasise on the need to support farmers with sound management and utilization principle, incentives, information, better germ plasm and marketing strategies in forestry and improvement of farmers access to information. From the household survey, no one category of farmer (CA, TT, and NT) that has achieved the 10% tree cover on their farm. CA has only achieved a 2.3% cover, TT only 1.8% and NT only 1.1% tree cover (See Figure 11).

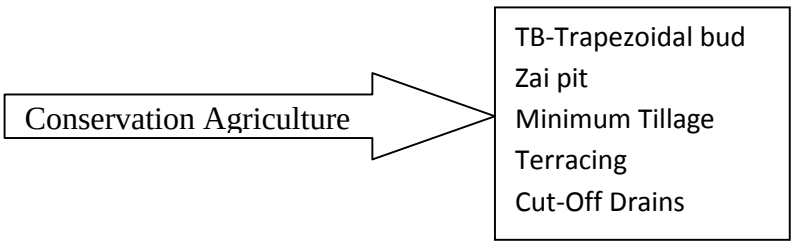
5.3.2 Approaches

From CETRAD Conservation Agriculture projects report (2008, 2007, 2009, and 2010), a number of approaches were employed during the implementation of the project. These are: first on the project inception where in the year 2002 a study by Chinwe (2002) found that famines are often linked to drought in semi arid areas of sub-Saharan Africa where not only the pastoralist, but also agro-pastoralists are increasingly affected. She suggested that approaches to deal with drought and famine have to target factors causing household food insecurity during non-drought periods. Therefore intervention by CETRAD by introducing CA in Makueni was based on this field survey that proposed an intervention of dry-land farming techniques in the region and other ASALs. First approach was to test the technology in Laikipia before out scaling to Makueni; secondly was use of participatory approach by using existing self help groups. This was by carrying out inventory of groups rather than formation of new groups as an entry point to reach out to farmers and ensure farmers participation in the implementation of the project and mobilization of other farmers; thirdly was the collaboration with other key stakeholders in the region that were promoting conservation approaches and also other activities to ensure interventions that are holistic in nature to ensure farmers receive a full package as well avoid duplication of activities; fourthly was carrying out farmers' led demonstration farms and model farm to act as learning centres and to stir social leaning among farmers; fifth approach was to capacity build farmers through training as trainers to ensure continuity of training activities after

project exit; and finally involving the line ministry in the implementation to ensure continuity of the project (project reports, 2008,2009, 2010 and 2011).

According to the Ministry of Agriculture Kathonzweni, they have a number of approaches that they employ to reach out to farmers and to ensure a resilient livelihood within the region. These are;

i. Trainings through farmer groups, field days, individual farm visits and holding a farmers information desk day at the head quarters to reach out farmers during market days.
ii. Inputs: for the last 10 years, the ministry has provided free certified seed to farmers at the beginning of every season in order to improve the district food security situation as well as ensure their livelihoods are resilient.
iii. Promotion of drought escaping crops- [Traditional High Value Crops (THVC)] (Cowpeas, Pigeon peas, Green grams and Maize). This is done to increase chances of harvesting even during the dry seasons. Through this project, farmers are contracted by KARI to deliver produce. They also promote root crops such as cassava.
iv. Market Information: Ministry of agriculture collects market information every week at various markets. This information is provided to the farmers any time they require it. Enables farmers to make informed decision in marketing of their produce. This has led to reduced exploitation by brokers.
v. Technologies technical support through training and demonstrations. This is done through collaboration with other partners such as CETRAD: Example; Conservation agriculture.



vi. Promoting Agro forestry: this is to ensure that vision 2030, and Agriculture act 2008, is implemented in full. According to Campbell et al., government approach of technological, structural, social, and economic development to bring about adoptive measure in compacting climate change is not enough thus need for a system approach of promoting biodiversity and climate change since strategies impact on biodiversity and biodiversity also impact on the strategies set. Therefore, the policy brings about the holistic way by ensuring the environment and forest resource are enhanced and

rehabilitate farms that are degraded through agro-forestry. Makueni County has a very low vegetation cover as shown in Figure 11.

vii. Composting (Soil fertility): According to MoA, Makueni farmers are the most reluctant in adopting use of fertilizer in their farm. Main reason given is that fertilizer makes their farm hard with time thus low number of farmers in the region utilise them. The Ministry promotes fertilizer and manure to increase their usage and improve soil fertility to increase yield per unit area of land.

viii. Post harvest handling: post harvest loses of produce in Makueni is very high leading to high loses of produce to pest and aflatoxin. Therefore the office trains and demonstrates to farmers the right practice. MoA believes that this has led to improved earnings for the farmers.

According to other key informant interviewed (UCCS, CRS and World Vision), other than promoting conservation tillage they have also involved in relief and food for work relief, and promotes dry land crops in the region (see figure 22).

5.4 Factors influencing household capacity to develop and maintain resilient livelihood

Farming communities continuously suffer from various challenges that affect their competitiveness and capacity to have sustainable livelihoods that are resilient. These challenges differ from one agricultural enterprise/system to another. In crop production, poor weather was identified as the main factor affecting production thus their capacity to build resilient livelihoods. Drought (49%), pest and diseases (17%), lack of financial capital (9%) and lack of human capital (6%) (See Figure 30) to invest in farming are the main factors that highly affect farmers' ability/capacity to maintain sustainable livelihoods. An emphasis should be put up that encourages farmers to carry out irrigation of crops as well as practice water conservation measures and embracing dry land farming techniques.

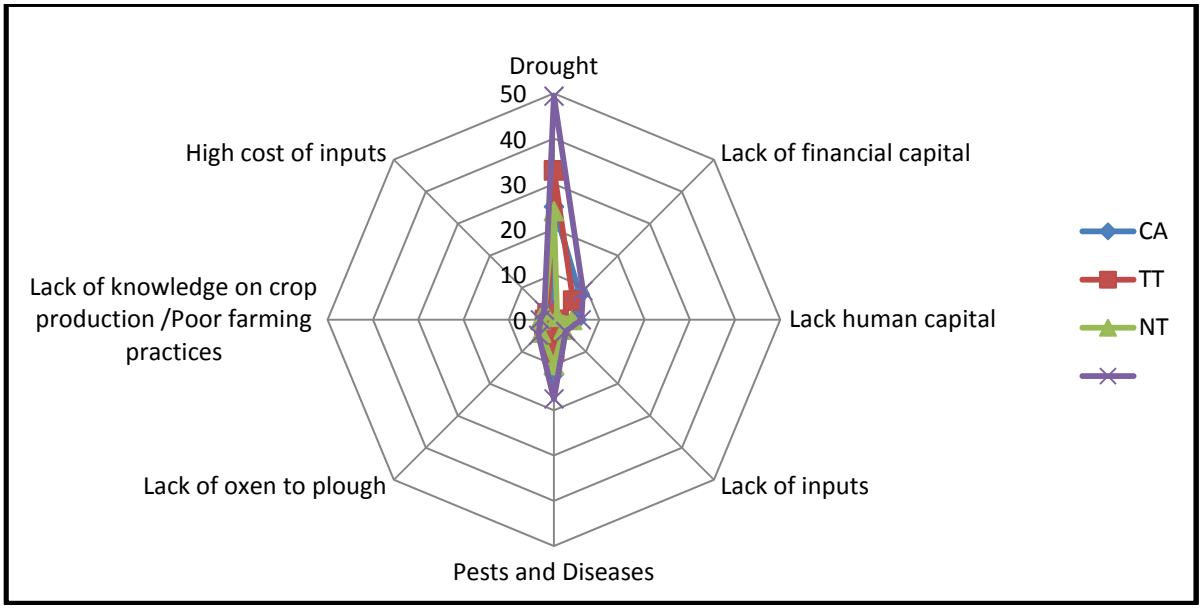


Figure 30: Factors affecting farmers' capacity in crop farming

In livestock production, the three main challenges mentioned are: lack of pastures (37%) basically due to frequent droughts in the region; pests and diseases (21%); and drought (9%) as a factor affecting livestock production (See Figure 31).

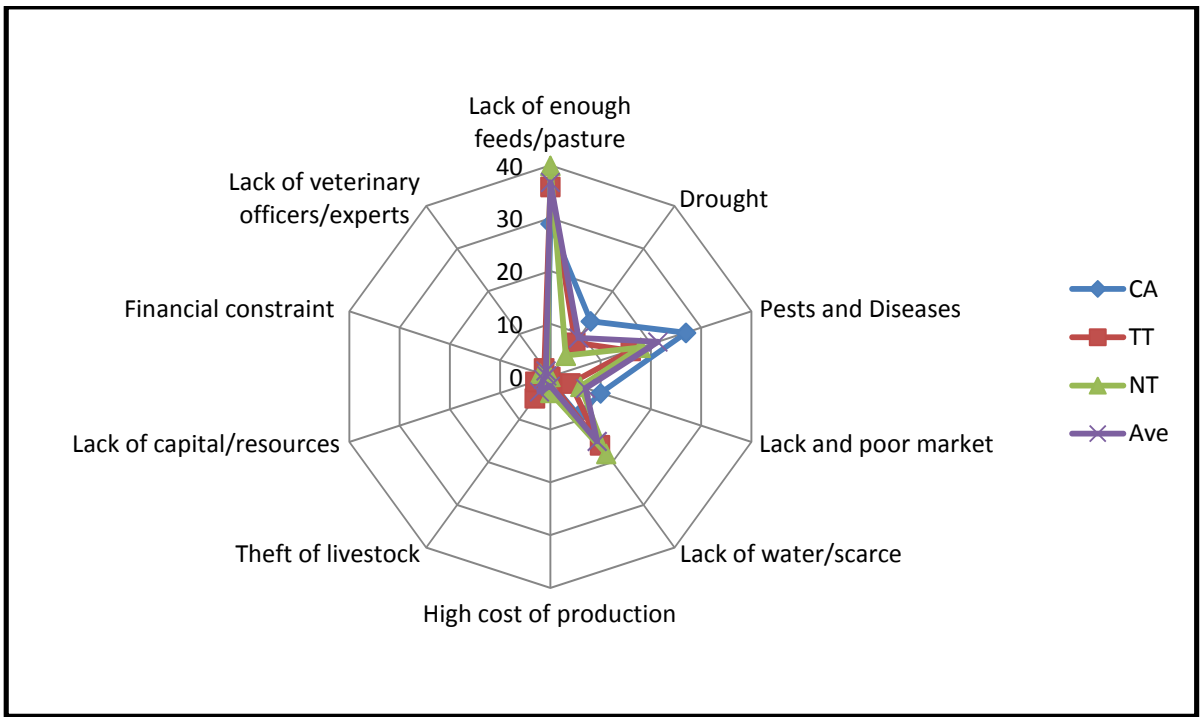


Figure 31: Factors affecting farmers' capacity to have reliable livestock farming

Other than factors affecting farmers capacity in resilience building, farmers identified poor government policy as not oriented in ensuring farmers are food secure and have resilient livelihoods, Though right to food is enshrined in the Kenyan constitution, the government continues to provide food through relief rather than empowering its citizen in feeding

themselves. Focus group discussion felt that the government's policies fail to address farmers' issues and challenges that have affected them for many years.

Focus groups confirmed the above where they mentioned drought as their main challenge affecting farmers in the region. Below is the full list in order of importance:

i. Poor weather condition ranging from poor onset, unreliable, poor distribution and short period
ii. Crop pests and diseases. Besides destroying crop produce, it has contributed to lack of seeds. This is because most of the crop produce that can be used as seeds are destroyed by caterpillars.
iii. Lack of capital for inputs acquisition- they felt that farming was a business like any other that needed capital but farmers are always at a loss in financing farming thus explaining poor production.
iv. Lack of human capital especially during critical periods of crop growth- due to large parcels of land, the groups argued that they are always in short of labour especially with the high number of migration of youth to the city leaving older generation in agricultural farming. They empasisied the need to embrace technology through mechanization in production system.
v. Shortage of water- the region has an acute water shortage, not only for irrigation but drinking water. Farmers takes a substantial amount of time to source water for domestic other than utilising in other productive activity
vi. Lack of planting materials i.e. certified seeds- though the government is providing seed at the beginning of the season, but most season they receive seed late into the season and they are usually in very low quantities.
vii. Insufficient knowledge and information on various crop production value chain- since the change in government policy on extension where farmers are required to demand for the service, information had been insufficient and not forth coming
viii. Poor soil conditions with low fertility.
ix. Lack of equipment e.g. mattock, rippers, sub-soilers, knapsack etc.
x. Lack of a suitable market for their farm produce. This has been propagated by the presence of farm produce brokers who prevent external buyers from accessing

6 SYNTHESIS

6.1 Introduction

This study looked at four objectives, first to identify and examine indicators of resilient agriculture-based livelihoods to seasonal climatic variations, secondly to identify farmers and local actors approaches and practices that contribute to resilient livelihoods in the face of seasonal variation, thirdly to examine factors influencing farmers capacity to develop and maintain resilient livelihoods in the face of climatic risk and finally identifying policy options for enhancing of resilient livelihoods. Below is the summary of the study findings:

6.2 Indicators of resilient agriculture livelihood

As shown in the charts, various indicators have proved to provide an insight to agriculture based resilient livelihoods. The study area provided an avenue to have a comparison of three agricultural production systems with the implementation of an intervention through conservation agriculture in the region for a number of years. Indicators ranging from farmers buffer capacity (endowment, entitlements, diversity) site specific knowledge and self organization were analysed. Specific indicators are access to food, human, financial, physical and social capital.

Agriculture is the primary sector in the region that contributes to farmers income and when reformed and well managed can contribute more to the household incomes, lead to food secure communities and in long term ensures community livelihoods are resilient to frequent droughts. As in the country and other arid regions, farmers have continued to depend on agriculture specialising in livestock and crops and with over 80% of the country's population depending on farming for their livelihoods, the study proves this true with each and every household respondent depending on agriculture as their main livelihood source.

Diversity in livelihood sources, enable households to be more secure during drought situations compared with households depending on single source of income. From the results, the main household sources of income are four that prove to be reliable in this region: farming; remittances which is very vital livelihood source for households in arid regions and formed under premise of monthly remittance by relatives working in other areas to the household; casual jobs and finally businesses. Encouraging these communities to diversify in livelihood sources as a coping mechanism to enable them cope during drought periods.

Farming is a highly risky livelihood venture especially in arid regions thus need for an elaborate strategy that can act as insurance during such periods.

Also with the growth of weather index insurance cover for farmers against drought in the country, more emphasis should be done to motivate insurance company to roll out the scheme in asal areas rather than concentrating in high potential regions. Currently such products are in some asal areas such as Mbeere on crop by UAP, Livestock product in north eastern by APA among others. Such intervention can highly benefit those farmers in asal by ensuring they are compensated during drought periods to enable them bounce back after the adverse situations.

The study offers a very clear insight by comparing the convention farming with a number of climate smart agriculture techniques that not only protect the environment, but also ensures sustained yields even during dry periods. A number of variables analysed have shown that CA technology also proved to produce more yields even during the drought year (2009) used in this study as the study reference year. From the year 2009, all categories had their yield increase, but more apparent however is the variation of production among the three categories. Also as shown that 61% of CA farmers don't acquire relief even during the drought period since they are food sufficient these compares to only 43% for non CA farmers. Poverty relief given by the government also it's minimal with CA farmers with only 10% receiving compared to 24% from the non-CA farmers. In this light, such practices that have proved to increase farmers' incomes and yield need to be encouraged.

6.3 Approaches and practices that contribute to resilient livelihoods

As ranked in the radar chart figure 28, farming techniques identified by farmers that have assisted them to cope with drought need to be adopted. Ripping which is a major component of CA was identified by 21% of respondents as a practice that has proven to offer yield even during drought. Terracing which is practiced by all farmers in the region was ranked second with 10.8%. Water harvesting and growing of drought tolerant crops were third and fourth respectively. All techniques mentioned are conservation techniques in farming and they have been practiced and tested by farmers on their performance. Also, farming using various methods other than specializing on one technology is more secure during drought periods.

Diversity in technology bring about security and acts as a coping mechanism. During the survey, three farmers identified as role model in the region, not only practice diversity in

terms of crops and enterprises, but also practice diverse farming techniques. Example: practicing conservation agriculture techniques (ripping, mulch, terracing and at the same time irrigate their crops during drought. All these techniques ought to be emphasized to improve farmers' outputs.

Also approaches employed by stakeholders in the region that assist farmers in securing their livelihood should be promoted. Stakeholders interviewed identified participatory approach where farmers and other key actors are involved during inception of the project and implementation. Other approaches are use of demonstration and models, training and exchange visits to facilitate social learning, and by involving line ministries to implement projects.

6.4 Factors affecting farmers ability in obtaining and keeping resilient livelihood

Another objective of this study was to identify key factors that affect farmers' ability to obtain and keep resilient livelihood. This was provided in sector base of livestock and crop farming. Farmers identified a number of challenges in both sectors which includes: for crops: climatic factors {Drought (49%)} bad weather condition as the most factor that affects farmers livelihood, pest and diseases (17%), lack of financial capital (9%) and lack of human capital (6%) (See figure 24).

In livestock: lack of pastures and fodder, poor weather condition and lack of markets for their animals, poor infrastructure and transport among others. Transport is an important factor in production system. Its availability and transport network can influence distribution of agricultural systems. In Kathonzweni, many farmers could not sell or sells at farm gate due high transportation costs to the markets (See plate 4 & 5).

7 CONCLUSION AND RECOMMENDATIONS

7.1 Indicators of resilient

The study identified and examined indicators of resilient agricultural based livelihoods which included specific indicators such as food access, financial security, entitlements and human capital. Food access for most households is exclusively derived from own production, supplemented from purchases and from relief food. The main economic activity for households in the study area is farming which is a major land use activity and contributes more than 20% to the total household income. Also, it contributes more than 10% of the total household income to over 67% of the interviewed households thus an indication of a reliable source. The overall average household farm size in the region stands at 9.3 acres of land with only four main land uses. Farming takes the highest share of 4.9 acres which is more than half of the total acreage.

According to this study, a household with a more diverse income and livelihood sources is more resilient than a household depending on a single source of income. There is need for a land use plan not only at household level but also at county level to allocate land for various economic activities in order to cushion farmers during drought period. Further, according to this study (See Table 17), forest cover ranges from 1.2 to 2.3% only which is way below the recommended requirement of at least 10% tree cover on every farm, otherwise referred to as the Agriculture Farm Forestry Rules of 2009 is yet to be achieved by farm households in Makueni.

Therefore there is need to re-orient land uses to not only cater for economic needs but also taking into account the environmental and social factors. Land uses should include but not be limited to various agricultural enterprises, agro-forestry and agro-processing of local production within the area for value addition. The main purpose is to select and put into practice those land uses that will sustainably meet the needs of the people within the county while safeguarding resources for the future. The driving force in planning is the need for change, the need for improved management or the need for a different pattern of land use dictated by changing circumstances. A robust training of farmers to ensure the 10% tree cover is implemented not only in public land but also in private land is necessary.

The study also shows that entitlements owned by household play a major role in ensuring food security to household during dry spell. Livestock, trees and household assets have

assisted household during drought period. These assets are sold and the returns used by households to buy food thus they act as security and usually are used to ensure that household can cope during and after drought. This point emphasises the need for a land use plan that enables farmers to utilise their farm not only for farming but have various enterprises. 10% tree cover, keeping of livestock and more is to encourage farmers to obtain assets during plenty to cushion the impacts of drought.

Physical infrastructure and availability of services are also challenges affecting locals. Good infrastructure contributes immensely to resilient livelihoods by facilitating movement of the primary goods to markets, access food as well as enabling them access services. Thus need for a land use plan that incorporates infrastructure expansion and improvement. From the survey, 96% of respondents use one to eight hours to travel to the nearest tarmac road and markets. This is a major hindrance to the realization of resilient livelihoods. Farmers need better roads to enable them lower their transaction costs in marketing of their produce. Also majority of the households travel long distances to the market. The distance ranges from 3 to 15 km away which is worsened by lack of motorized transport to the formal markets. This has disadvantaged farmers during marketing. They are immensely exploited by the brokers. For households to attain resilient livelihoods they need better marketing structure to enable them achieve higher incomes from their produce. There is need to allocate public land in various wards within the county for infrastructure development to make them more accessible to farmers to enable them not only raise their to increase their income but also lower their cost of farming as well as lower prices of industrial goods.

7.2 Approaches and practices that contribute to resilient livelihoods

Various techniques were identified by farmers to contribute to resilient livelihoods. These are sub-soiling, ripping, terracing, water harvesting and growing of drought tolerant crops. These techniques used by farmers have been practiced for a number of years and have proved to increase yields and improvement of soil over time. It’s due to this reason that the county needs to promote and encourage farmers to adopt and increase acreage under these techniques. There is also need for the county to allocate land specifically for the set up of water harvesting infrastructure such as dams and as well encourage farmers to allocate space for water pans to ensure households harvest water as a contingency measure during drought period. This venture will assist the County increase the number of acres under irrigation from

the current 1,866 hectares which is only 0.3% of the total cultivable area and allow farmers to irrigate crops during the drought period to reduce risk.

7.3 Factors affecting farmers ability in attaining and keeping resilient livelihood

Drought was the single most factor affecting farmers' ability in attaining and keeping livelihoods which are resilient. Almost 100% households depend on agriculture as their main source of income but it's highly affected by frequent droughts. This is clear that the county needs water conservation measures in order to carry out irrigation as indicated above. Thus, this strengthens and supports the need to plan for dams in the study area. In addition, animal fodder is a major challenge in livestock production. Information from the key informants indicates that fodder is only abundant during the rainy season but this is usually short lived once the dry spell kicks in. In other counties, such as Laikipia and Isiolo, a program by ASAL from the government supported farmers at division level to set up large scale fodder storage and bulking centres. This can also be planned and included in the County land use plan by allocating sufficient land for fodder production and construction of the fodder storage centres. This is mainly because livestock production is an important livelihood source for majority of households within the county. This can also be promoted at household level.

7.4 Policy interventions

To enable the County achieve the above land use, there is need for policy review to allow for allocation of land as well as sufficient funding for investment in communal dams for irrigation. Thwake river escarpment can be used to set up a huge dam that can serve people within the county and out of the county. The County can take advantage of the national Government plan to build a dam within the escarpment to supply water at the proposed Konza city by incorporating the dam in the strategic plan. The dam can be utilized within the county as well as the Konza city and can be utilised by farmers during the drought periods.

The study also recommends the construction of fodder bulking store at every location to enable farmers to store fodder during periods of plenty for use during dry periods. At the same time, farmers in the study area can be encouraged to have store at household level to boost animal production. To ensure these bulking centres have enough fodder for storage, there is need to put up policy structure that encourages the community to produce fodder in

large scale. This can be done by provisions that allow farmers to obtain inputs such as certified seed and fertilizers at reduced prices. Also changes to extension service should be evaluated and change from the current demand driven to ensure farmers have access to these service.

Radar chart (Figure 7) on sources of livelihood has shown that fruit trees (mangoes, oranges and paw paws) are a source that has emerged in the area to have contributed immensely to livelihood. With over 20% of household depending on fruits for their livelihoods, there is need to have a policy in the area that can assist in the growth of the enterprise. Processing plants for value addition also ought to be established in strategic plan to reduce exploitation of locals by middle men. If 10% tree cover policy is implemented will go a long way to support environmental conservation as well as improve farmers' incomes thus offering security to farmers.

The main road linking the former division headquarters to the County headquarters need to be improved. These roads are: Mavindine to Kathonzweni; Matiliku Wote and Kwa kavisi to Kathonzweni roads. These roads links the most productive part of the County with a diversified produce ranging from animals, vegetables, pulses and fruits. Also the County acts as the main producer of pulses (pigeon peas, cow peas, dolichos and greengrams) seed for KARI. Also with the increased demand for sorghum in the county by the two main brewers shows that the county need better infrastructure to enable Makueni to be competitive in the market thus improve their incomes.

As with other counties where marketing structure is cooperative based, such as Meru cooperative, Makueni need to put in place policies that will support a marketing organization owned by the farmers. This will enable collective marketing structure that will lead to reduced exploitation, higher income, and provide the county a bargaining power for their produce as well as purchases.

The big question that arises after this survey is whether current agricultural and other related policies in Kenya adequately responds to the highlighted problems and challenges by communities in semi-arid areas in enabling them to maintain livelihoods which are resilient to drought exposure? Some of the acts existing in Kenya are: Kenya Agriculture Act (Cap. 318) 1955 and revised in 2012 is an act of Parliament to promote and maintain a stable agriculture, to provide for the conservation of the soil and its fertility and to stimulate the

development of agricultural land in accordance with the accepted practices of good land management and good husbandry. This Act provides rules relative to good agricultural practice and in particular rules for the use of agricultural land and aiming at its development and preservation. Furthermore, the Act provides for administrative instruments to ensure a sound agricultural development and the marketing of agricultural products; The National Food and Nutrition Security policy 2011, which aim to: achieve good nutrition for optimum health of all Kenyans; increase the quantity and quality of food available, accessible and

affordable to all Kenyans at all times; and protect vulnerable populations using innovative and cost-effective safety nets linked to long-term development (Government of Kenya, 2011); The national ASAL policy 2012 which was titled 'Releasing our full potential', has five key elements among them affirmative action that equitable development needs the support of all Kenyans; an enabling environment for accelerated investment in 'foundations' to reduce poverty and build resilience & growth; a responsive government to the uniqueness of arid lands which include ecology, mobility, population distribution, economy and social systems. The policy also focuses on climate resilience requiring Government to find solutions to climate challenges and come up with measures to manage drought & strengthen livelihoods. All these elements are hinged on an institutional framework for their delivery. The ASAL Policy is complemented by Vision 2030 Development Strategy for Northern Kenya and other Arid Lands, which accommodates the unique realities of the ASALs to achieve the goals of Kenya Vision 2030. Through this policy, resilience study result can be employed to inform measures that the County government can propose and implement to bring out the potential of Asals; The IPRSP aims to facilitate sustained and rapid economic growth, to improve governance and security, the quality of life of the poor, equity and participation, and to increase the ability of the poor to raise their incomes (Government of Kenya, 2000b).

Therefore for Makueni County to make informed policy and choices on action plan to enable agricultural/ farming community to increase their income, adopt, acquire and maintain resilient livelihood, it requires information and clear evidence on the characteristic of agriculture dependent community and that which has proven resilient to past climatic related problems. Also production systems or technologies analysed in this study to provide an insight to farming systems that better cushions farmers by enabling sustenance of sustainable livelihood in the past using case base of a drought year.

The resilience framework assume that systems are relatively stable, and can lay groundwork for policies which help socioeconomic systems cope with, adapt to and even shape change. Furthermore, it provides a framework for combining both short and long term actions to increase resilience. With a history of short term action to alleviate food insecurity in the county, the framework will enable the County to include short term actions aimed at supporting households' own coping strategies during the acute phase of the crisis, and long term actions such as investment in health and education which build resilience over time.

By pin-pointing the specific factors which make household resilient, the framework gives decision makers clear indications of where to intervene. For example, the study shows how farmers fare when various variables are analysed to provide an insight into systems that have proved resilient to adverse weather conditions. The area of this study is an area with high incidences and history of drought, but from variables analyses, it's very clear that despite the trend, techniques adopted have assisted farmers to maintain their livelihood. Also, having examined farmers in the three categories, shows that there is prove without doubt that CA farmers can maintain their production in drought period where convention farming has failed. From the t test conducted for the four years of maize yield for households interviewed, its very clear that the yield differences are significant with 95% confident that CA farmers produces more than non CA farmers.

With the new Kenyan Constitution which paved way to devolution through the county government, a number of national government ministries (roles and activities) were devolved to the county governments. One such ministry is the Ministry of agriculture, livestock and fisheries development. As with the nation, almost all counties will depend on agriculture sector for revenue, ensure a food secure community and more resilient county. As policies are implemented at these levels, the study will play a role to inform Counties on farming systems that have been proven to build resilience. Conservation agriculture farmers in Makueni situation can be out-scaled and up-scaled at various levels, not only in Makueni County, but also to other asal counties with similar agro-ecological situations. From the study, Kathonzweni Sub County and conservation agriculture farmers' situation can play a major role in formulation and implementation of policies and by laws that can assist other farmers in the region and other community beyond. Thus production systems and technologies that have shown to have enabled farmers in Kathonzweni to maintain their livelihood even during

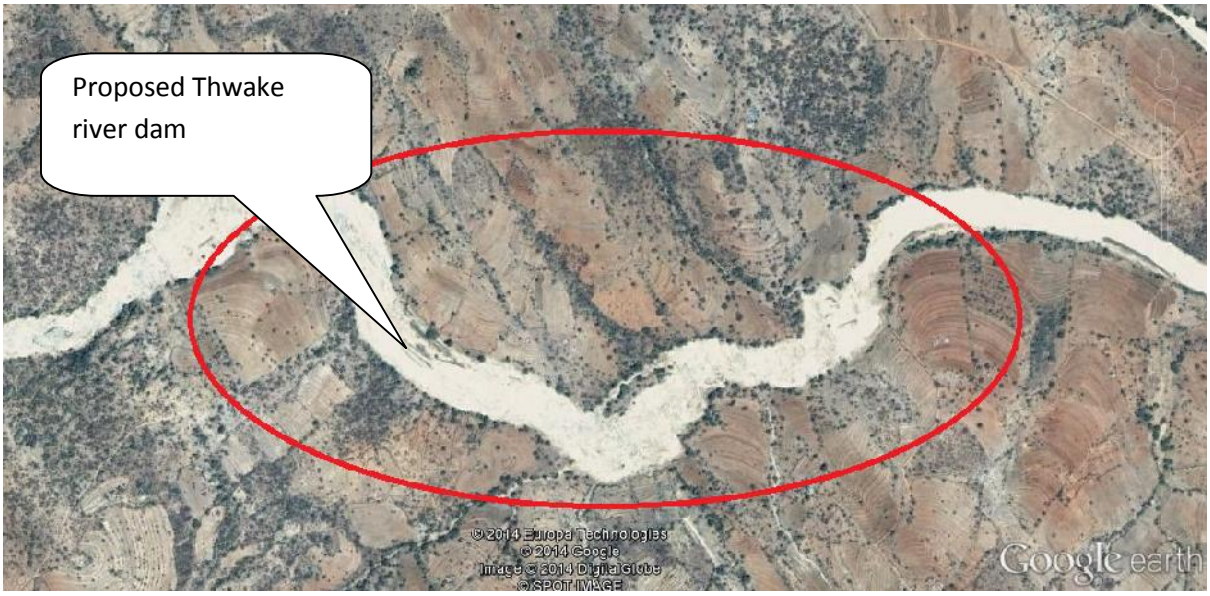
drought period must be promoted through generation of policies that favour practices that are sustainable.

Therefore, information generated through this study can be utilised to fill gaps in-order to increase the understanding of how communities cope with impacts of climate related problems, providing useful insights into the structure, and drivers of resilience and also useful lessons for ensuring sustainable livelihoods in the face of climate variability.

According to the respondents, the bulk does not only fall to the farmers but also the government need to do a lot in promoting and ensuring farmers livelihoods are resilient to climatic variation. Some of the issues raised are: issuing of farm inputs before onset of the rains to promote dry planting; protection of farmers through input price regulation; come up with irrigation policies and implement them; policies to discourage corruption in the sector; scrap demand driven policy on extension and offer extension to farmers; offering subsidised farming services (e.g. tractor services); offer soil test service to enable farmer to invest in soil fertility to improve yields; linking farmers to markets for produce; and finally to carry out research on farming and disseminate to the rural communities.

7.5 Summary of Recommendations

i. Allocate more land under various techniques that farmers have tested over a period of time and that they have proved seen benefits from these techniques. These are sub soiling, ripping, growing of drought escaping crops, water harvesting. These will go along way of improving farmers' welfare thus more food secure and more income.
ii. To minimise challenges faced by farmers in the process of marketing their produce, there is need to open up formal markets at ward level to minimize travel time to major towns. Already market centres exist but there is need to formalise markets that are structured. This will enable farmers to reduce their transaction costs during marketing. Such markets are Mavindini and Kateiko market in Kathonzweni Division.
iii. To cushion farmers from the adverse effect of poor weather (drought), there is need to promote rain water harvesting through construction of a dam at Thwake river escarpment. This will lead to damming of millions of litters of water and will lead to increased acreage under irrigation from the current 1,866 hectares in the county which is only 0.3% of the total cultivable area. This project is estimated to cost ksh 250 million.



Map 9: Proposed Thwake dam

iv. To boost the lucrative livestock production in the county, there is need to promote communal fodder stores as well as individual household stores. This venture has been done in other regions with success such as Laikipia. During time of plenty farmers can store their surplus fodder that can be used during dry periods. Communal stores can be done at location level to benefit as many farmers as possible.

This project is estimated to cost ksh 25 million.

v. Within the county, mangoes have proved to be a stable source of income to farmers but most season farmers sells mangoes at through away prices. To protect farmers the county needs to construct mango processing factories at the County head quarters to promote value addition at the same time improve farmers' income. This project is estimated to cost Ksh 55 million.

vi. To minimise marketing challenges, there is need for infrastructure improvement in the county. The county roads that connect farmers to markets need to be improved. Therefore this study proposes improvement of roads such as the Mavindini to Kathonzweni which is 23 km and Kwa kavisi to Kathonzweni roads which is 19 km. This project is estimated to cost ksh 65 million.

vii. A robust tree planting project in the county need also to be started to increase the current 0.2% tree cover to 10%. This should be done by setting certain days for tree planting exercise in the whole county. This project is estimated to cost ksh 10 million.

7.6 Summary of land use plan

a) Construction of mango processing factory at the County HQ

b) communal and households fodder stores

c) Allocate more land under CA technology

d) Opening up of formal farm markets at ward level to minimize travel time to major towns

e) Dam Thwake river escarpment Increase acreage under irrigation from 1,866 hectares which is only 0.3% of the total cultivable area

f) Infrastructure improvement- Mavindine to Kathonzweni; Mbooni Wote; Matiliku Wote and Kwa kavisi to Kathonzweni roads.

g) Tree planting

Figure 32: Summary of land use plan

7.7 Future areas of study in agriculture based resilient livelihood

It's important to note that this study assumed that farmers income are from sustainable sources thus need for a study to identify and map out negative coping mechanisms accrued from unsustainable sources or unethical practices When comparing the three categories, there is need to identify and analyse critically sources since some households could be resilient in the short term, because they are able to cope by engaging in unsustainable or unethical practices – for example, increased sale of firewood/charcoal where forest management is an issue, or early marriage of daughters. A key example from the study is the remittances source of income which is key source in the region, thus need to understand the genesis. Therefore, there is need to identify communities where resilience may be supported by negative adaptive capacity, as these will need to be re-classified as not resilient.

Another area that came out is on the need to have a comprehensive assessment pertaining social learning. Though it's said in various literatures that farmers learn from their neighbours, it was very clear that farmers neighbouring CA farmers do not learn nor adopt what neighbour farmer is implementing. This is a clear indication of poor learning among farmers at that level where a farmer has succeeded while neighbours are still ravishing in poverty. The question is why a farmer doesn't adopt models set up by other farmers within their neighbourhood?

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9 APPENDICES

9.1 Research instruments

9.1.1 Household Survey – Agricultural-Based Livelihoods Resilience

SNSF AMBIZIONE PROJECT PZ00P1_137068: RESILIENT AGRICULTURE-BASED LIVELIHOODS AND RESILIENT AGRICULTURAL LANDSCAPES? ADAPTATION TO CLIMATE CHANGE IN AFRICAN AGRICULTURE: CENTRE FOR TRAINING AND INTEGRATED RESEARCH IN ARID AND SEMI-ARID LANDS DEVELOPMENT (CETRAD), NANYUKI, KENYA / UNIVE.OF BERN, CDE/INSTITUTUTE OF GEOGRAPHY, SWITZERLAND / BUR 604: MA (PLANNING) 2013, UNIVERSITY OF NAIROBI, DEPARTMENT OF URBAN AND REGIONAL PLANNING.

Disclaimer: The information collected during this survey is purely for academic purposes and will not be divulged to any other person in whatever circumstance.

A: SITE CHARACTERISTICS

Questionnaire identification	Enumerator names:
District:	Tel. No:
Division:	Interview date:
Location:	Name of farmer group:
Sub-location	Category: Conservation agriculture farmer: [ ] Conventional agriculture farmer: [ ]
Village:	GPS Coordinate code: GPS Coord:
Respondent name:	Respondent Tel:
Time started:	Time ended:

B. RESPONDENT AND HOUSHOLD CHARACTERISTICS

2. Characteristics for members of the household

No	Name	Relation to HH-head	Age (years)	Gender (M/F)	Education level attained	How often on farm?	Main economic activity (work)?	What other work?
1	Household head	HH						
2	Respondent							
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

3. Type of the household headship (male/female/children) Male headed [ ] b) Female managed [ ] c) Female headed [ ]
d) Children headed [ ]

C. Financial/Economic capital (Incomes)

4. What are the sources of income from the following activities? Estimate amount for your household. (Household on-farm livelihoods diversity)

S/No	Source	Estimated amount per year (Kshs)	
		2011	**2012**
A	Casual labour		
B	Business (specify)		
C	Remittances		
D	Salaried employment		
E	Pension		
F	Fruit trees (pls. specify)		
G	Other trees		
H	Water sale		
I	Others; specify		

Comment:Off-farm income: From the above we can determine how significant off-farm income is for the household. (E.g. for "less than 10% of all income," "10-50%", ">50%")"

5. Household monthly expenditure Kshs.

a.	Item	Estimated Amount in Kshs
b.	Food	
c.	Clothing	
d.	Health	
e.	Education	
f.	Fuel	
g.	Rent	
h.	Transport	
i.	Water	
j.	Entertainment	
k.	Donations to relatives	
l.	Others (Specify)	
m.		

6. a) **Remittances**: Does the family receive support from other members living outside the homestead? Yes [ ]No [ ]

b) How often do you receive the money from family members?

	Amount	Sending person$_1$	Amount	Sending person$_2$
Weekly				
Monthly				
Occasionally (not often)				
Quarterly				

D. Natural capital

7. a) Household farms/plots

Plot no.	Size (acres)	Use in 2012 (a)	Distance/time to the farm (c)	How acquired? (d)	Tenure situation (e)	Legal status (f)	Crops (in order of importance)	Variety	CA/ TT
1(homestead)							a.		
							b.		
							c.		
							d.		
2							a.		
							b.		
							c.		
3							a.		
							b.		
							c.		
4							a.		
							b.		

a) Use (past year)

1) Food crop
2) Cash crop
3) Grazing
4) Fallow
5) Not used
6) Given out
7) Other (specify)

d) How acquired?

1) Inherited
2) Hired/rented
3) Purchased
4) Gift
6) Other (specify)

e) Land tenure

1) Trust land
2) Government land
3) Rented land
4) Family land
5) Settlement scheme
6) Publics
7) Freehold

f) Legal status of this land

1. Titled
2. Allotment letter
3. Self-allocation
4. Verbal agreement
5. Written agreement
6. No legal document

8. a) Amount of crops harvested and sales (2009 – 2010)

	Crop produced	**2009**		**2010**		**Avg Price 2009**
		Mar-Jun	Oct-Jan	Mar-Jun	Oct-Jan	
1	Maize: Harvest					
	Sales					
	Months sold					
2	Cow peas: Harvest					
	Sales					
	Months sold					
3						
4						
5						
Reason for sale	2009:			2010:		

b) Crop produce harvested and sold (2011- 2012)

	Crop produced	**2011**		**2012**		**Avg selling Price 2010 -2012**
		Mar-Jun	Oct-Jan	Mar-Jun	Oct-Jan	
1	Maize: Harvest					
	Sales					
	Months sold					
2	Cow peas: Harvest					
	Sales					
	Months sold					
3						
4						
5						
Reasons for sale	2011:			2011:		

9. Where do you sell your produce? a) Farm gate [ ] b) market centre [ ], c) formal marketing groups [ ], d) Others (specify

10. Crop produce (food) purchased (Quantity in Kg/bags 90kg/debes)

	Crop purchased	2009	2010	2011	2012	Avg buying Price 2009	Avg buying price 2010-2012
1	Maize: Amount bought						
	Month of purchase						
2	Cow peas: Amount bought						
	Months of purchase						
3							
4							
5							

11. Where do you buy/purchase produce?

a.....

b. .....

c. .....

12. Why do you grow these different types (mix) of crops?.....
.....
.....

13. How much do you usually use per month of the crops you produce? .....

Crops	Amount used (Kg)

E. Physical capital-household

14. **Any other functional assets that the household has?**

Indicate whether the household possesses the following items and how many.							
Car		Television		Plough		Bank savings	
Motorcycle		Radio		Modern furniture		Ripper/sub-soiler	
Bicycle		Cart		Wheelbarrow		Mobile phone	
Others (specify)							

15. Have you ever had to sell household assets? Yes [ ] No [ ]

If yes

Years of sale	Item sold	Reasons for selling

F. Livestock production

16. Do you keep livestock? YES[ ] NO. ([ ]

Livestock production ((TLU = 1 milk cow; distributed as follows for others: 0.7 for other cattle, 0.5 for heifers, 0.25 for calves, 0.52 for donkeys, 0.15 dairy goats, 0.1 for goats and sheep, 0.02 for other small stock like poultry-chicken). (Average market prices to be collected from a trader)

Animal	Number				
	2009	2010	2011	2012	Purpose/use
Milk cow					
Catlle-Bull					
Cattle Heifer*					
Cattle calfs*					
Donkey					
Dairy goats					
Goats					
Sheep					
Poultry					
Occupied Beehives					
Others					

* Use: livestock production/building herd

17. Do you sometimes sell your animals? Yes [ ] No. ([ ]

18. How many livestock did you **sell** in the last 2 years? (2011&2012)

Type of livestock	**No sold**	**Year(2011 or 2012)**	**Purpose**	**Price/unit**	**Where sold**

19. How many livestock did you **purchase** in the last 2 years? (2011&2012)

Type of livestock	**No bought**	**Year (2011 or 2012)**	**Purpose**	**Price/unit**	**Where purchased**

20. How many livestock products did you **sell** in the last 2 years? (2011&2012)

Livestock products	**No sold**	**Year (2011 or 2012)**	**Purpose**	**Price/unit**	**Where sold**

21. How many livestock products did you **purchase** in the last 2 years? (2011&2012)

Livestock products	**No bought**	**Year (2011 or 2012)**	**Purpose**	**Price/unit**	**Where purchased**

22. What are the main diseases affecting livestock and their possible causes? (to be compared later with information from extension officer)

Animal	Disease	Symptoms	Possible Cause (e.g. pests, etc.)	Common Season or Months
Cattle				
Sheep				
Goats				
Poultry				
Donkeys				
Bees				
Others (specify)				

23. List other major constraints faced in livestock production in order of seriousness.

……..
……..……..……
…….
…….

24. What other ways does your livestock production support your crop production?

……..
……..……..……
…….

G. Physical capital – services and infrastructure

25. **Nearest co**mmunity facilities and services

	Facility	**Name/ location**	**Mode of Transport**	**Time taken to facility**	**Provider (Public, Private, Others)**
a	School;Pry				
b	School; Sec				
c	Health facility				
d	Social hall				
e	Crop ext. services				
f	Livestock ext. services				
g	Village centre				
h	Recreation				
i	Worship				
j	Public libraries				
k	Slaughter houses				
l	Input market				
m	Food / Produce market				
n	Livestock market				
o	Other service				

26. Indicate distance to the nearest tarmac road on foot. .....

27. Indicate distance to the nearest murram road on foot. .....

28. Is there public transport along these roads? .....

29. How often do you have Matatu?.....

30. Indicate distance to the nearest market centre on foot (indicate time) .....

31. List the types of services at the market centre (not shopping centre)

    i) .....

    ii) .....

    iii) .....

    iv) .....

H. Site-specific knowledge

32. How many years have you continuously lived in this area/district? .....

33. How long have you worked in agriculture?
Years:……Months:……

I. Crop Production

Farming and cropping characteristics

34. a) Area under (i) Crops; …….. acres, (ii) Grazing: ……. acres

(iii) Farm Forestry/woodlot size:……..…..acres/No of trees …….

(iv) Grass / fodder: ……. acres

(v) Home compound: …… acres, vi) Others: …… acres

b) Trees grown

Nr. Natural	Nr. planted	Name (list)	Indigenous	Exotic

35. Which of the following technologies/ approaches do you apply?

	Techniques	Yes/ No	Gender (M/F)	No of years practiced	From whom did you learn the technique?	Rank the best 5 techniques	Reasons for adoption
	Minimum soil disturbance						
a.	Hand ripping (use of Jembe)						
b.	Oxen ripping						
c.	Hand Sub soiling (Use of Mattock)						
d.	Zero tillage (use of planting holes)						
e.	Pre emergence herbicide application						
f.	Post emergence herbicide application						
Soil cover (mulch and cover crop)? Yes ( ) No ( )							
g.	Mulching						
h.	Cover crops/green manure						
Crop rotation?Yes ( ) No ( ). If yes explain							
Other CA related techniques							
i.	Fallowing						
j.	Growing drought tolerant crops						
k.	Early planting						
l.	Terracing						
m.	Water harvesting						
n.	Zai pits						
o.	Intercropping (name crops)						

	Techniques	Yes/ No	Gender (M/F)	No of years practiced	From whom did you learn the technique?	Rank the best 5 techniques	Reasons for adoption
p.	Agro-forestry						
q.	Relay cropping (green manure)						
r.	Alley cropping						
s.	Cut off drains						
Conventional farming (TT)							
t.	Tractor ploughing						
u.	Hand ploughing						
v.	Oxen ploughing						
w.	Hand weeding						
x.	Oxen weeding						
y.	Others: specify						

36. If herbicides are used, name them

Name of herbicides	Seller	Frequency of use per season

37. What are the advantages and disadvantages experienced in the implementation of these {CA or TT (traditional tillage)} techniques?

Conservation tillage (CA)	**Traditional Tillage (TT)**
Advantages	**Advantages**
Disadvantages	**Disadvantages**

38. What machinery or equipment do you use for farm production

Machinery/Equipment	Ownership/Access	Costs of hiring if not own

J. Stewardship

39. How do manage your soils so that they can remain healthy?

Practice (e.g. manure, mulch, etc.)	Frequency per season	Effects on soil

40. Do you use fertilizer? Yes [ ] No [ ]

41. If yes, what type do you use and how many times do you apply in a season?

Type of fertiliser	Frequency of application per season

42. Where is fertilizer placed? a) Applied uniformly on soil surface [ ] b) applied as a band on the surface [ ] c) applied as a band below surface, usually 5-20 cm deep. [ ] d) banded with the seed at planting [ ] e) banded below the seed at planting [ ] f) banded below and to the side of the seed at planting [ ] Any explanations:

.....

.....

43. Where do you source seeds for planting?

Crop type	Source of seed

44. a) Where do you store your farm produce?

.....

.....

.....

b) What are the major storage problems that you face and how you address them?

Problems	Ways you address them	Rank effectiveness (1-4)

45. Have you received support in the form of inputs at a reduced price or free in the last 12 months?

Inputs	**Source**	**Use**

46. Crop production Gross Margin for **CA** for season Oct 2012-Jan 2013

Areas cropped (acres):	Units/Amounts	Costs	Who does what? (Gender)
A) INPUTS –Materials			
Maize Seed			
Cowpeas			
Manure			
Fertilizer			
Herbicide			
Other materials			
INPUTS-Labour			
Ripping			
Planting			
Sub-soiling (filing)			
Herbicides application			
1st Weeding			
2nd Weeding			
Harvesting			
Transport			
Processing harvest (threshing/winnowing)			
Any other cost			
Total Variable cost			
B) OUTPUTS			
Kgs harvested (Maize)			
Kgs harvested (Cowpeas)			
Value of Maize Output			
Value of Cowpeas Output			
Value of own consumption: Maize			
Value of own consumption: Cowpeas			

47. Crop production Gross Margin for **TT** for season Oct 2012-Jan 2013

Areas cropped (acres):	Units/Amounts	Costs	Who does what? (Gender)
C) INPUTS –Materials			
Maize Seed			
Cowpeas			
Manure			
Fertilizer			
Herbicide			
Other materials			
INPUTS-labour			
Ploughing			
Harrowing			
Ridging			
Planting			
Herbicides application			
1st Weeding			
2nd Weeding			
Harvesting			
Transport			
Processing harvest (threshing, winnowing)			
Any other costs			
Total Variable cost			
D) OUTPUTS			
Kgs harvested (Maize)			
Kgs harvested (Cowpeas)			
Value of Maize Output			
Value of Cowpeas Output			
Value of own consumption: Maize			
Value of own consumption: Cowpeas			

48. Do you have any other source of food other than own production?

Other sources	Tick	Explanation
a) Social grants (disability, child support)		
b) Pensions		
c) Business		
d) Formal employment		
e) Informal employment (casual labour)		
f) Poverty relief(government scheme)		
g) Relief food		
h) Remittances from relatives		
i) Loans		
j) Hunting		
k) Collecting wild plants		
l) Rely on neighbours		
m) Rely on friends		
n) Others (specify)		

49. If relief food is identified as one of the sources, how has it been in the last 5 years?

Sources	**Frequency**	**Quantity**	**Quality**	**Explanation**

50. What are the main diseases/pests affecting crops and their possible causes? (to be compared later with information from extension officer)

Crops	Disease	Symptoms	Possible Cause (e.g. pests, etc.)	Common Season or Months
Maize				
Beans				
Cowpeas				
Pigeon peas				
Others (specify)				

51. How does your crop production contribute to your livestock production?

……..
……
……

52. What are some of the major problems faced in crop production by the household? Arrange in decreasing severity.

……..

……

……

K. Natural capital

Water sector

53. Your current main water sources: Indicate distance and time taken (to & from).

Source	Distance (km)	Time to source (hrs.)	Time at source(hrs)	Months used (per year)	Ownership	Freq.	Amount of water fetched per trip	Cost	Who fetches water	Mode of transport	Water uses
Shallow well											
Water hole											
Bore hole											
Tank /Jar											
Dam											
River/ stream											
Others											

54. What amount of water does the household use daily?

55. If in table above, the household owns a water source, what necessitated you to develop your own water source?

……

……..

56. Do you practise rainwater harvesting? Yes [ ] No [ ]
57. If no (to above), why?

a)…..…….....

b) …….

c)……

58. Rain water harvesting techniques

RWH techniques applied	**Method1**	**Method2**
Catchment area		
Catchment method (silt trap etc.)		
Storage amount (M^3)		
Investment year		
Investment costs		
Maintenance costs		
Uses Domestic (cash equivalent): Irrigated area/crops (cash equivalent): Water sale (price per unit): Livestock watering (cash equivalent):		
Months water available in a year		
Problems in method; (water quality, health, maintenance, security, risks, enough water)?		

59. What types of water storage facility or facilities are in the homestead? Indicate capacity.

Type of storage facility	Capacity (litres)

60. Reliability of water supply for crop production (Mark the ones applied; Yes/No)

	Y/N	Explanation
Rain-fed		
post-flooding		
mixed rainfed-irrigation		
Full irrigation		

61. What major water-related problems do you experience here?

……
……
……

L. LEARNING

Knowledge base

62. Which languages do you speak and hear (understand)?

Speak	Understand

63. What training have you undergone in the last 5 years? (*Can also provide information about farmers' attitude towards innovation*)

Training topic	Who offered the training?	Year	Language	Duration (days)	What did you apply from what you learned?

Shared societal vision about conservation agriculture/agricultural production

64. In what ways are you **supported** in your crop production and by whom in the last 5 years?

Crop production support	Organization /person providing support	frequency	How did you use it in your crop production?	Rank importance of support (1-4)

Ranking: 1-not important; 2-somehow important; 3-important; 4- very important

M. SELF-ORGANISATION

Institutional analysis

65. Are there organizations in the area promoting agriculture and food security enhancement? Yes [ ] No [ ]
66. If yes, name them……

Organization	Activity	Year (s)	Importance to your household (rank 1-4)

Ranking: 1-not important; 2-somehow important; 3-important; 4- very important

Commitment to learning

67. Interactions with organisations - in the last 12 months, which extension meetings have you attended?

Topic	Organisation/actor	When	Benefits/outcomes

Farmer knowledge identification capability

68. What plans do you have on crop production in the coming season?

……..
…..……
……..……
…….....

69. What new inputs and practices (seeds, tools, technologies, approaches) have you tried?

Inputs/Practices	When tried	When last tried (Mth/yr)	Why? Reasons/Explanations	Innovation source

Knowledge sharing/transfer capability

70. What kind of support/advice did you **give** to other farmers in the last 12 months?

Support/advice provided	To whom?	Relationship	Frequency	Outcomes

71. What kind of support/advice did you **receive** from other farmers in the last 12 months?

Support/advice received	From whom?	Relationship	Frequency	Outcomes

Functioning feedback mechanisms

72. To whom do you go to when you seek support (information, money, inputs etc?) on crop production?

Problems faced	Person/organisation	Support received	Frequency of contacting the person	If in 2012, please tick	Rank usefulness of support/advice	Outcomes

***Ranking**: 1-not important; 2-somehow important; 3-important; 4- very important*

Knowledge feedback mechanism – Seasonal forecasts

73. Did you have any forecasts (from any source) about the drought event of 2009? **[YES] [NO]**
What was predicted? …….....…….....

……...

74. How accurate was the forecast? …….....…….....

75. What preparedness actions did you take? …….…….....

76. Did you consult any sources on the current season? (e.g. radio-meteo-reports, churches, astrologers, diviners, others.)? (YES)(NO)
Explain:……
……

77. What actions have you taken/will you take based on the prediction(s)?……

……

78. How often do you listen to the weather forecasts on radio? …….
……

N. Cooperation and networks – structural social capital

79. **Current group memberships** (*Farmers belonging to more groups are likely to improve their crop production resilience; Farmers with old memberships are more likely to improve their farm resilience than others with no membership/ less maturity*)

Group/ organisation name	Year of formation	Group activities	Nr of members	Household member	Member ship year	Freq. group meeting	Benefits (social capital)	Participation frequency of farmer/year	Role of hhld member	Rank 1-4

Ranking: 1-not important; 2-somehow important; 3-important; 4- very important

80. If member of a famer group, how many times have you missed the meetings of the farmer group in the last 12
months?.....

81. Reasons for missing meetings.

……
……..…..……
……..……
…….....

82. What other benefits do you get from relationships with other people in the last 6 months? (**Limit to 5**)

Person/relationship	Benefits	Frequency	Rank 1-4	Support you gave (reciprocity) to same person	Frequency

Ranking: 1-not important; 2-somehow important; 3-important; 4- very important

Trust (Cognitive social capital)

83. Tick where appropriate.

(Cognitive social capital, Barham J. and Chitemi C. 2009)	(1) Agree	(2) Neutral or ‘‘middle”	(3) Disagree
Most members in your village can be trusted (General Trust);			
Most members in your village are willing to help if you need it (Help Trust);			
In your village, members can generally trust each other in matters of lending and borrowing money (Money Trust).			

Social network (social learning):(measure of information on minimum soil disturbance from social networks)

84. How many of the people you know are practising minimum tillage?

85. How many of these belong to your household?

86. How many of these are neighbours and friends in the village?

O. Network structure

87. Which three (3) households do you exchange (give/receive) information, labour, food, or money in times of stress such as the 2009 Drought?

Production activities	Name of household	Relation to each Household
Information		
Labour		
Food		
Money		
Others:		
Others:		

Friend, relative –specify etc.

Lending network

88. Are there person(s) who you cannot do without their support to carry out your crop production?

Person/relationship	Activity/support

89. Are there any persons who cannot do without your support to carry out their crop production?

Person/relationship	Activity/support

P. Labour exchange/reciprocity:

90. If you needed **people outside your household** to help you for free in agricultural work (land clearing, planting), whom would you ask? (in order of importance) **[if existing up to 10)**

	Person	Relationship	Activity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

91. What do you think can be improved so that changes in rainfall do not harm your farm production?

a. What can you do as an individual?

……

……..……

…….....

.....

b. What can the household do?

……

……

…….....

.....

c. What can the Government do?

…….

…..……

…….....

.....

d. What can other actors do?

…….

…..……

……

……

92. Do you have traditional ways of determining the suitability of soils for cultivation? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……
……
……
(c) Which ones do you apply?……..……
…….
……
……
93. Do you have traditional ways of protecting crops from drying? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……
……
……
(c) Which ones do you apply?……..……
…….
……
……
94. Do you have traditional ways of protecting crops from pest and diseases? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……
……
……
(c) Which ones do you apply?……..……
…….
……
……
95. Do you have traditional ways of protecting livestock from pest and diseases? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……
……
……
(c) Which ones do you apply?……..……
…….
……
……
96. Do you have traditional ways of preserving seeds? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……

……
……

(c) Which ones do you apply?……..……
…….
……
……

97. Do you have traditional ways of preserving harvests? (a) Yes [ ] No [ ]; (b) If yes, how?.....
……
……
……
……

(c) Which ones do you apply?……..……
…….
……
……

98. Do you have traditional knowledge of rainfall patterns in this area? (a) Yes [ ] No [ ]; (b) If yes, please explain?.....
……
……
……
……

(c) How do you use this knowledge?……..…….
……
……

Q. OBSERVATIONS

99. Housing: What is your **main house** constructed of? (*Observation rather than ask the building structure types)* (a) Roof [ ] (b) Walls [ ] (c) Floor [ ]

Type of roof

1= thatch - grass 2= iron sheets 3= tiles 4= others……..

Type of walls

1= mud 2= wood 3= stone/brick/cement 4=iron sheets 5.others……

Type of Floor: 1= *earth 2= wood 3= stone/brick/cement 4= others……*

100. Do you have a toilet /latrine? Yes [ ] No [ ]

101. If yes, what type?

102. Assess the present status, materials of construction, general cleanliness, hole cover, etc.

……

……

……

Comment on the interview:

……

……

……

9.1.2 Focus group discussion

CA ☐

Non CA ☐

Farmers Present

Name	**Phone Number**
i. ……	……
ii. ……	……
iii. ……	……
iv. ……	……

Facilitators

i. …….
ii. …….

1. What are the benefits of conservation agriculture (CA?)

2. Challenges faced by farmers practicing CA

3. Reasons for adoption of CA and continued practice

4. The adoption of different CA techniques by farmers:

Technique	Number of farmers practicing

Reasons for selective adoption of the CA techniques

Reasons for not practicing CA on the whole shamba

5. Government support for CA in particular and agriculture in general and NGO/research support in general

6. CA impact on food production

7. CA impact on soil

8. Problems faced in practicing CA, how to address them

9. Why are they not adopting across the whole farm?

10. How many farmers were affected by the 2009 drought?

11. What is needed to improve crop production in the area especially against rainfall variability?

12. Potential of livestock fodder production in the area.

13. Collective action issues –what issues in crop production could be improved through collective action?

14. Sub –soiler, ripper:-if they were provided a rip[per/sub-soiler on a cost use basis ,how many are willing to use them?

15. A lot of erosion (gully erosion) on roads and footpaths, sometimes on the farms –could they provide more information on this and the effect on their crop production?

16. Besides economic costs of adopting CA, are there other costs (e.g. social costs, environmental cost etc.) which need to be considered?

17. If lack of capital mentioned as a problem in crop production and adoption of CA-Assuming a farmer had a choice to buy herbicides for crops and money was provided for this ,would they purchase the herbicide (opportunity costs).Also ask for fertilizer.

18. Marketing of farm produce

	Selling Price (Ksh./Kg)		Buying Price(Ksh./Kg)	
Crop	Highest	Lowest	Highest	Lowest

19. General farming challenges in crop production.

20. Institution working in the area towards food security.

21. Livelihoods sources/resources in the area and what is sourced outside the region

22. Calendar of daily activities

23. Questions from farmers

9.1.3 Key informant questionnaire

Name of respondent

……..

Name of Organization

…….

Date

……..

1. Main overall goal of the organization

   ……

   ……

   ……

   ……

   ……

   ……

2. Areas of operation in Makueni

   ……

   ……

   ……

   ……

3. Project(s) previously undertaken or going on in Kathonzweni District (indicate the project activities and the duration)

   ……

   ……

   ……

   ……

   …….

4. Other resilient building project and where implemented

   ……

   ……

   ……

   ……

   …….

5. Approaches used by the organization to promote resilient building in the region.

   ……

   ……

   ……

   ……..

6. What's the best approach (es) that have proved to be reliable in dissemination of the project(s) activities?

   ……

   ……

   ……

7. Has the project met its goals and objectives

   ……

   ……

   ……

   ……

   ……..

8. Does the organization provide relief to the community? If yes, provide the trend of quantities for the project duration

……

……

……

……

……

9. What are the future plans of the organization in the region and in the country to promote resilient livelihood?

……

……

……

……

10. What are the challenges faced by the organization in the implementation of the project? Please provide solution to the challenges?

……

……

……

……

……

……

……

……

……

11. What do you think can be done to further improve livelihoods which are resilient to changing weather variation?

Household level

……

……

……

Organization level

……

……

……

The Government

……

……

……

……