AN ANALYSIS OF HOW SMALL SCALE ARABLE FARMERS ARE ADAPTING TO THE IMPACTS OF CLIMATE VARIABILITY: A CASE STUDY OF CHISARE VILLAGE IN CHERANGANI, TRANSAZIA EAST SUB-COUNTY

By

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N36S/16466/2009

A research project submitted to Kenyatta University in partial fulfillment of Bachelor’s Degree course in Environmental Planning and Management

APRIL 2014
DECLARATION

I hereby declare that, to the best of my knowledge, this work is my original work and has never been presented to any other academic institution for an award of degree or any other academic award.

Signature …………………………….  Date …………………………….

Mungo Carol Chepkemoi

N236S/14466/2009

This work has been submitted for examination with my approval as a university supervisor.

Signature …………………………….  Date …………………………….

Mr. Dekow Mohammed

Kenyatta University

Department of Environmental Planning and Management
DEDICATION

I dedicate this report to all small scale arable farmers in Trans-Nzoia especially one Mr. Robert Masibo who experienced a harsh mini cyclone in 2011 that brought down five greenhouses he had invested in.
ACKNOWLEDGEMENT

I would like to foremost acknowledge the almighty God for enabling me to carry out the project from inception to completion.

I also sincerely thank the following people for their help and support in doing my project to a successful end; my supervisor, Mr. Dekkow Mohammed for his unwavering support and guidance throughout the project, all the farmers who duly filled my field questionnaires and lastly, Chisare Secondary School teachers for being very supportive with information about the area and the trends in farming pattern in the area.

I appreciate the patience and time of representatives from Kenya Seed Company Limited, Kenya Agriculture Research Institute (KARI), National Environment Management Authority (NEMA) and the Ministry of Agriculture for giving me important interviews with very valid information that quenched my research thirst.

Lastly, I would like to sincerely appreciate my parents and fellow students’ for their motivation throughout my entire research project process.

I appreciate anybody who in one way or another helped in making this project a success even though I may not have mentioned their name. Thank you all, may God bless you abundantly.
ABSTRACT

The recent irregular trends in weather patterns have brought about challenges and opportunities in key sectors of the economy especially in developing countries. Agriculture and tourism are just but examples of these sectors that have been widely impacted by climate variability. Countries as Kenya where agriculture and tourism are the leading earners of the economy has seen a downhill scale in the recent years and climate variability is one of the factors that can held responsible. This challenge is not only posing a threat to the economy of a nation but on food security as well.

The study was carried out in a small village in Cherangani Constituency-Trans-NzoiaEast Sub County called Chisare. It aimed at assessing the impacts of climate variability to small scale arable farmers in Trans-Nzoia; evaluating the adaptation strategies to climate variability by small scale arable farmers in Trans-Nzoia; assessing the existing farming methods among small scale arable farmers in Trans-Nzoiaand developing a climate variability adaptation action plan.

Both secondary and primary sources of data were used in collecting data. A sample of 25 small scale arable farmers and 4 institutional interviews were used in data collection. Additional primary data was collected through observation and photography. Data analysis was conducted both qualitatively and quantitatively to derive various attributes according to the research objectives.

Result from the data analysis show that although efforts are being made by small scale arable farmers who largely depend on weather patterns for growth of their crops, the agriculture sector is generally facing challenges from the recent drastic change in weather
patterns threatening food security in the country because Trans-Nzoia is one of the food basket counties in Kenya and therefore it needs urgent actions to avert the situation. The study proposes a climate variability adaptation action plan which can be used to promote the capacities of farmers to adapt to this current situations.
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LIST OF ACRONYMS

CAN- Calcium Ammonium Nitrate

CSOs- Civil Society Organizations

DAP- Di-ammonium Phosphate

GHGs- Green House Gases

IPCC- Inter-governmental Panel on Climate Change

KARI- Kenya Agriculture Research Institute

KFS- Kenya Forest Service

LT- Long Term

MDGs- Millennium Development Goals

MLN- Maize Lethal Necrosis

MT- Medium Term

NEMA- National Environment Management Authority

ST- Short Term

UNFCCC- United Nations Framework Conventions on Climate Change
1 CHAPTER ONE: INTRODUCTION

1.1 Background to the Problem

“One of the biggest obstacles to making a start on climate change is that it has become a cliché before it has even been understood” - Tim Flannery, 2013. For that reason, how can one understand climate change?

Planet earth is facing a huge problem named Global Warming. This is caused by the invisible greenhouse gases which insulate the Earth. They trap the sun's heat and keep the planet warm enough to sustain life. Some greenhouse gases in our atmosphere do exist naturally. But a large portion of the greenhouse gases in our atmosphere today have been, and continue to be, created by humans. This means that more of the sun's heat is being trapped than the Earth actually needs. Hence, too much heat is being trapped, and the planet is warming too much in turn. Global warming is affecting weather patterns all over the world and this effect is what's known as climate change.

A region's climate means the usual weather patterns and conditions of a region. So, a change in weather patterns and conditions is a change in climate. The world's weather patterns are changing. This includes temperature changes (warming in some places and cooling in others) and altered rainfall patterns, as well as more frequent occurrences of hazardous weather events like droughts and floods. Changing climates pose risks to the health and safety of people, wildlife, forests, farms and water supplies.

Climate change has posed measurable ramifications on the source of income of small scale farmers. It has been predicted that the adverse impacts of climate change are
expected to lead to production losses in the sector, compromising the attainment of the Millennium Development Goals (MDGs), especially Goal 1 “Eradicate Extreme Poverty and Hunger” and Goal 7 “Ensure Environmental Stability”.

The UNFCCC (United Nations Framework Convention on Climate Change) highlights two fundamental response strategies: mitigation and adaptation. While mitigation seeks to limit climate change by reducing the emissions of (greenhouse gases) GHG and by enhancing carbon reduction (sink) opportunities, adaptation aims to alleviate the adverse impacts through a wide-range of system-specific actions. Sensitivity to the issue of adaptation has grown over the last couple of years and it has now emerged as an urgent policy priority, prompting action both within and outside the climate change negotiations. According to (The Energy and Research Institute-TERI, 2012), adaptation to climate change is a new process for both developed and developing nations and concrete experience in applying an integrated approach to adaptation is limited. It involves coping with climatic change – taking measures to reduce the negative effects, or exploit the positive ones, by making appropriate adjustments. The level of preparedness of a person, community or nation refers to pre-defined emergency actions that could be activated when extreme climate events or natural disasters occur in order to minimize damages which are likely to result.

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC-Intergovernmental Panel on Climate Change , 2007) . Thus, the adaptive capacity of a system or society describes its
ability to modify its characteristics or behavior so as to cope better with changes in external conditions. The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Hence, there is an urgent need to identify approaches that strengthen the adaptive capacity of farmers and enhance their ability to respond to climate change.

Farmers around West Africa, Ghana in Accra have considerable experience in dealing with climate variability, the outstanding levels of variability is associated with long-term climate change within the realm of traditional coping strategies as crop diversification.

For most countries in East Africa, small-scale agriculture is the main economic activity and source of livelihood for most people living in rural areas. Agricultural development is therefore likely to play a crucial role in the future development of this region. Strategies for this type of development include ways to help small-scale farmers cope with climate variability. Climate variability and change is devastating for East African countries such as Ethiopia and Kenya, where smallholder farmers depend on rain fed agriculture. The agricultural sector in these areas is particularly vulnerable to adversities of weather, not only because farmers depend on rain, but also because farming is subsistence-oriented and is practiced with relatively basic technologies on small pieces of land (Davis, 2009).

Farmers in Chisare Village in Trans-Nzoia East Sub-County are experiencing inconsistent rainfall pattern, frequent droughts and dry spells, high temperatures which increase evaporation of soil moisture to name but a few. All this are directly affecting crop yield production in the area. In 2014, the county produced 4.5 million bags of food but the future of this crucial cash and food crop is at a crossroads. Most farmers have no
explanation for the change while others blame the drastic change on the ‘traditional gods’ claiming they are angry with them.

Therefore, the adaptive capacity of small scale farmers should be strengthened to deal with this change in weather patterns and minimize loss.

1.2 Statement of the Problem

Kenya’s continued reliance on maize from the traditional North Rift counties of Nandi, UasinGishu and Trans Nzoia is becoming unsustainable.

It is obvious that unless concerted efforts are made to reduce the crippling uncertainty of rain-fed agriculture through irrigation, many farmers will fight a losing battle with a hostile climate.

Small scale arable farmers in Trans-Nzoia are confronted with the starkest of dilemmas in having to produce more food efficiently, under more volatile conditions.

It is clear that there is need to adapt to technologies that reduce the vulnerability of rural communities to climate change. It is with this in mind that this study has been designed to find out how small scale arable farmers are adapting to climate variability to ensure consistency in crop yield production.

1.3 Research Questions

The study was guided by the following research questions:-

a) What are the existing farming methods?
b) How is climate variability affecting farming and crop yield production?

c) Are farmers aware of climate variability adaptive farming tools?

d) What are the farmers doing to adapt to climate variability and enhance food production in the area?

1.4 Research Objectives

The study was guided by the following objectives:

a) To assess the impacts of climate variability to small scale arable farmers in Trans-Nzoia

b) To evaluate the adaptation strategies to climate variability by small scale arable farmers in Trans-Nzoia.

c) To assess the existing farming methods among small scale arable farmers in Trans-Nzoia

d) To find out the role of different institutions in capacity building on adaptation to climate variability among farmers in Trans-Nzoia.

1.5 Research Premises

a) The research work was based on the premise that:-

b) Farmers are aware of the existence of climate variability.

c) Farmers are not exposed to climate variability adaptive tools.
d) Farmers are not willing to adopt to alternate farming methods which are adaptive to climate variability.

1.6 Justification of the study

The UN’s Intergovernmental Panel on Climate Change (IPCC) recently in its most comprehensive assessment of the impact of climate change, warned that the yields of maize, rice and wheat will decline by 25 per cent by 2050, when the world population will have hit the nine billion mark. Scientists have pointed out that Southern Africa could lose more than 30 per cent of its maize crop by 2030 due to climate change.

Trans-Nzoia is the leading producer of maize, Kenya’s staple food hence it is often referred to as the food granary of the country. In 2012, it produced 4.5 million bags but recent fears have expressed that the future of this crucial cash and food crop is at the crossroads.

This is a ripple effect because if the crop yields are very low, it means the county will not be able to feed the wider country especially drought stricken counties as Wajir and Turkana who majorly depend on such Strategic Grain Reserves (SGR) and relief aids programs. Therefore, cases of food insecurity leading to deaths of people and livestock will automatically increase. This research is therefore mandatory for Trans-Nzoia mainly because of the wave effect that will be caused by the continuous decrease in food production as a result of drastic change of rain patterns.
1.7 Significance of the study

This study aims to echo and address the fact that currently no is going to be left untouched by the effects of climate change. Adaptation is the means of anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later.

This study will help farmers in Trans-Nzoia realize the need to become accustomed to new and improved technologies, skills and knowledge, or to be linked to existing technologies which are currently inaccessible in order to adapt to the recent climate variability. These may include, for example, improved water management such as using rainwater harvesting or soil stabilization techniques; soil conservation and erosion control through terracing and agro forestry; and greater use of renewable energy through biogas and solar.

Farmers in Trans-Nzoia County will reduce instances of loss once exposed to this farming methods and techniques that are going to favor their crops and introduce new techniques that are climate smart in their farming.

The findings of this study would provide information and motivate agricultural institutions and managers in enacting policies that can provide adequate preparation for farmers to engage in climate smart agriculture.
The study will also help support county governments realize or implement initiatives already in place being undertaken in relation to adapting the impacts of climate variability among farmers in Trans-Nzoia.

1.8 Scope of the study

The study was carried out in Chisare Village in Cherangany, Trans-Nzoia East Sub-County of Kenya. The study primarily focused on small scale arable farmers’ mainly cultivating crops as maize, beans, bananas, potatoes among others. The study assessed farmer’s involvement in climate smart agriculture and what they are doing in regard to utilizing alternative farming methods as a way to cope with climate variability. The study mainly focused on documenting the impacts of climate variability on crop yield production and also in identifying the role of institutions in capacity building of these farmers. The information collected was used to make conclusions, recommendations and come up with project to foster knowledge, attitude and practice of climate variability adaptive tools.

1.9 Limitation of the study

The following are the likely limitations of the study:

1. Since the County covered is in a rural set-up and the findings may differ from a study carried out in an urban setting hence any generalization should be done with caution.

2. Limitations in regard to context where it was difficult to explain some concepts to the farmers in the rural setting which was unheard of such as climate change.
3. The study area was also partially covered due to limitation in time and human resource with samples being used to represent the whole area.

### 1.10 Operational terms

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<td><strong>Adaptive capacity</strong></td>
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<td><strong>Climate Change</strong></td>
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<td><strong>Climate Variability</strong></td>
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<td><strong>Climate-smart Agriculture</strong></td>
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<td><strong>Mitigation</strong></td>
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<td><strong>Mixed farming</strong></td>
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<td><strong>Small scale farmer</strong></td>
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Source: Researcher, 2014
2 CHAPTER TWO: LITERATURE REVIEW

2.1 EFFECTS OF CLIMATE CHANGE ON AGRICULTURE

The Inter-Governmental Panel discussion on Climate Change (IPCC) in their most recent report predict that climate change will lead to decreasing crop yields in most tropical and sub-tropical regions owing to alterations in temperature and precipitation patterns, thereby negatively impacting on agricultural sectors and worsening the prevalence of hunger in developing countries (International Institute for Environment and Development (IIED), 2012). Climate variability will increase almost everywhere. Northern latitudes will experience more rainfall; many subtropical regions will see less.

(Food and Agriculture Organization (FAO), 2007) reported that up to 11% of arable land could be highly affected by climate change in the developing world.

Brazil and other nations of Latin America and the Caribbean, are more negatively affected by climate variability. The explanation for this is their location, predominantly at low latitudes; in these areas, temperatures are already too hot, sometimes above optimum levels for agriculture. In low latitudes, the rural poor tend to live in the hotter and drier regions of each country. Climate variability is likely to damage these regions more severely than the more temperate zones of each country. Moreover, according to Cline (2007) and Stern (2007), as the sector accounts for a significant portion of the income in developing nations, a certain percentage reduction in agricultural potential would lead to higher losses than in developed economies
Africa is among the continents most vulnerable to climate change and climate variability. In addition to inflicting these direct climatic impacts, climate change will compound the existing vulnerabilities of smallholder farmers, as a result of poverty, sensitivity of their geographical locations, high dependence on natural resources and limited capacity to adopt new livelihood strategies. Smallholder farmers are particularly vulnerable given their marginalized status and dependence on climate-sensitive livelihood strategies.

Figure 2-1: A pictorial summary of some effects of global warming on agriculture
Source: UNFCCC website

2.1.1 Crop yield production

According to (International Livestock Research Institute, 2009) due to climate variability, maize yields will decline drastically, almost to zero in some regions. They go further to explain that such precipitous declines, which could displace human populations, altogether, can be addressed only by making major changes to the current agricultural
system. An example to this is practicing agro forestry, mixed farming, utilizing soil and water conservation technologies among others. Some regions as Eastern Brazil have predicted maize yields to moderately decrease up to 25% if there are no changes in the current production practices. In this case, scientists think that farmers will be able to maintain if not increase their current production levels by applying different maize breeding and agronomy practices. This if widely adopted will reduce instances of loss in the sector and to the national economy.

Contrary to the belief of loss, elsewhere, such as in the Ethiopian highlands around Addis Ababa, smallholder rainfed maize production benefit from climate change, with yields in some areas as much as doubling due to constant rain in the area.

As a developing country, Kenya is equally vulnerable to climate change because we heavily depend on agriculture which tends to be relatively warm already, in addition to lack of infrastructure to respond well to increased variability and lack of capital to invest in innovative adaptations poses a great threat to the production of crops in the area.

Recently, due to the unprecedented climate change-linked phenomena have resulted in the waters of Lake Baringo and Lake Bogoria submerging farms under the Perkerra and Eldume irrigation schemes, spelling doom for an already food insecure Baringo County.

The Daily Nation echoes these discussions by explaining that Trans-Nzoia County is the food granary of the country because of its good potential farming area with very favorable farming conditions that supports a vast diverse variety of crops to grow. The main cash crops grown in the area are maize, tea, sunflower, coffee, pyrethrum and
beans. These crops have been largely affected by the drastic change in weather patterns in the area which has led to declining crop yield posing a food security threat in the country.

Last year the county produced 4.5 million bags but the future of this crucial cash and food crop is at a crossroads (Daily Nation, 2013). A combination of factors including climate change, expensive inputs and inadequate seed supply has all led to a drop in production.

The soils have also become too acidic over time affecting not only growth of crops with addition of fertilizer but also have affected dairy farmers by leading to a drop in milk production.

2.1.2 **Emerging new diseases**

(Environmental Protection Agency (EPA), 2013) has stated that many weeds, pests and fungi thrive under warmer temperatures, wetter climates, and increased Carbon Dioxide levels. Currently, farmers spend more than $11 billion per year to fight weeds in the United States. The range weeds and pests are likely to expand and this would cause new problems for farmers crops previously unexposed to these species. Moreover, increased use of pesticide and fungicides may negatively affect human health.

Farms are being infested by new emerging diseases that are resistant and have affected growth of crops. The recent dreadful disease in the area that has led to declining maize production is the Maize Lethal Necrosis disease (MLN).

The disease was first identified in the USA in 1976 (Niblett and Claflin 1978). MLN is caused by the double infection of maize plants with Maize chlorotic mottle virus
(MCMV) and any of the cereal viruses in the Potyviridaegroup, such as Sugarcane mosaic virus (SCMV), Maize dwarf mosaic virus (MDMV), or Wheat streak mosaic virus (WSMV). MCMV or SCMV typically produce milder symptoms when they infect maize alone; in combination, these two viruses rapidly produce a synergistic reaction that seriously damages or kills infected plants.

**Tanzania:** In August 2012, reports of an unknown maize disease emerged from Mwanza, near Lake Victoria, and Arusha. Infected plant samples from the Mwanza and Arusha regions were serologically positive for MCMV a SCMV, confirming the presence of MLN.

**Kenya:** Initial reports of an unknown disease outbreak surfaced in September 2011 in the Bomet county in the South Rift Region; further reports appeared in early 2012 in Naivasha, Narok North, Narok South, Chepalungu, and Sotik, as well as parts of the Eastern Province (Embu and Meru) and the Central Province (Murang’a, Kirinyaga, and Nyeri). MLN has also been reported recently in Trans-Nzoia, UasinGishu, and Busia.

*Plate 2-1: Maize field infected by the Maize Lethal Necrosis Disease*

*Source: Researcher, 2014*
o What are the typical symptoms?

- *Mild to severe mottling on the leaves, usually starting from the base of young leaves in the whorl and extending upwards toward the leaf tips.*

- *Stunting and premature aging of the plants.*

- *Dying (known as “necrosis”) of the leaf margins that progresses to the mid-rib and eventually the entire leaf.*

- *Necrosis of young leaves in the whorl before expansion leading to a symptom known as “dead heart” and eventually plant death.*

2.1.3 Economy loss

According to (Environmental Protection Agency (EPA), 2013) more extreme temperature and precipitation prevent crops from growing. Extreme events, especially floods and droughts harm crops and reduce yields as in 2008, the Mississippi River flooded just before harvest period for many crops causing an estimated loss of $8 billion for farmers.

The economies of many African nations are dependent on sectors that are vulnerable to climate conditions, such as agriculture, fisheries, forestry, and tourism. Agriculture and natural resources provide the livelihood for 70% to 80% of the population, and account for 30% of GDP and 40% of export revenue in Sub-Saharan Africa. In Sub-Saharan Africa agriculture employs 60% to 90% of the total labor force.

Agriculture continues to be the leading sector in the Kenyan economy in terms of its contribution to real GDP (Government of Kenya, 2010). It contributed 36.6% of GDP in
the period 1964–74, 33.2% in 1974–79, 29.8% in 1980–89, 26.5% in 1990–95 and 24.5% in 1996–2000. During the same periods the manufacturing sector recorded a growing contribution to GDP of 10%, 11.8%, 12.8%, 13.6% and 13.3%. Between 1993 and 1998, however, the contribution of agriculture to GDP stagnated at 25% while that of manufacturing declined from 13.8% to 13.3%. In spite of the decline in the agricultural sector’s contribution to GDP, it remains one of the most important sectors driving economic growth. Agriculture is, however, the largest contributor to employment despite fluctuations in the percentage share. A large proportion of the labor force (82%) is based in rural areas, while small-scale agriculture absorbs the largest share of new additions to the labor force (Karanja, 2007). The agricultural sector accounts for about 70% of export earnings, with food and beverages constituting over half of the total export earnings. Agriculture is also responsible for providing food security for both the rural and urban populations. However, rapidly expanding population, rapid urbanization and the shortage of high potential arable land cause occasional imbalances between the national demand for food and its supply.

Agriculture remains central to the economy and the growth of the sector is positively correlated to growth in the overall economy.

According to the (Agricultural Sector Development Strategy, 2009-2010) the sector contributes 24% of the country’s GDP and employs 70% of the population in both basic production and industry (Government of Kenya 2009). The sector is also given priority under the economic pillar, one of the three growth pillars envisioned in Kenya Vision 2030, the road map by which the country hopes to arrive to at a newly industrialized
status by the year 2030 (Government of Kenya 2007). Agriculture in Kenya is mainly rainfed and is practiced by smallholders, who have noticed changes in weather patterns and have employed various coping mechanisms (Macharia et al. 2010; Kuria 2009).

2.2 ADAPTATION TO CLIMATE VARIABILITY

(International Food Policy Research Institute, 2009) states that the ability of smallholder farmers in developing countries to cope with the effects of climate change is impacted by limited capacity, few alternative sources of income, lack of expertise, and lack of appropriate public policies and financing.

This argument was supported by (Dani, 2006) who highlighted that it is important for farmers first notice that the climate has changed, and then identify useful adaptations and implement them and the ability of a nation or region to adapt to climate change has been said to relate closely to its level of wealth, strength of educational institutions and access to technology.

Further (International Food Policy Research Institute, 2009) explained that in Europe, adaptation policy has been developed across all levels of government, with some adaptation planning integrated into coastal and water management, into environmental protection and land planning, and into disaster risk management while in Africa, most national governments are initiating governance systems for adaptation. Disaster risk management, adjustments in technologies and infrastructure, ecosystem-based approaches, basic public health measures, and livelihood diversification are reducing vulnerability, although efforts to date tend to be isolated. Farmers have poor access to technical or financial supporting mechanisms and they lack the capacity to strategically
confront future challenges. Therefore, they need support to deal with the emerging challenges in order to intensify research and develop both mitigation and adaptation strategies.

(Gbetibouo, Farmers adaptive capacity to climate change and variability, 2009) went ahead and emphasized that agricultural adaptation to climate change practices consists of various scales (local, regional, global), actors (farmers, firms, government), and types:

a) Micro-level options, such as crop diversification and altering the timing of operations;

b) Market responses, such as income diversification and credit schemes;

c) Institutional changes, mainly government responses, such as removal-preserve subsidies and improvement in agricultural markets; and

d) Technological developments—the development and promotion of new crop varieties and advances in water management techniques

2.2.1 Best adaptation practices in Africa

In South Africa, as a way to cope with these changes, a few women become members of the Rawsonville cooperative run by Oxfam's partner organization, Women on Farms Project. The organization aims to help seasonal and unemployed workers who suffer from adverse effects of climate change to increase their income. Their cooperative grows gourmet mushrooms, which they sell to a commercial farmer in Stellenbosch. The women receive a stipend of 500 Rand (US $60).
In Nigeria, the main system for clearing a farm land is bush burning. And it is this type of activity has been known to increase CO₂ emissions engendering global warming, climate change and sea level

The main adaptation strategies of farmers in the Limpopo River Basin are switching crops, changing crop varieties, changing planting dates, increasing irrigation, building water-harvesting schemes, changing the amount of land under cultivation, and buying livestock feed supplements.

In Uganda, (Twinomugisha, 2014) describes in his research the use of traditional strategies like the natural processes and resources in which farmers generally avoid eliminating all weeds in the soil because they can counter the impact of pests that attack certain crops. Community elders explained how traditional knowledge considers the interdependencies between food, pest-control and the maintenance of soil health in the same breath. He also describes another principle based on the need to maintain crop diversity to maximize output as well as protect against climatic risks. This principle necessitates a balance between crops, animals and birds. He adds that in order to survive, farmers try to secure household food security using food reserves kept in granaries for those few families who have them or kept in baskets and sacks in the house for those that do not. Farmers also grow food crops that can stay in their gardens for long periods, especially tubers like cassava, sweet potatoes and yams. Almost all households have a kitchen garden with vegetables and fruits grown to improve family nutrition. Farmers find that these strategies are more effective at ensuring food security than market-based strategies, which they regard as too risky. Experience has taught them that, when they sell
their food crops at harvest time, the prices are usually low and, by the time there are food shortages, market prices are usually too high for them to afford.

In Kenya the (Kenya Agriculture Research Institute (KARI), 2012) highlights seeds of drought-tolerant crop varieties are being produced and promoted by its seed unit, while studies are underway on improving the productivity of livestock such as camels, indigenous chickens, small ruminants, bees, and guinea fowl. Other proposals aimed at reducing the vulnerability of farmers and pastoralists include developing special livestock insurance plans, the breeding of animals that adapt well to climatic vagaries, regular vaccination campaigns, and the promotion of economic livelihood diversification especially by pastoralists (Government of Kenya, 2010).

According to (World Radio for Environment (WREN), 2010) two innovative insurance projects are underway. (KilimoSalama (“safe farming” in Swahili) is an insurance plan that protects farmers’ investments in seeds, fertilizers, and other inputs. Piloted in 2009, the plan pays when experts monitoring local weather conditions and rainfall determine that crops have died. Some practices that farmers are adopting to cope with climate change include diversifying both crops and farming practices, such as the adoption of fish farming, kitchen gardening, hay stacking, and bio-intensive agriculture (Participatory Ecological Land Use Management Association Kenya (PELUM-K), 2010).

Farmers are supported in these and other practices, such as tree planting in both communal and private landholdings, by government ministries, private sector initiatives, and many Non-Governmental Organizations.
At the policy level, the (Government of Kenya, 2010) recommends a number of interventions to help adapt to and mitigate the impacts of climate change. Investment in early warning systems as well as in the construction of water harvesting dams and food storage facilities is proposed.

(National Environment Management Authority [NEMA] 2007) states that agricultural practice options include the promotion of underutilized crops that are drought- and salt tolerant and pest- and disease resistant, such as millet and cassava, as well as the protection of the natural resource base through soil and water conservation efforts such as the promotion of conservation agriculture.

2.2.2 Factors Inhibiting Adaptation

According to a study done by (Fatuase A.I, 2013) the major barriers identified were inadequate funds (89.6%), inadequate information (64.4%), shortage of labor (41.5%), shortage of land (34.1%), inadequate technology know how (29.6%) and others (23%).

2.3 BEST FARMING METHODS

2.3.1 Mixed Farming

Mixed farming exists in many forms depending on external and internal factors. External factors are weather patterns, market prices, political stability, technological developments, etc. Internal factors relate to local soil characteristics, composition of the family and farmers’ ingenuity (Environmental Protection Agency [EPA], 2013). Farmers can decide to opt for mixed enterprises when they want to save resources by interchanging them on the farm - because these permit wider crop rotations and thus
reduce dependence on chemicals, because they consider mixed systems closer to nature, or because they allow diversification for better risk management.

There is wide variation in mixed systems. Even pastoralists practice a form of mixed farming since their livelihood depends on the management of different feed resources and animal species. At a higher level, a region can consist of individual specialized farms and service systems that together act as a mixed system. Other forms of mixed farming include cultivation of different crops on the same field, such as millet and cowpea or millet and sorghum, or several varieties of the same crop with different life cycles, which uses space more efficiently and spreads risks more uniformly.

Mixed farming systems can be classified in many ways - based on land size, type of crops and animals, geographical distribution, market orientation, etc. Three major categories, in four different modes of farming, are distinguished here. The categories are:

- On-farm versus between-farm mixing
- Mixing within crops and/or animal systems
- Diversified versus integrated systems

### 2.3.1.1 Advantages of mixed farming

a) It offers highest return on farm business, as the by-products of farm are properly utilized.

b) It provides work throughout year.

c) Efficient utilization of land, labour, equipment and other resources.
d) The crop by products such as straw, bus, fodder etc. is used for feeding of livestock and in return they provide milk.

e) Manures available from livestock maintain soil fertility.

f) It helps in supplying all the food needs of the family members.

g) Intensive cultivation is possible.

h) If one source of income is lost he can maintain his family from other source of income.

i) Milk cattle’s provide draft animals for crop production and rural transport.

j) Mixed farming increases social status of the farmer.

(Kenya Agriculture Research Institute (KARI), 2012) states that in Kenya the livestock is much closed connected with agriculture because animal power is the main source of power in agriculture. FYM is the main source for maintaining soil fertility and animals make good use of subsidiary and by-products on farms and in turn they provide milk under such circumstances mixed farming will most suit in Indian conditions.

2.3.1.2 Disadvantages of mixed farming

  a) Indigenous method of cultivation is used till now.

  b) Draft and mulch animals should be sold when they fail in production.

  c) Healthy calf should be reared to replace age old animals.

2.3.1.3 Requirements of mixed farming

  a) Complicated management practices.

  b) Sound cropping scheme.

  c) Good cattle in suitable number
d) Transport facility

e) Marketing facilities.

2.3.2 Organic Farming

2.3.2.1 Integrated Pest Management (IPM)

IPM is a method of crop management that uses a variety of complimentary strategies to control pests. It is an intensive practice that relies on pest prevention, observation and finally intervention. The most celebrated aspect of IPM is the use of biological controls where "good" bugs to eliminate "bad" bugs. Picture an army of lady bugs swooping down and devouring, and thus destroying, a cloud of leafy green hungry aphids (International Livestock Research Institute, 2009).

Other mechanical controls include good hand-picking of bugs and vacuuming pests off of infested plants. I've also seen farmers sweep home-made blowtorches across greens laden with flea beetles eating their fill. The poor little buggers didn't know what hit them.

- **What is good about IPM?**

  IPM relies on close observation of crop health. This keeps the farmer in tune with their land and facilitates a quick response to any problems. The practice is based on acceptable pest levels, allowing them to coexist in the ecosystem until there is a problem.

- **What is bad about IPM?**

  The final stage allows for a chemical dousing if that is what will save the crop. Perhaps saving the farmer his livelihood, but harming the land and distilling farming down to a purely economic activity.
2.3.3 No-Till Agriculture

No-till farming has been making waves of late in the parts of Europe and US. It works just like it sounds (Environmental Protection Agency (EPA), 2013). Farmers don't break the soil, opting instead to seed directly on top of the soil. Rodale Institute has developed an organic system of no-till farming. Instead of using herbicides the institute has developed a piece of equipment called a "roller-crimper" that rolls down an over-wintering cover crop and leaves the land ready for planting. If organic no-till agriculture were used successfully on all of the earth's 3.5 billion tillable acres, it would absorb and sequester more than half of all present-day CO2 emissions every year.

- **What is good about No-Till?**
  It sequesters carbon and prevents soil erosion.

- **What is bad about No-Till?**
  If not practiced with organic methods, farmers use chemicals to keep weeds in check.

2.3.4 Biodynamic Agriculture

Developed by Rudolf Steiner in 1924, biodynamic agriculture is a holistic system that treats the farm as an organism. The goal is a closed loop, where no inputs are brought on to the farm. Soil fertility is built through cover crops and on farm animal manure (United States Department of Agriculture, 2013).

To be certified biodynamic a farm must also be organically certified. Farmers using his method also use nine homeopathic preparations to treat compost, soil, and plants. They also follow the rhythms of nature and the cosmos for tasks like seeding, and other on-farm rituals. Throw into the mix the fact that biodynamic farmers think in terms of
processes and forces, as opposed to substances, and you have a whole new way of looking at agriculture.

- **What is good about Biodynamic?**

  Closed loop system does not allow for chemical inputs. Thinking holistically only helps with long-term sustainability.

- **What is bad about Biodynamic?**

  While the carrots from local biodynamic farm are out of this world, so maybe are some of the cosmic cycle watching associated with biodynamics.

2.3.5 **Permaculture**

"Permaculture (permanent agriculture) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems."

It was developed in the 1970's by Bill Mollison and David Holmgren on the southern Australian island state of Tasmania.

Their design sets out to create different agricultural 'zones', so that many productive edges are formed. But permaculture in imitating the complexity of natural systems, right down to how night air moves, defies simple explanation.
2.4 THEORETICAL FRAMEWORK

2.4.1 The Malthusian Theory of Population

The theory is by Thomas Malthus who was an English clergyman. In 1798, he published the famous essay “Essay on the principal of population” The essay had two propositions.

1. That food was necessary for existence of man

2. The passion between two sexes was also necessary for the existence of man

Malthus stated that population doubled every generation when its growth is unchecked thus the number will grow exponentially in 1-2-4-8-16 ...... up to 256 by the 8th generation. However the means of subsistence will increase with arithmetic progression of 1-2-3-4-5 ...... up to 9 by the 8th generation. Malthus thought that the balance could only be maintained if famine, disease and war periodically checked the population and this pessimistic view was accepted by other 19th century scholars in Europe. The ultimate principal of Malthus hypothesis implies that Mankind is faced with the dismal prospect of being able to solve the problem of food insecurity.

This theory for the first time focused the public attention on the problems of food supply rising from a rapidly increasing population. The essence of the Malthusian theory in his own words is that “the power of the population is indefinitely greater than the power of the earth to provide for man’s subsistence” The theory has been highly criticized as it has not been realistic in most parts of the world. His inability to foresee the green revolution, the technological revolution and family planning has made it not to be
as he predicted but the theory continues to be a concern in Africa due to persistent problem climate variability leading to famine and degradation of natural resources which forms the source of food and income to people.

2.5 THE CONCEPTUAL FRAMEWORK

The declining agricultural productivity in Kenya is worrisome and a real challenge for a government with a population of approximately 40 million to feed. Worse still is the expected adverse impact of global warming on agriculture in the future. Global circulation models predict that global warming will lead to increased temperatures of about 4 °C and cause variability of rainfall by up to 20% in Kenya by the year 2030. From these predictions, the two extreme climate events that may adversely affect the agricultural sector are drought (crop water stress leading to declining yields) and flooding (resulting in water logging) in both the arid and semi-arid areas and the high potential areas.

Against this background of limited arable land, predicted adverse climate conditions and declining agricultural productivity, the biggest challenge facing the Kenyan government is to intensify food crop production so that output can keep pace with rapid population growth without a large increase in land devoted to food crops, especially maize and milk. Currently, agricultural intensification is based on a combination of inputs such as fertilizers and pesticides, plant breeding technology, irrigation and improved agricultural practices such as multiple cropping. However, productivity continues to be undermined by unpredictable weather and climate conditions and declining soil fertility. The researcher conceptualizes the study as follows.
2.5.1 Conceptual Framework Model

Anthropogenic GHG emissions

Climate change - change in average climatic conditions and variability

Environmental effects
- Change in extreme weather (high temperatures/very low temperatures)
- Ecosystem effects
- Rising sea level
- Environmental degradation (floods/drought)

Mitigation

Adaptation

Agricultural and food processing effects
- Changing livestock/fisheries and crop yields
- Altered ecosystems which produce food
- Altered use of pesticides and fertilizers
- Altered planting methods and seasons

Effects on food
- Altered food choice through changes in prices and availability,
- Changes in food safety and the nutritional content of food especially due to pest

Source: Researcher, 2014
3  CHAPTER 3: AREA OF STUDY

3.1  INTRODUCTION

This chapter presents the area of study. It covers such areas as physical setup, social/economic set-up, ecological set-up of Trans-Nzoia County with the aim of finding out how small scale arable farmers in Chisare village in Cherangani are adapting to climate variability.

3.2  PHYSICAL SET-UP

3.2.1  Physical Location and extent

Trans Nzoia is one of the 21 counties of the Rift Valley. To the West it borders the republic of Uganda while Bungoma and Lugari counties to the South, West Pokot county to the north, and Marakwet county to the East and UasinGishu County to the South East.

The county lies between latitudes 0° 38' and 1° 18' North of the equator and longitudes 34° 38' and 35° 23' East. It covers an area of 2,467 sq.km, which represents 0.42% of the whole republic and 1.4% of Rift Valley province.
3.2.2 Physical and Topographic features

Trans Nzoia County is generally flat with gentle undulations rising steadily towards Mt. Elgon in the Northwest with an altitude of 4,313m above sea level. It is the second highest mountain in Kenya. The mountain is an important ecosystem shared between Trans Nzoia and Bungoma counties in Kenya and Uganda hence a unique resource in environmental and wildlife conservation efforts. Most parts of the county are plateaus with gentle undulation rising steadily to Mt. Elgon.

On average the County has an altitude of 1800m above sea level. The altitude drops gradually to 1,400 meters above sea level towards the North. Because of the hilly nature, the Northwest and the Eastern parts of the county, there are difficulties in communication especially during the rainy season when roads sometimes become impassable. This has
also affected farmers who sell their farm produce at distant markets because they might end up spoiling on the road for example tomatoes.

The County is drained by Rivers Nzoia and Suam. River Nzoia and its tributaries, Sabwani, Ewaso, Rongai, Koitobos and Noigamet, flow into Lake Victoria while Suam River drains into Lake Turkana through River Turkwel. The water from these rivers could be annexed for the generation of hydroelectric power in support of rural electrification, irrigation, fisheries and domestic consumption and subsequently contribute towards controlling floods. The River Nzoia and its tributaries are threatened by encroachment, agriculture and other human activities in the catchments and its riverbanks. This is a risky situation regarding the variability in weather conditions that may lead to drying of the rivers.

The natural forest cover occurs in Mt. Elgon and Cherangany Hills. Continued human pressure has significantly impacted negatively on the catchment. This forest encroachment has significantly caused a change in weather patterns within the area thereby affecting normal growth of crops. Forest also act as windbreaks for crops most crops and when trees are cut strong winds eventually lead to huge crop loss.

The County is endowed with a variety of natural resources including relatively fertile soils, natural forests and water resources. Whereas the county experiences high precipitation, there have been incidences of prolonged drought. This is majorly being attributed to the change in weather patterns which is caused by anthropogenic activities such as deforestation within the county. The highland and forests in the county are critical as they form water catchments which drain in both the lowlands and distant lakes.
3.2.3 Geology and Soils

Trans Nzoia is well known for its rich soils and favorable climatic conditions for agricultural activities. A large proportion of the County has a high agricultural potential. The county lies in a basement system. The rocks are mainly sediments: grits, sand stone, shales and limestone. The rocks have been formed through metamorphosis of a series of shales sandy and calcareous shales sandstone and limestone enabling the resultant gneisses.

Soils found on the South East to the East of the County consists of well drained deep red to dark red, very friable to friable clay, dark sandy loam to loam derived from the basement rock complex. This is a soil characteristic of Chisare in Trans-Nzoia East Sub-County which is of potential use for forestry, pyrethrum, wheat, maize, horticulture among others. Soil erosion has been the main degradation status of soil in the area.

3.2.4 Climatic Conditions

The County has a highland equatorial kind of climate. Rainfall is fairly well distributed throughout the year. The slopes of Mt. Elgon to the west receive the highest amount of rainfall while the region bordering West Pokot County receives the least. The County experiences bi-modal rainfall pattern. The long rains occur from April to June, while the short rains fall from July to October. The mean temperature in the County is 18.6°C; however, temperatures vary between 10°C to 30°C. The average daily relative humidity is 65 percent and the wind speed is 2 knots. The county has favorable climate for both livestock and crop production hence, any change in this regular pattern has largely
affected farmers within Trans-Nzoia who now have to look for alternatives to their farming systems or adjust planting season according to the rainfall patterns.

3.3 ECOLOGICAL SET-UP

3.3.1 Agro-ecological zones

The major agro-ecological zones in the county are as follows:

a) Upper Highland Zone

The upper highland zone covers the hills and steep slopes of Mt. Elgon, Cherangany and the boundary zone towards West Pokot County. This zone lies between altitude 2400 and 4,313 meters above sea level and constitutes about 16 percent of the county. Land use in this zone includes sheep and dairy farming and forest reserves. There are some shallow stony soils with rocky outcrop in this zone. Mt. Elgon National Park which is situated in this zone is a major tourist attraction. Establishment of a transition zone around the Mount Elgon National Park would play a significant role in buffering the protected area and mitigating against human-wildlife conflicts.

b) Lower Highland Zone

The Lower highland zone covers the slopes of Mt Elgon and Cherangany Hills with an altitude between 1,800-2,400m above sea level and the region constitutes 34 percent or 848.64 Sq. km of the area of County. This is mainly transitional zone in the county with high potential for various agricultural and livestock activities. The activities in this region include growing pyrethrum, wheat, tea, maize, barley, sunflower, coffee and horticulture as well as rearing of cattle and sheep. The soils found in this zone are red and brown
clays derived from volcanic ash. These soils are fertile with a high content of clay mineral which gives, during the weathering process, a continuous supply of plant nutrients. Despite the high potential of these areas the major set-back to full development is the poor communication network for efficient transportation of the farm produce to the markets.

c) **Upper Midland Zone**

This zone comprises about 50 percent or 1,248 sq. km of the area of the County. The zone lies between altitudes 1,700m-2,000m above sea level. The mean annual rainfall is between 900 to 1,400mm per annum. The region includes the Endebess plains stretching East to the Kitale plains and further towards the areas below the slopes of Cherangani Hills. To the South the zone stretches to the area bordering Tongaren scheme of Bungoma County and northwards towards West Pokot. Well drained deep red and brown clays and sandy clays. A considerable area of black cotton soil occurs along the Koitobos River in the Endebess Plains.

3.3.2 **Flora and Fauna**

Wild life is any non-domesticated fauna or flora life forms or creature living in either artificial; or natural habitat. There are numerous wildlife resources in nature with their distribution being influenced by the varying climatic condition i.e tropical or temperate climates.
Fauna is the invertebrate and vertebrate life forms found in the ecosystem. These are the reptiles, mammals, birds, amphibians, insects, and molluscs, which are the consumers. Of the importance here are the mammals and avian life forms.

In the case of Mt. Elgon ecosystem, there are about 20-recorded mammal's species. These include elephants, oribi, bushbuck, and buffalo, waterbuck, giant forest hog, red duiker, impala and rodents. The primates include the black colobus monkey, blue monkey, de'brazer monkey, and olive monkey. The carnivores include the leopards, spotted hyena, civet and genet cats. There are also porcupines, aardvark, groove-toothed mole, cave bats and the African hare. These wildlife species are divided into three categories of key, threatened and species of special concern. Key species are those that bring about a remarkable change on the ecosystem cause of their feeding and the mode of their home range i.e. the species can transform a forest habitat into shrub land and open grassland. Or displace other species by out competing them.

Threatened species are those that face threats of human activities that both destroy them and their habitat e.g. the elephant, giant forest hog, leopard and the oribi that are threatened due to poaching and habitat loss. Species of special concern are those highly regarded by both conservationists and tourists. An example is the elephant due to its touristic value and habitat modification.

There is no clear distribution pattern of wildlife in Mt. Elgon National Park since the animals according to the forage availability use the entire ecosystem collectively. However, the grazers prefer the lower grassland like buffalo and the waterbuck. Elephant's use all habitats including the open wooded grassland, bamboo zone and the
moor land. Primates are found in the gallery forest areas and sometimes-open grassland. The groove-toothed moles are restricted to the moor land. There is no preferred habitat specification for a particular species but it may be preferences due to assured security and availability of forage.

Degradation of catchment areas due to anthropogenic activities has led to increased soil erosion, loss of biodiversity and a general decline in wildlife in the area. Human-wildlife conflict has led to arising cases of poaching in Mt. Elgon, human deaths as elephants trespass to people’s homes and in line to climate variability leading to crop loss, this conflict has seen it many crop being destructed and destroyed.

3.4 Economic Set-up

3.4.1 Transport

The county has 154 kilometers of bitumen roads, 167 of gravel and 786 earth roads. Most of the roads are in poor quality. The bitumen main road from Eldoret has numerous potholes, while the gravel roads are not in good conditions. The earth roads are impassible during the rainy season. The conditions of the roads are a major bottleneck to development in the county which is rich in agricultural produce because transporting this fresh farm produce with a poor road network and unpredictable weather patterns has led to damage on these crops while on transit. The county has 23 Kilometers of rail that ends in Kitale town. The rail transport has been dormant but there is possibility of revival if the national plans on the revival of the railway transport will be implemented as planned. The county should be prepared to benefit the railway transport through transportation of bulky goods to and from the country.
The county has only an airstrip but has two international airports in proximity. As the county plans, this proximity should be an opportunity to maximize horticulture and people transport.

**3.4.2 Communication**

Development in the communication industry has resulted to a decline in the use of postal services. The postal services however remain relevant in the county until a time when majority of people have access to other technologies. The county has 3 post offices and 6 sub-post offices. Increasingly, the courier services have taken over postal services and filled a gap that could have impaired parcel and letter movements.

The prevalent communication means is the mobile telephone and coverage for household heads is over 60% according to the last census.

Improving communication channels and means is of key importance especially among farmers in Trans-Nzoia who are often being faced by the current change in weather patterns and where most of them are oblivious on what to do in this situation. Therefore, with the rising statistics on the use of mobile phones, this opportunity should be tapped to effectively channel messages to farmers to SMS centers for example.

Farmers are currently getting agriculture information through the SMS platform and some through social media platforms as the Mkulima Young where a lot of information is delivered.
3.4.3 **Trade and Commerce**

The county has 12 banks with all the top banks having branches in the county. These are Barclays, National, Cooperative, Oriental, Standard, Kenya Commercial, Family bank, Equity, Eco bank, Trans-National Bank and K-Rep banks. The banks provide secured loans to entrepreneurs with tangible collateral in the county. K-Rep is one of the financial institutions that specialize in microfinance by providing loans and saving services to small business commonly referred to as Jua kali. No collateral is required on small loans of up to KShs.250,000. The bank relies on the group and the Trust pressure model as in Grameen bank of Bangladesh. It is believed that providing banking services to the small income earners and the informal sector is commercially viable and important development intervention for poverty eradication. As a result, the bank plans to provide loans to small, medium and large-scale entrepreneurs in the county.

This loan facility should be available to all including farmers within the area who need finance support to adjust to the recent weather changes by developing new structures as green houses, irrigation systems, to insure their crops through KilimoSalama initiative and to name but a few.

Kenya has experienced an explosion in financial inclusion mostly driven by the mobile money transfer in the last few years, the interface between banks and mobile phone money transfers. The Trans-Nzoia County has been caught in this positive wave like the rest of Kenyans and this has adequately enabled farmers to buy agricultural commodities at the comfort of their homes without having to queue in banks.
3.4.4 Agriculture

Compared to the rest of the counties in Kenya, Trans Nzoia is well endowed with one of the most favorable climate for agriculture. The county experiences bimodal rainfall pattern. The long rains occur from April to June, while the short rains fall from July to October. It has a mean annual precipitation of 1,296.1mm. The mean temperature is 18.6°C; however, temperatures vary between 10°C to 37°C. It is in a high potential area and therefore suitable for growing different crops and livestock production. However, maize growing takes the largest acreage, which has popularly made the county to be called the granary of the county. This is however set to change if the current weather situation keeps changing and no adaptation mechanisms put in place.

Agriculture and livestock industry brings about use of agro-chemicals, which comprise pesticides and fertilizers. Pesticides include insecticides, fungicides, herbicides, acaricides, nematicides and fumigants/soil sterilants among others. Fertilizers include nitrogenous, phosphates, potassic and compound fertilizers, trace elements, foliar feeds and soil improvers. Agrochemicals have been extensively used for agricultural production without satisfactory management of their health and environmental impacts. These agrochemicals in areas where they have been poorly used they have negatively impacted fish industry. The main fish farming practice in the county is the construction of the fishponds.

The farming/cultivation practices involve the use of tractors mainly for land preparation. Hand and animal draught power (oxen) is used on a small scale. Weeding is mainly done by hand. However, some farmer’s especially large scale is using herbicides for weeding.
The use of chemical fertilizer is the order of the day as without it, very low yields are realized. This is due to the fact that mono cropping of maize and little or non use of organic fertilizers has led to a decline in soil fertility. Also a large amount of organic fertilizer required is not readily available.

This has to be changed in with the recent climate variability factors because the county is yet to experience a lot of pests in their farms due to the high temperatures. Farmers also have to be able to adapt to using organic fertilizer since chemical fertilizers have increased acidity in the soils.

Table 3-1: Types and Status of Land use Systems

<table>
<thead>
<tr>
<th>Type of farming system</th>
<th>Extent (ha)</th>
<th>Distribution (% of the total)</th>
<th>Location</th>
<th>Agricultural products</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Food crops</td>
<td>105,170</td>
<td>57.4</td>
<td>Cherangani Kwanza Saboti Kaplamai Central Endebess</td>
<td>Maize Beans Potatoes</td>
<td>Yield per unit area decreasing</td>
</tr>
<tr>
<td>Main Cash crops</td>
<td>78,063</td>
<td>42.6</td>
<td>Kwanza Cherangani Kaplamai Saboti Central Endebess</td>
<td>Wheat Coffee Tea Sunflower Horticultural crops</td>
<td>Yield per unit area declining</td>
</tr>
</tbody>
</table>

*Source: County Agriculture Office, Kitale 2010*

The indigenous foods grown include sweet potatoes, cassava and local vegetables e.g. *sucha* and *saga*. Acreage grown is as indicated in the previous table. Also of the subteranean types *White ants* is a real delicacy to the Luhya tribe.

While opening up more and more canals for cultivation to produce food for the growing population the environment is exposed to degradation every time. More vegetative cover is reduced even on hilly areas which have been encroached e.g. Milimani and Kapolet in Cherangani and Kaplamai Division respectively. Also poor agricultural practices have caused a lot of land degradation.

The Ministry of Agriculture extension personnel is still carrying out soil conservation efforts. Much of the recommendation now is more of biological measures such as grass strips, unploughed strips and trash-lines.
The major undoing is the failure by farmers to maintain the structure. Also subdivision of land into uneconomical sizes has put a lot of pressure on the existing laid terraces being destroyed. Rapid increase in the population has resulted in the encroachment onto the riverbanks. Pegging for riverbank protection is being done but the implementation by the farmers is still a problem hence posing a threat to water resources.

3.4.5 Forestry and Agro Forestry

The county has over 18% of forest cover as compared to the country which has a cover of 1.7%(Kenya National Climate Change Strategy 2010). This positions the county at an enviable position in Kenya as one of the 10 top forested counties.

3.4.5.1 Main Forest types and size of forests

The table below shows the main forests in Trans-Nzoiacounty.

<table>
<thead>
<tr>
<th>Sub-County</th>
<th>Forest Area</th>
<th>Size in Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans-Nzoia East</td>
<td>Kapolet Forest</td>
<td>1,551.60</td>
</tr>
<tr>
<td></td>
<td>Kapolet Trust land forest</td>
<td>746.7</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td><strong>2,298.30</strong></td>
</tr>
<tr>
<td>Trans-Nzoia West</td>
<td>Saboti Forest</td>
<td>10,035.20</td>
</tr>
<tr>
<td></td>
<td>Sosio Forest</td>
<td>10,035.20</td>
</tr>
<tr>
<td></td>
<td>Kitale Township Forest</td>
<td>401</td>
</tr>
<tr>
<td>Forest Name</td>
<td>Area (ha)</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Kitalale Forest</td>
<td>2037.2</td>
<td></td>
</tr>
<tr>
<td>Kwanza</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kimothon Forest</td>
<td>11,024</td>
<td></td>
</tr>
<tr>
<td>Kiptogot Forest</td>
<td>10,243</td>
<td></td>
</tr>
<tr>
<td>Suam Forest</td>
<td>2,390</td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>22,508.60</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Kwanzu</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>23,657</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>48,463.90</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Source: Kenya Forest Service (2010)*

Note: There are many other undocumented forest areas under private and institutional ownership including the Mount Elgon National Park.

### 3.4.5.2 Promotion of Agro-Forestry and Green Economy for:

**Income generating activities including farm forests**

This is farming in which agroforestry is practiced. It involves growing trees that are later sold as timber or firewood. The county has an excellent opportunity in this area as the trees grown can be intercropped with maize and other crops including coffee. There are several benefits in this type of agriculture:

a) There is possibility of obtaining carbon credits

b) The trees planted should be trees that fix nitrogen in the soil thus fertilizing the soil
c) Soil erosion prevention for trees reduces the force on rain and thus run-off is reduced.

3.5 SOCIAL SET UP

3.5.1 Demographic analysis

The 2009 Population and Housing Census enumerated a total of 818,757 persons in Trans Nzoia County, of these 407,172 were male and 411,585 were female.

The county has a population density of 441. This is a fairly densely populated county – it is among the top 15 densely populated counties in the country (Kenya County Data sheets). The table below presents the population density for the county by Sub County. Trans Nzoia administrative sub County is the most populated sub county while Kwanza is the least populated.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans Nzoia West</td>
<td>746</td>
<td>387,366</td>
<td>520</td>
<td>432,841</td>
<td>581</td>
<td>483,654</td>
<td>649</td>
<td>520,802</td>
<td>699</td>
</tr>
<tr>
<td>Kwanza</td>
<td>1,120</td>
<td>236,218</td>
<td>211</td>
<td>263,949</td>
<td>236</td>
<td>294,935</td>
<td>263</td>
<td>317,588</td>
<td>283</td>
</tr>
<tr>
<td>Trans</td>
<td>630</td>
<td>195,173</td>
<td>310</td>
<td>218,085</td>
<td>346</td>
<td>243,687</td>
<td>387</td>
<td>262,404</td>
<td>417</td>
</tr>
<tr>
<td>Nzoia East</td>
<td>2,496</td>
<td>818,757</td>
<td>328</td>
<td>914,875</td>
<td>367</td>
<td>1,022,277</td>
<td>410</td>
<td>1,100,794</td>
<td>441</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>---------</td>
<td>-----</td>
<td>---------</td>
<td>-----</td>
<td>-----------</td>
<td>-----</td>
<td>-----------</td>
<td>-----</td>
</tr>
</tbody>
</table>

*Source: Kenya Bureau of Statistics, 2009*

Population density in Trans-Nzoia East Sub-County is expected to be on the rise by 2017, this is clearly an alarming figure since the area is facing challenges in regard to adapting to the recent change in weather patterns. Unless alternative farming methods are used, farmers within the area may not be able to feed the growing numbers.

### 3.5.2 Population projection

The increase of population in the County has resulted to increased pressure on land. This has subsequently impacted on the quality of the environment and the livelihood of the people. The steady but rapid population growth has and continues to be driven by the good agro-climatic conditions and the need to own land in a cosmopolitan county. This has put pressure on land as a valuable resource and subsequently resulted to cases of landlessness dating back to pre-colonial period.

The demand for more land for settlement and farming has witnessed people open up steep slopes of up to 70° gradient in Cherangani and wetlands across the county. The disputes over wetlands ownership is on rise in the county. The slopes of Cherangani could start experiencing landslides hence a disaster in waiting if they will continue cultivating. The
degradation of wetlands will affect the quality and quantity of water in the long term. It will also erode the ecological functions of wetlands.

Kitale town has recently experienced population explosion estimated at 200,000 people against the infrastructure designed during the pre-colonial period. Inadequate housing and low income has resulted to emergence of slums as people look for shelter they can afford. The road network in town cannot hold the ever increasing traffic (vehicles & bicycles). The town has also been experiencing water shortages in the recent times. The increase in population has also resulted to increased waste generation which is often left piling in the streets and the estates. The town does not have adequate waste management infrastructure be it the equipment or the skills and physical infrastructure.
4 CHAPTER FOUR: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The purpose of a research methodology is to explain, defend, and justify a concept. This chapter contains the approach taken towards designing the study. Furthermore, it is a representation of the populace under study not forgetting samples required. It also contains the data collection instruments such as interviews, questionnaires, observation, focused group discussion, mapping and photography. The chapter attempted to prove reliability and validity of data collection instruments through pre-testing and close scrutiny. It is also important to bring into light data analysis strategies as well as ethical considerations applied during the research.

4.2 RESEARCH APPROACH AND DESIGN

This research was carried out among small scale farmers in Chisare Village Trans-Nzoia Sub-County to gather information on their knowledge about the recent trend in climate variability and how they are adapting to it. Data was also collected from government agencies such as KARI to find out their role as institutions in educating farmers on how to ensure that waste is minimized. The study was mainly a survey research. This is a design used to investigate populations by selecting samples to analyze and discover occurrences. The purpose is to provide quantitative and numeric descriptions of some part of the population. It’s used to generate possible leads and ideas which can be used to formulate a realistic and testable hypothesis.
4.3 NATURE AND SOURCES OF DATA

The study sought to analyze how small scale arable farmers are adapting to the impacts of climate change. To attain this goal, two types of data were collected. The primary data from the field gave first information about the challenges farmers are facing due to the current trend of climate variability and the adaptation strategies they have put in place. Secondary data was gleaned from documented information, that is, writings by others on how small scale arable farmers are adapting to the impacts of climate variability.

4.3.1 Secondary Source

This included information about the global change in weather patterns, climate variability and their impact on agriculture. Both published and non-published sources of information were used.

Secondary information was used to provide a strong background to the study area by informing on the existing adaptation strategies among small scale arable farmers.

Data used included existing reports such as the Inter-Governmental Panel report on Climate Change, topographical sheets and from relevant academic sources.

4.3.2 Primary Source

Primary data sources included observation, questionnaires, interviews, photography, and meetings and focused group discussions. Types of activities within the area of interest were observed and noted. These included types of crops cultivated, topography of the area, infrastructure, services and the authentic environment. Other primary data were sourced from the farmers and relevant government departments.
4.4  SAMPLING DESIGN

Population is defined as all elements (individuals, objects and events) that meet the sample criteria for inclusion in a study. Population can include all people, objects or items with the characteristics one wishes to understand.

Due to limited financial, time, human and material resources, a census was hard to conduct and therefore a sample survey was used. The sampling techniques employed by the study ensured a truly representative sample and adequate coverage of the area. These included the following:

a)  **Purposive sampling**

Purposive sampling was used to select Trans-Nzoia County among other counties. The criteria used included its geographic criteria and the fact that the area has one of the most favorable soils that support agriculture hence the food granary of the country.

b)  **Simple random sampling**

In reaching the sample a simple random sampling design was used to draw a sample of 25 farmers.

c)  **Systematic sampling**

This was used to select 4 institutions for interview.

This sample size deemed sufficient and reliable by the researcher considering the time, logistic and human resource constraints experienced during the research. Subjects
included in the sample were selected to meet specific criteria which included: location, relevance to the topic of study and availability of resources.

4.5 METHODS OF DATA COLLECTION

4.5.1 Primary data collection

The instruments of primary data collection:

4.5.1.1 Interviews

This involved face-to-face interaction between the respondents and researchers. The personal appeal and quality of data derived from the method made it the most preferable as a technique of data collection. Interviews were conducted in various government offices and the relevant players on the area of study. These included:

a) Kenya Agriculture Research Institute (KARI) office
b) Ministry of Agriculture
c) Kenya Seed Company
d) National Environment Management Authority (NEMA)

4.5.1.2 Questionnaires

The questionnaires developed were inclusive or conclusive depending on the nature of the anticipated respondents. Semi-structured questionnaires were used to collect information from key informants such as households, this is because is it both closed and open-ended hence gives the respondent room to express their view in the most effective way.
Pre-testing the questionnaires

A pretest refers to a trial administration of an instrument to identify flaws. This is necessary to determine whether questions and directions are clear to subjects and whether they understand what is required from them. The questionnaires were tested by the supervisor and found suitable for the entire project.

4.5.1.3 Observation

Observation allowed for comparison between the information obtained from the respondents and the reality on the ground. Direct observation during the study incorporated observation of the new emerging crop diseases which is suspected to be as a result of climate variability and the types of crops planted in a single farm in the area.

4.5.1.4 Photography

Photographs were used to capture the real situation on the ground such as the types of crops grown, type of agriculture or the slope of the area

4.5.2 Secondary data collection

The study relied on secondary information such as reports, books, existing environment literature. Period of review as per the information used here was relevant in terms of attaining consistency and gathering relevant information. Some of the sources of information used here include; The Inter-governmental Panel on Climate Change report (IPCC), The United Nations Framework Convention on Climate Change (UNFCCC),
Trans-Nzoia Count Integrated Development Plan (2013-2017), and Trans-Nzoia County Environmental Action Plan among many others.

4.6 DATA ANALYSIS

Field questionnaire was analyzed using Microsoft Excel and the results expressed in tables and pie charts form. Data gathered through interviews were grouped into related terms and analyzed using content techniques. Content analysis is the process of analyzing verbal or written communications in a systematic way to measure variables. Analysis of data entailed

- **Sorting data**: organizing both coded and random data into categories that best serve the purpose of the study. It also entails prioritizing information based on relevancy and reliability.

- **Quality control check**: this is a control strategy in research that ensures all data collected are important and relevant. Research without quality control systems has flaws that subject them to many questions.

4.7 RELIABILITY AND VALIDITY

Reliability is the degree of consistency with which an instrument measures the attribute it is designed to measure. The study measured reliability of data based on the set guidelines and ability to meet objectives. Content validity is the extent to which an instrument represents the factors under study. To achieve content validity, the study relied on current data from relevant stakeholders.
5 CHAPTER 5: RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter presents the analysis of data collected from a research conducted among small scale arable farmers within Ngoyek Village in Cherangani Trans-Nzoia East Sub-County. The main purpose of the study was to assess the impacts of climate variability to small scale arable farmers in Trans-Nzoia. It also aimed at evaluating the adaptation strategies put into practice by small scale arable farmers in Trans-Nzoia and eventually develop a climate variability adaptation action plan. The study was also important to identify the existing farming methods among farmers in Trans-Nzoia. This information can be valuable to inform the delivery of information regarding best farming methods and adapting to climate variability to farmers. Therefore, the findings of this study can be relied upon to make major decisions and to guide the development and delivery of climate variability adaption techniques and best farming methods.

The study also involved administration of questionnaires to relevant departments and authorities to be able to meet its set objectives. This included the Kenya Agriculture Research Institute (KARI), Ministry of Agriculture, National Environment Management Authority (NEMA) and Kenya Seed Company offices.

The questionnaires were administered to 25 farmers of which 56% were male and 44% were female.
5.2 Results and Discussions

The different types of small scale farmers in the area of study are as shown below:

![Chart 5-1: Types of farming](source: Researcher, 2014)
According to the data collected, mixed crop farming accounts for a high percentage of the type of farming practiced among small scale farmers in Trans-Nzoia. This shows a positive sign because it is highly recommended as a way of adapting to the variability in weather patterns because some crops are resistant to either extreme heat or extreme cold according to International Livestock Research Institute. (2009).

Favorable farming condition was the prominent reason most farmers settled in the area. Data collected indicate that 56% of the farmers have settled in the area between 10-30 years. This has enabled them realize the variability in weather patterns and its impacts on crop yield production over time as climate variability.

![Chart 5-2: Number of years respondents have settled in the area](source: Researcher, 2014)

The study also showed that 88% of the farmers interviewed own land between 1.5-4.5 acres, while 4% of farmers own land below 0.5 acres and 8% own more than 5 acres. Despite the size of land, farmers in Trans-Nzoia have been able to maximize the potential of farming that the area has to offer. This is viewed by the different crops farmers have put in the farm such as bananas, beans, maize, sweet potatoes and vegetables.
5.2.1 Impacts of climate variability to small scale arable farmers in Trans-Nzoia

The research study findings show that some farmers within Trans-Nzoia are knowledgeable on climate variability while to others answers such as “climate change has not yet arrived here” could be identified. 48% of the farmers have some knowledge on what is happening in regard to weather patterns that is from what they have heard and experienced over time while 36% of the farmers barely understood what it meant. However, 16% of the farmers have been able to gather a lot of information regarding climate variability and are very knowledgeable about it. This is according to their description on climate variability and what are the impacts witnessed in the area.
According to the farmers’ knowledge on how climate variability has impacted them, 40% concluded that it is the cause of yield reduction in the area which they linked to economic losses that accounts to 36% and new emerging diseases which accounts to 24% of the impacts.
5.1.1.1 Yield production

A unanimous view of all farmers shows that crop yield production has been on a downhill scale with most receiving half of the outputs as compared to what they used to receive. For example, one of the farmers stated that he received 5 bags from half an acre last harvest compared to the usual 10 bags usually received while another farmer received 20 bags from 5 acres instead of the usual 50. This is attributed to the high temperatures which lead to maize failure while variability in rain patterns for example rain during harvest season has led to crop rotting.

According to institutions findings, unpredictable and unplanned planting patterns due to variability in weather has caused farmers to miss out on the right certified seeds, fertilizers and maturity chances of most crops. Soils have also become too acidic over time affecting not only growth of crops with addition of fertilizer but also have affected dairy farmers by leading to a drop in milk production.

Farmers however are practicing methods such as agro forestry and mixed farming to ensure they find alternatives to their farming and minimize ultimate loss which occurs from planting one crop (maize for example). Mixed farming and crop rotation has been discussed as a way of reducing crop yield loss by (International Livestock Research Institute, 2009) discusses in literature review.

5.1.1.2 New emerging diseases

Farms are being infested by new emerging diseases that are resistant and have affected growth of crops. The recent dreadful disease in the area that has led to declining maize
production is the Maize Lethal Necrosis disease (MLN). According to the farmers, this disease has slowly spread from Bomet and has hit their area especially since they are fond planting maize throughout the season without a break either twice or thrice a year. This has largely affected growth of crops in the farms and the virus has spoilt so many crops leading to huge losses.

This problem has been echoed by relevant authorities interviewed such as KARI who are currently going to explain to farmers on this disease and what it entails.

![Invasive weeds in the farm](Plate%205-1.png)

**Plate 5-1: Invasive weeds in the farm**

*Source: Researcher, 2014*

### 5.1.1.3 Economic loss

Research findings indicate that farmers have been highly affected by the variability in weather patterns on their farms and their constructed farm structures as well. For example the mini cyclones that occurred in the area took down five greenhouses that used to produce 2000 tomatoes each with a constant market, this farmer is yet to recover from this adverse impact.
Farmers who have received almost half of what they used to receive has posed a threat to sustainability to their enterprises due to lack of adequate household self-sufficiency and the generation of surplus for sale. The factor of increased expenditure to deal with the new emerging variability and low income is a visible more economical challenge to these farmers.

The available strategies to deal with climate variability such as the KilimoSalama initiative by the Government which has been discussed in literature review entails insuring crops adds another economic burden to a ordinary farmer.

5.2.2 Adaptation to climate variability

5.2.2.1 Adaptation measures put in place by farmers

Research findings show that majority of the farmers are embarking on practicing both new and indigenous methods of dealing with climate variability and ensuring they minimize losses and maximize on the profits despite the challenges they are currently facing.

Below are some of the adaptation tools used by the farmers according to the research findings:

a) Variability in farming systems to majorly focus on mixed farming where two or more crops are planted in a farm. This farming practice, such as the adoption of kitchen gardening and bio-intensive agriculture has been advocated by Participatory Ecological Land Use Management Association Kenya [Pelum-K], 2010) in literature review.
b) Practiced agro forestry where most farmers are currently including trees in their farms which help to create a micro climate in the area and at the same time act as a windbreak for some crops to prevent them from string winds. Trees also play an important role when they shed off their leaves which act as organic manure to crops.
c) Crop rotation where different crops are planted during each season to reduce constant loss in case the latter is being affected for example maize.

d) Crop diversification where farmers include drought resistant crops to their farms especially legume crops as beans and cassava. In literature review, NEMA advocates for the promotion of underutilized crops that are drought- and salt tolerant and pest- and disease resistant as millet and cassava.

e) Adjusted planting seasons to deal with the variability in weather patterns. This has helped maximize the impact of climate variability because some crops will undergo early maturity due to increased rainfall and some species of maize for example can be planted into two seasons. This has been discussed in literature review where in other maize growing regions as Addis Ababa where smallholder farmers who rely on rainfed maize production have benefited from climate change, with yields in some areas as much as doubling due to constant rain in the area.

f) Practiced soil control methods mainly through soil testing to be able to find out the level of acidity in the soil and hence regulate the use of fertilizers.

g) Embraced organic farming especially through the use of manure which increases soil fertility and water retention instead of DAP/CAN which increases acidity in the soil. This is cheaper and traditional method of reducing the acidity as compared to using lime which is highly priced.

h) Some farmers are using biogas as a form of energy conservation reducing cutting down of trees for charcoal or firewood at a domestic level.
i) Farmers have embraced use of irrigation systems because rain pattern is not consistent

j) Farmers have adapted the use of green house technology which is more controlled.
<table>
<thead>
<tr>
<th>Practices in detail</th>
<th>Number of times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation agriculture</td>
<td>15</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>6</td>
</tr>
<tr>
<td>Crop diversification</td>
<td>7</td>
</tr>
<tr>
<td>Adjusting farming seasons</td>
<td>6</td>
</tr>
</tbody>
</table>

*Source: Researcher, 2014*

5.2.2.2 Delivery of climate variability information

Previous studies in the literature review have showed that information is mandatory in adaptation to climate variability. This is because what the world is currently going through is new and to some they are in oblivion on where to start from to adjust to it.

Research findings show that farmers in Trans-Nzoia access agricultural information from various sources as shown on the *Figure 6* below. Farmers interviewed mostly rely on agricultural radio programs and information from fellow farmers for their source of
information on market trends, improved agricultural practice and climatic conditions. Although extension officers have been and still are an important source of information on best farming practices, study findings show they are irregular in their visit and this is caused by the situation of having one agriculture officer covering a big area hence lack of efficiency especially in follow ups.

According to the study, institutions mainly use local radio stations as West Fm to deliver agricultural information and advice to farmers. Social media platforms have also been explored by various institutions such as Kenya Seed Company who have a Face book page and a website that delivers all sorts of information in regard to agriculture. The study also shows that institutions conduct farm visits and farm trials at least once a month for farmers to be able to visit one farm and adopt the farming method in their farms.

![Chart 5-6: Most reliable source of information](source.png)
The reliability and effectiveness of information delivery by different institutions stated that 48% farmers rated the delivery to be bad, while 32% rated it to be fair and 20% rate is as good.

Farmers constantly expect to receive information regarding variability in weather patterns and deliberate means of adjusting to it. 68% of the farmers receive information regarding variability in weather patterns and this information has been helpful to them especially those regarding warnings for example on El Nino, droughts and floods. 32% of the farmers however do not receive any information regarding variability in weather patterns and this has consequently affected them because they are found unaware with most phenomena hence affecting their crops.
Therefore, there needs to be a constant channel through which information can be shared and distributed to these farmers to ensure their knowledge on how to adjust to this phenomenon is timely and effective.

Relevant institutions need to effectively perform their roles to attain their mandate; this will in effect ensure the country attains food security. The Government should increase the number of agriculture extension officers and invest in delivery of information as well.

5.2.3 Farming methods practiced by small scale arable farmers in Trans-Nzoia

5.2.3.1 Farm inputs used

Results from the study showed that 88% of the respondents use DAP/CAN fertilizers once every planting season because it is easy to use. 28% use manure which is mainly used at small scale for example in green houses and others use it for top dressing such as in planting banana. Hand tools such as jembe is the commonly used farm tool at 80% because most of the farmers own an average of 2.5 acres of land while 5% of the farmers prefer to used mechanized way of farming by using tractors. Certified seeds are widely used, accounting to 72% which is in line with the literature review as Kenya Seeds
Company regularly advices farmers to buy genuine certified seeds from their retails to maximize profits from produce; other farmers however have decided to stick to local seeds which accounts for 28% of the farmers. This can be summarized in the Table 5-2.

Table 5-2: A summary table showing the use of different farm inputs among farmers

<table>
<thead>
<tr>
<th>Farm inputs</th>
<th>Types of inputs used</th>
<th>Number of Respondents (X)</th>
<th>Percentage representation (x/25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>DAP/CAN</td>
<td>22</td>
<td>88</td>
</tr>
<tr>
<td>Manure</td>
<td>Residues from livestock, poultry and crop farming</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Farm tools</td>
<td>Hand tools</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Tractor</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Seeds</td>
<td>Certified seed</td>
<td>18</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Local seeds</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Others</td>
<td>Spraying</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Researcher, 2014
5.2.3.2 **Source of water used for farming**

Rainfall in Trans-Nzoia is well distributed throughout the year with long rains occurring between April to June which is primarily the planting season for main crops in the area. This reduces dependence on irrigation as study findings show that 88% of the farmers rely on rain fed agriculture. However 8% of the farmers use irrigation methods such as drip irrigation in cases of greenhouses while 4% use other sources as well mainly livestock.

![Chart 5-9: Source of water for agricultural use](chart)

**Chart 5-9: Source of water for agricultural use**
*Source: Researcher, 2014*

5.2.3.3 **Conservation practices**

The community practices soil and water conservation in the area through agro forestry and mixed farming which accounts for 26% and 20% respectively of the conservation practices. Other conservation practices are as shown on **Chart 5-10** below. Mixed farming prevents total loss incase crops are affected by weather patterns and agro forestry is key in modifying the micro climate of the area.
Study findings show that firewood is the most commonly used source of energy followed by charcoal. This is alarming because trees are rampantly being destroyed to obtain this energy. Biogas has also been explored by 2 farmers within the area which is a positive sign.

5.2.3.4 Challenges identified

Some of the challenges herein faced by farmers are as follows:

a) Inadequate knowledge on where to get the information on weather variability’s

b) Inadequate communication channels on how the information is delivered

c) Time of delivery is inefficient because of lack of consistency

d) Agriculture Extension Officers are inadequate to be able to reach all the farmers and when they reach the few, there is no follow up to be able to know if the advised methods are working.
e) The cost of input in practicing best farming practice is high for example because DAP brings a lot of acid to the farm, lime is the best option but it is expensive

f) There is drastic variability in weather patterns which directly affects farming

Findings also show that institutions are faced with challenges in delivering information on best farming practice. They include:

a) Farmers do not turn up during barazas or agricultural trial sessions

b) Farmers rarely take up new mechanisms e.g. new seed crops, new planting methods to name but a few.

c) There is variability on farms such that blanket recommendation cannot apply to all farmers equally
6 CHAPTER 6: RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

This chapter presents a summary of findings; give recommendations on the way forward, make a conclusion and explore areas of further studies.

6.2 Summary of the Findings

In line with the study objectives below is a summary of findings of the research:

6.2.1 Assessments of the impacts of climate variability to small scale arable farmers

The first objective sought to assess the impacts of climate variability to small scale arable farmers in Trans-Nzoia. The study finds that small scale arable farmers in Chisare village are directly facing the impacts of climate variability. Recently, the farmers are experiencing rains during dry seasons when they want to plant and during dry seasons when they expect to harvest, rains occur. This is a major challenge because planting patterns is largely determined by the weather patterns and with the recent trend they have to adjust their current planting seasons.

Study finding also show that there is no much improvement in farming because people are not very much conversant of what is happening. 36% of the farmers do not understood what climate change is. However, crop failure and emergence of new crop diseases in the area could not go unnoticed by the farmers where 40% and 24% linked this to climate variability. This has had a ripple effect to economic loss in the area because farmers have to put up infrastructures that will help in mitigating this situation.
6.2.2 Adaptation to climate variability by small scale arable farmers

The second objective sought to evaluate the adaptation strategies to climate variability by small scale arable farmers in Trans-Nzoia. Study findings show that despite the knowledge level of farmers on how to adapt to the recent changes being minimal, both new and indigenous methods of dealing with this situation is being exercised.

Conservation agriculture through agro forestry, biogas and green house technologies, soil and water conservation methods as mulching, water harvesting and drip irrigation are being exercised by farmers. Other farmers are practicing crop rotation which they have not been doing so in the past years while others are diversifying the variety of crops to be planted in an area to more drought resistant crops.

Information is mandatory to be able to adjust to this situation. Hence, the study findings have shown that farmers rely on information from fellow farmers regarding agriculture and new practices. It is therefore important for institutions to utilize this platform and perform farm trials where other farmers can use as a point of reference.

Farmers require adequate and reliable sources of information concerning change in weather patterns; however the study findings show that 68% of farmers do not receive information regarding this situation. Agriculture extension officers should therefore be deployed far and wide for effectiveness in this area.
6.2.3 Existing farming methods practiced by small scale arable farmers in Trans-Nzoia

The third objective sought to assess the existing farming methods practiced by small scale arable farmers in Trans-Nzoia. In analyzing the farm inputs regularly used by farmers, the study showed that 88% of the farmers use chemical fertilizers such as DAP/CAN fertilizers every planting season and during top dressing because it is easy to use. However, according to institutions interviewed, this trend should change because soils are becoming too acidic in the area due to excessive use of these chemical fertilizers.

80% of the farmers use hand tools compared to 5% who use mechanized farming. While Kenya Seed has always been the main supplier of certified seeds in the area, study findings show that 28% of the farmers are still using local seeds due to cases of malice where some seeds have been corrupted by middlemen and are not certified.

The study also identified that 88% of the farmers rely on rain as a source of water for agriculture; this is a common trend in the whole country. Some are practicing irrigation especially in green houses but this should be adopted at a large scale because rain patterns are not reliable any more.

6.3 RECOMMENDATIONS/ACTION PLAN

With the aim of adapting to changes in weather patterns and maintaining a stable agriculture production status from the bread basket of the country, the study proposes the
following action plan according to the study objectives, the strategy for reaching the desired end, the proposed activities, the timeframe for action and the actors as shown in the Table 6-2.

Table 6-1: Proposed climate variability adaptation action plan

<table>
<thead>
<tr>
<th>Objective</th>
<th>Strategy</th>
<th>Activity</th>
<th>Timeframe</th>
<th>Actors</th>
</tr>
</thead>
</table>
| Assessment of the impacts of climate variability to small scale arable farmers | Minimizing loss incurred by crop loss and failure due to climate variability | • Provision of early weather forecasts and warnings  
• Establishment of weather forecast stations after every 10km  
• Manual removal of invasive plant species  
• Promote organization willing to build capacity means of | ✓ | Kenya Meteorological Department, KARI, VI-Agro forestry, Farmers, Government of Kenya, CBOs/NGOs |
<table>
<thead>
<tr>
<th>To evaluate the adaptation strategies to climate variability</th>
<th>Equipping farmers with knowledge on adaptation measures</th>
<th>Sensitization and capacity building on climate change</th>
<th>Government to intervene with subsidies in climate change</th>
<th>KARI, CBOs, NGOs, banks, Ministry of Agriculture, Insurance agencies, farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>adaptable inputs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
| To assess the existing farming methods among small scale arable farmers in Trans-Nzoia | Adjusting present farming methods and incorporating new technologies that will adapt to the current change in weather patterns | • Afforestation and re-afforestation projects

• Optimize on the alternative sources of energy such as use of biogas.

• Sustainable land management practices

• Carry out routine monitoring and document best practices that can be adopted by other farmers | ✓ | ✓ | Kenya Seed Company, NEMA, KFS, KARI |
• Improve communication from relevant authority to farmers through field days, workshops and agricultural shows.

Source: Researcher, 2014
6.4 CONCLUSION

Technically, it is obvious that farmers still find it difficult to adapt to climate change in developing countries like Kenya. To ensure that small scale arable farmers can do this independently, the government CSOs and other economic actors have an important role to ensure that arable small scale farmers can independently carry out practices that promote adaptation to climate change. Policymaker should ensure that farmers have access to affordable credit to increase their ability and flexibility to change production strategies in response to the forecasted climate conditions. Due to the fact that access to water for irrigation increases the resilience of farmers to climate variability, irrigation investment needs should be reconsidered to allow farmers increased water control to counteract adverse impacts from climate variability and change. Pricing systems and reforms ought to be reformed to fit the specific needs of each country.

6.5 AREAS OF FURTHER STUDIES

Future researchers should investigate the following pertinent areas:

a) Livestock production is an important area in the agriculture sector that the county benefits from. Hence it is important for further research to assess the impacts of climate variability to livestock production in Trans-Nzoia Count

b) To most farmers, traditional beliefs are hindering them from swiftly adjusting to the current situation; hence further studies should explore the nexus between changing farmers’ mindset and adopting to some traditional practices.
c) Also, further studies should be carried out on the alternative crops that can do well in Trans-Nzoia for farmers to start shifting planting patterns from the maize norm.
REFERENCES


Rica and Ghana. Radboud University Nijmegen, Centre for International Development Issues, nijmegen, Netherlands.


APPENDICES

Appendix 1: Household Questionnaire

KENYATTA UNIVERSITY
Department of Environmental Planning and Management

HOUSEHOLD INTERVIEW QUESTIONNAIRE

INTRODUCTION

I am a Kenyatta University undergraduate student pursuing a Bachelor in Environmental Planning and Management. I am carrying out a research on “An analysis of how small scale arable farmers are adapting to the impacts of climate variability: A Case Study of Chisare Village in Cherangany, Trans-Nzoia East Sub-County”. I am kindly requesting for your time to answer some questions. The information you will provide shall solely be used for academic purpose.

Household Questionnaire

Name of Interviewer……………………………………………………………………………………
Name of Interviewee……………………………………………………………………………………
Date of Interview……………………………………………………………………………………
A. BACKGROUND INFORMATION

i) Do you stay in this area? Yes  NO

ii) How long have you lived in this area?

Less than 10 years  
10-20 years  
21-30 years  
31-40 years  
More than 41 years  

iii) What is your main occupation?

- farmer, business person, public servant etc

If a farmer proceed to section B

B. BEST FARMING PRACTICE AMONG FARMERS

i) What type of farm inputs do you use?

<table>
<thead>
<tr>
<th>Farm inputs</th>
<th>Yes</th>
<th>No</th>
<th>Frequency</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm tools (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Seeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ii) What is your source of water for farming?

A. Rainfed

B. Irrigation

C. Other sources (specify)--------------------------
iii) Are you aware of any source of information regarding best farming practice methods? Yes [Blank] No [Blank]

iv) If yes, fill the table below by ticking the appropriate (you can tick more than one)

<table>
<thead>
<tr>
<th>Sources of information</th>
<th>Frequency per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural extension officers</td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td></td>
</tr>
<tr>
<td>Television</td>
<td></td>
</tr>
<tr>
<td>Fellow farmers</td>
<td></td>
</tr>
<tr>
<td>Social networks</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

v) What challenges do you face in regard to exercising best farming practice?

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

vi) What form of conservation methods do you practice in your farm?

<table>
<thead>
<tr>
<th>Category</th>
<th>Practice</th>
<th>Mark appropriately</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Biogas, Firewood, Charcoal, Electronic</td>
<td></td>
</tr>
<tr>
<td>Soil Conservation</td>
<td>Terracing, Agro forestry, Mixed farming, Crop Rotation, Mulching, Composting</td>
<td></td>
</tr>
<tr>
<td>Water Conservation</td>
<td>Rain harvesting, Drip irrigation, Rain harvesting, Water Pan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>
C) ADAPTATION TO CLIMATE CHANGE BY FARMERS

i) Have heard of climate change? yes no

ii) If yes, what do you know about it? A- Very Knowledgeable

B- Knowledgeable

C- Less Knowledgeable

iii) What are the impacts of climate variability to you as a farmer?

iv) What are the impacts of this climate change on crop yield production in your area?

v) Are you aware of any forms of farming practice that will help in adaptation of climate change?

vi) What have you done to adapt to this phenomenon?

vii) a) Do you receive any information in regard to climate change in your area?

Yes  No
b) If yes, how effective has this information been to you as a farmer?

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……………………………………………………………………………………
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……………………………………………………………………………………


c) What challenges do you face in receiving this information regarding climate change?

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……………………………………………………………………………………
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d) How would you rate the delivery of this information by relevant authorities

Good □ Fair □ Bad □

e) What do you think should be done to improve the delivery of this information to farmers?

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………


viii) The Government in 2009 started a project called ‘KilimoSalama’ which is an insurance plan that protects farmers’ investments in seeds, fertilizers and other inputs. Are you aware of this?

Yes □ No □
Appendix 2: Institutional Questionnaire

KENYATTA UNIVERSITY

Department of Environmental Planning and Management

HOUSEHOLD INTERVIEW QUESTIONNAIRE

INTRODUCTION

I am a Kenyatta University undergraduate student pursuing a Bachelor in Environmental Planning and Management. I am carrying out a research on “An analysis of how small scale arable farmers are adapting to the impacts of climate variability: A Case Study of Chisare Village in Cherangany, Trans-Nzoia East Sub-County”. I am kindly requesting for your time to answer some questions. The information you will provide shall solely be used for academic purpose.

Institutional Questionnaire

A. Sustainable Agriculture Land Management practices (SALM)

i) Do you encourage any form of conservation practice for use by the community? Yes □ □ No □ □ If yes specify?

<table>
<thead>
<tr>
<th>Category</th>
<th>Practice</th>
<th>Mark appropriately</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Biogas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Firewood</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Charcoal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electronic</td>
<td></td>
</tr>
<tr>
<td>Soil Conservation</td>
<td>Terracing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro forestry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mixed farming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crop Rotation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mulching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Composting</td>
<td></td>
</tr>
<tr>
<td>Water Conservation</td>
<td>Rain harvesting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drip irrigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rain harvesting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water Pan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>
ii) Do you provide any form of agricultural information and how often?
   Yes [ ]   No [ ] which one?

<table>
<thead>
<tr>
<th>Form of information delivery</th>
<th>Frequency per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural extension officers</td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td></td>
</tr>
<tr>
<td>Television</td>
<td></td>
</tr>
<tr>
<td>Social networks</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

iii) a) What challenges do you face in providing agricultural information for the farmers?

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..................................................................................................................................................
..................................................................................................................................................

b) What do you think should be done to solve the above challenges?
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B. ADAPTING TO CLIMATE CHANGE BY FARMERS

ix) What are the impacts of climate variability to farmers?
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..................................................................................................................................................
..................................................................................................................................................

x) What are the impacts of this climate variability on crop yield production in the area?
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
xi) What forms of farming practice exist that will help in adaptation of climate change?

…………………………………………………………………………………………
…………………………………………………………………………………………
………………

xii) What have farmers done in the area to adapt to this phenomenon?

…………………………………………………………………………………………
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