

**EFFECTS OF DROUGHT ON CROP PRODUCTION AND COPING
MECHANISMS UNDERTAKEN BY SMALL SCALE FARMERS: A CASE OF
MAKUENI COUNTY, KENYA.**

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UNIVERSITY OF NAIROBI

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or any other award.

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DEDICATION

This Thesis is dedicated to my loving husband Mr. Munene Gitere and my Children Tatiana Wanjira and Ryan Gitere.

To my mother and late father “thank you for tirelessly providing a great foundation for my education’

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Thank you and God bless.

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LIST OF ACRONYMS

ASALs	Arid and SEMI-Arid Lands
CIDP	County Integrated Development Report
FAO	Food and Agriculture Organization
GoK	Government of Kenya
IPCC	Intergovernmental Panel on Climate Change
KARI	Kenya Agricultural Research Institute
KALRO	Kenya Agricultural and Livestock Organizations
KBS	Kenya Bureau of Standards
KDHS	Kenya demographic and Health survey
SDG	Sustainable Development Goals
UN	United Nations
WSP	Water Supply and Sanitation

ABSTRACT

Drought has adversely affected Kenyan agricultural production. This is evident as Kenya experiences extreme droughts every ten years and less adverse ones every three to four years. Although some mitigation technologies have been employed to reduce food scarcity across the board. However, the situation of food insecurity continues to be a major challenge and sometimes even worsens among human livelihoods.

This study seeks to assess farmer's access to food in the face of drought, to determine how farmers' attitudes to drought determine their vulnerability or resilience. To assess farmers' perceptions on drought adaptation mechanisms and determine drought adaptation mechanism undertaken by farmers in the study area. The researcher also was able to widely examine other literature documented on how drought has greatly affected food production globally, in the African region, in Kenya and finally narrowed down to Makueni County formally Makueni district. A cross-sectional descriptive survey was conducted for the research where Data was collected by use of a questionnaire, an observation checklist and key informant interview guide. Data analysis was done using SPSS (version 11.5). The adaptation mechanisms employed by farmers was found to be planting of drought resistant varieties and use of irrigation though the use of irrigation was very low which prompted the researcher to advise that there was need in future to carry out a study and verify whether use of irrigation was effective and reduced food insecurity in the study area. It was equally found that majority of household heads and principal care givers had up to primary level of Education (63%) a status that contributed to low uptake of adaptation measures recommended by research Institutions and experts and therefore contributing to household food insecurity. Majority of households had a higher number of household members (6 members per household) which was higher than the national household members (4 members per household) a situation that equally contributed to a status of food insecurity. Maize was found to be the main source of food among households where it was mainly sourced from the market as opposed to own production a situation that contributed to increased poverty levels among households as a higher percentage of their income was used to purchase food. It was therefore recommended that there was need to increased capacity for extension workers to disseminate the most needed information on climate change to farmers because the information that is given by experts such as the Kenya Meteorological department is complex and its packaging is not understood by farmers who are the end users. The entire stated hypothesis was rejected as the hypothesis showed significant relationships. The results obtained was meant to add to the body of knowledge as well as inform policy makers on better ways of adapting to drought by small scale farmers in order to build capacity for implementation and improvement in crop production.

CHAPTER ONE: INTRODUCTION

1.1 Background

Agriculture in the African continent is a main source of food and livelihood among households and a major sector affected by climate variability (*IPCC 2007*). There are challenges presented by change of climate in the area of crop production where a big percentage of Africans depends on crop production which is a climate sensitive activity (*FAO 2010*). The agricultural sector in Africa has already experienced episodes of floods and droughts during el-nino and la-nina, where the sector is losing 2-7% of its Gross Domestic Product(GDP) in western Africa and 2-4% of GDP in central Africa(*World bank report 2010*). It is estimated that by the year 2080 over 100 million people will face hunger in the world with 80% of them being from Africa (*Carter,2007*).

The agricultural sector is characterized by farmers who contribute greatly in ensuring there is enough providence of food in the African continent. They therefore contribute immensely to domestic food production and providing food for export markets as indicated by (*Quan, 2011*). However, crop and livestock farming to a greater extent is impacted on by extreme droughts and floods (*FAO, 2012*)

Kenya has an area of 583,684 sq km kilometers of which less than 5% of Kenyan land is covered by forests.75% of Kenya's population earns its living from agriculture. Kenya's food security sector is dependent on rain as opposed to irrigation for agriculture and when drought occurs, it causes a decline in food production (*GOK, 2007*).

The variation in production is attributed to droughts and floods which is also known to cause crop production failure and emergence of new crop diseases. Kenyans have therefore continued to face food shortages as a result of frequent droughts (*Asiti, et al., 2010*). The small-scale farmer plays a major role in tackling household poverty and its total alleviation (*FAO, 2012*). These they have done through adapting to the effects of climate variability by taking up new technologies for their crop production, although the uptake on various technologies is still very low (*Antal, et al., 2012*). Understanding how smallholder farmers perceive drought will be helpful to policy makers by enabling them to implement fully technologies already being used by farmers to ensure sustainability of their crop productivity when faced with drought (*FAO, 2012*).

Makueni county is located on the southern end of the Eastern part of Kenya, It has an area of 7968.8 square kilometers and has a total population of 883671 people (*Census, 2009*). The county which was formerly Makueni district has nine sub-counties and the three main livelihood zones are mixed farming, coffee/dairy/irrigation and food crops/cotton/livestock. Major crop grown in the county is maize, other crops are cowpeas, beans green grams and pigeon peas.

The residents of Makueni County depend on rain for agricultural production, a practice that is highly vulnerable to the effects of climate change such as droughts (*CIDP, 2013*).

Makueni County is faced with serious water scarcity challenges. Recurring droughts have diminished water supply rendering many rivers seasonal and drying them completely (*UN report 2013*). High rates of deforestation have made the problem worse by severely

reducing water catchment capacity. Degradation of upstream catchment mainly due to agricultural expansion due to increasing population is equally impacting water availability. Destruction of forests in the county and the resultant biodiversity loss is also a key environmental challenge.

The majority of Makueni county population use wood fuel for cooking (*KNBS,2010*).It is estimated that 96% of households use firewood or charcoal for cooking and heating. Population growth and associated increases in demand for farming and residential land will accelerate deforestation and the effects of climate change (*UN report 2013*).

1.2 Problem Statement

The changing climate and weather variability has constrained maximum use of modern science and technology in agricultural production especially in Africa specifically in Kenya despite having an established research system in the country. The increasing challenges and effects of a changing climate are exploiting on land use and other land resources, events such as floods and droughts are notably shifting growing seasons meanwhile exposing the population to food insecurity. There is equally a big gap regarding information on climate change and variability to small scale farmers who are not aware on when to expect the rains as interpretations on weather forecasts disseminated by the National Meteorological and hydrological services remain a challenge for the non- climate expert end users. There is therefore increased need for simplified communication approaches to inform and alert the vulnerable small scale farmers.

Makueni county is one such an ASAL area that has continued to experience frequent household food insecurity due to droughts (*GOK,2009*).Due to the mentioned observation and occurrences, the study on the effects of drought on food production was deemed necessary in order to document the findings for future action by researchers and policy makers.

1.3 Objective of the research

It was to add to the body of knowledge on the effects of drought on food production and its implication on food security agenda in Makueni County.

1.4 Specific Objectives

They were as follows:

- To assess limitation of farmers access to food in the face of drought
- To determine how farmers attitudes to drought determine their vulnerability or resilience
- To assess farmers perceptions on drought adaptation mechanisms
- To determine drought adaptation mechanisms undertaken by farmers in the study area

1.5 Research Hypotheses:

- H1 There are no limitations of farmers access to food in the face of drought.
- H3 there is no significant relationship between farmers attitudes towards drought and their adaptation ability

- H4 there is no significant relationship between perceptions and adaptation mechanisms undertaken by farmers on the face of drought and food production

1.6 Justification of the Study

The first Sustainable Development Goal (SDG) is to eradicate extreme poverty and hunger by 2030. This will in particular depend on raising the productivity of smallholder farmers (*Asfaw, et al., 2010*). Achieving agricultural growth in Kenya is not possible without enhancing options for ASAL areas which comprises 82% of Kenya's Territory (*Gitu, 2004*). Agricultural research and technical improvement is therefore critical to increasing agricultural productivity thereby reducing poverty and variability on their agricultural practices.

1.7 Scope and Limitation

The research was carried out to determine actions undertaken by small-scale farmers when faced by drought, how their perceptions and attitudes determine their decisions to undertake adaptation measures that further resulted in resilience or Vulnerability. The study focused on small-scale farmers households in Makueni County where the population is sparsely populated. The Simple random selection was used to determine the sample where 4 sub-counties were randomly selected and finally 160 respondents were arrived at as the method eliminates bias though it turned out to be costly as a wider geographical region needed to be covered as well as time-consuming. The study area was sparsely populated and cluster sampling was further conducted in order to interview the respondents. Cluster sampling is cheap and easy although it had the disadvantage of

having clusters that are like others, therefore, producing larger sampling error and reduce the representativeness of the sample. An overlapping may take place if an adequate number of cases from the standpoint of increasing the precision of the sample is not selected.

The Drought was an independent variable in the study and it was difficult to determine the truth on whether low production of crops was a result of drought or poor agricultural practices by small- scale farmers within the study area. The variable (drought) was therefore not completely controlled and there was a likelihood of causing bias to the results obtained after analysis. A t-test was carried out to determine whether there was any significance difference on the means in production of food crops and it helped in informing the researcher on whether to accept or reject the stated hypothesis. The advantage of a t-test is that it requires very little data and one value from each of the subject. A chi-square was also used to determine significance association between variables, it was easier to compute as the data used was already categorical and the methodology used was simple random sampling which was appropriate although it was sensitive to frequencies which could have led to an erroneous conclusion.

In the face of drought, households depended on market as their main source of food which was a contradiction to previous studies done that stated, “majority farm household depended on own production as a source of food” .Maize was singled out as the main source of food and households that had no production of maize or low production of maize were observed to be food insecure. Obtaining food from the market further

impoverished households as a high percentage of household incomes was used for purchasing food thus contributing to poverty levels and therefore Sustainable Development Goal number one of eradicating extreme poverty and hunger may never be achieved unless robustness of households is improved to mitigate the effects of drought on crop production. Majority of farmers adapted to drought by use of drought resistant varieties which they obtained from KALRO although they equally stated that despite the use of drought resistant seed variety, crop production failed. Minority farmers were observed to use irrigation which was capital intensive and those who adapted by use of irrigation were observed to have access to more assets and depended on incomes other than farming.

The researcher concluded that the small-scale farmer's capacity needs to be enhanced by simplifying complex climate change information that is not clearly understood by a majority of the small-scale farmers who are battling poverty, hunger and expected to produce food not only for self but also for the rest of the county in order to improve crop production to ensure sustainable food security

CHAPTER TWO: LITERATURE REVIEW

2.1 Global food production in relation to drought

Impacts of population growth and climate change are making food production increasingly an important concern for humankind globally. A major challenge to agricultural production from changes in climate and variability is through increases in the episodes of drought. The economic impacts of droughts can be far reaching, historically, Droughts have led to migration of people, wars and collapse of governments, as indicated by (*Grove, et al.,2007*) For example, recent droughts in India have continued to have dangerous impacts such as failure of monsoons in India. Another example is the land area affected by dust storms in China which has increased since 2000.Crop failure in 2000-2002 in South Asia due to drought, water shortages and forest fires in south East Asia as indicated by (*Parry, et al., 2007*) These issues are critical, particularly pressing in the developing world where Agro-ecosystems have less resilience, households have fewer assets to rely on if farming suffers especially as it is rain-fed agriculture.

A myriad of factors have been responsible for the continued world food insecurity yet quantifying that climate change is directly affecting food production has been a difficult task as it is not directly related (*Parry, et al.,2007*) Food prices of internationally traded food commodities such as wheat rice and corn are equally impacted by change of climate. It is established that inflation of wheat is at 125% and rice at 75%(*World Bank,2008*).Another factor is poverty, an estimated 100 million people have become extremely poor in the last few years for instance, in 2007,Afghanistans households were spending 75% of their income on food(*World Bank,2008*).Dependence on food imports

also influences food insecurity. A case in point is Haiti where over 80% of staple rice is imported. The result of it is that over half of the population of the country is undernourished and 24% of children suffer from chronic malnutrition (*FAO, 2008*). Fresh food exports of horticulture produce from Ghana to Europe for monetary gains has made the nation to import a large amount of its staple food such as rice, leaving the county exposed to the spiraling food prices. Moreover, global warming causing climate change has greatly contributed to world household food shortage (*World Bank 2008*). El-nino and La-ninas hamper good food production in latin America and the sub-Saharan Africa. Droughts caused by la-nina have caused household food insecurity especially in Ethiopia where 7 million people are classified as food insecure and a further 10 million classified as prone to drought. Other issues that influence household lack of food in the world include: politics, environmental degradation, population growth and a shift to non-agricultural technology.

Lack of sufficient food among households in the world has also resulted to poverty globally. food security has been defined as “ a situation that exists when all people at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” (*FAO, 2002*). Household food production will always result to security or insecurity of food. The focus is the implication of food security to individuals in the family households.

Currently, frequent and extreme weather changes such as occurrence of droughts, rising sea levels and floods, are impacting on agriculture negatively. This affects availability of food and its accessibility leading to increased emergencies, decreased livelihood assets and income as well as extreme poverty. (FAO, 2007). The drought have been observed to have both negative and positive changes such as, changes in distribution and productivity of resources, changes in the incidence and vectors of different types of pests and diseases, loss of ecosystem and biodiversity, loss of arable land due to aridity, ground water depletion and death of animals, changes in health risk, and international migration and redistribution of crop growing limits.

2.2 Food production in Africa

Various countries in Africa have experienced the devastating effects of household food, insecurity. For instance, Cameroon in west Africa, Egypt in Northern Africa, Ethiopia in the eastern Africa and south Africa in the southern African region. The world food program describes Cameroon as a country that has no enough food repeatedly affected by prevalence of frequent droughts leaving a majority of the population food insecure (World Bank, 2007) Egypt produces half of its demand for wheat. In spite of the average food production, the country is exposed to escalating food prices due to its wheat imports. It is classified as the number one importer of the produce in the world (FAO, 2007). The population growth of Egypt is at 2% per annum, moreover the desert terrain of the Sahara limits crop production. Ethiopia experiences serious household food insecurity. High population growth in the country increases the food insecurity problem further (Chu, 2009) although South Africa produces bumper harvest; it has been affected by declining

world food prices. High food prices are causing hardships among poor households who end up spending a much amount of their earnings on food.

2.3 Food production in Kenya

Household food insecurity in Kenya is caused by inadequate farming area. It is only 18% of Kenya's territory which is suitable for farming. Another cause is poverty, the 2007/2008 United Nations development report noted that almost 23% of Kenyans are living on extreme poor incomes(CBS,2009)Droughts in the ASAL area of Kenya has brought a decline in crop and livestock production among households .Moreover, floods make displacement of people making them vulnerable to food insecurity. The 2007/08 post election violence disrupted the March/April agricultural production. The World Food Program reported that 50% of farmers were not prepared to farm due to the post election turmoil. In addition erratic rainfall exacerbates household food security in the country. Poor rains in 1996 prompted the government to declare a state of disaster in January 28th (*IRIN humanitarian report 1997*)

The government Kenya has assisted farmers in crop production by providing farm inputs subsidy such as granting 10% decrease on seed prices(*FAO,2007*)The government in collaboration with World Food Program is equally feeding 1 million people under the emergency intervention program.

2.4 Makeni County Environment And Climate Change

Majority of the county residents depend on rain for their agricultural activities, an exercise that exposes them to the effects of climate variability such as droughts, this is

according to Millennium Development Goals indicators of 2013 now Sustainable Development goals (FAO, 2013).

There is an occurrence of frequent droughts which have depleted water sources a case of many seasonal rivers drying them completely (UN report 2013) Water catchment capacity has reduced due to high rates of deforestation. The county population growth is high while climate change continues to compound water scarcity the county also experiences Loss of forest cover which has consequences on food security and the ecosystem. The majority of Makueni county households use wood fuel for cooking (KNBS, 2010). It is estimated that 96% of households use charcoal or firewood for heating and cooking.

2.5 Farmers perceptions on drought and adoption measures

In Kenya, information on climate change at the grass-root level is very low where majorly small scale farmers are based, as a result the very farmers are unable to identify problems arising from local environmental challenges and climate change and variability. For individual farm households, agricultural techniques begin from the farm, this is according to Food and Agriculture Organization report of 2012 (FAO, 2012). For instance, the quality and quantity of harvest is greatly determined by proper land preparation at the initial stage as research has shown (Kamau, 2005). However, some of the agricultural techniques negatively affect the vegetation cover hence leading severe soil erosion (Khisa, et al., 2002). The Government of Kenya has recently created awareness on several farming improvement programs through chosen institutions. One

example of the program that is being implemented is on soil management project with the aim of increasing crop production and fertility of the soil (Nyangena, 2008). Food insecurity has also increased over time due to failure of traditional technologies of farming therefore calling on the government to implement modern day technologies such as use of drought resistant varieties of seed in order to feed the growing population.

2.6 Theoretical perspectives

Adaptation: It refers to adjustments to practices, processes and systems to minimize current and or future adverse impacts of climate change and variability and take advantage of available opportunities to maximize benefits in agricultural production (Eriksen, et al., 2011). Adaptation can either be autonomous or planned with the former being done.

The level of sustainable adaptation depends on, knowledge, robustness of livelihoods, skills, alternative resources and institutions accessible to enable undertaking effective adaptation which greatly influences the adaptive capacity (IPCC, 2007). Such factors as, access to appropriate technology, institutions, robustness of livelihoods, perceptions and proper policies influence adaptive capacity (Ager, et al., 2003; IFAD, 2008).

Smithers & Smit (2009) Effective adaptation is not guaranteed by having perceptions that climate change is occurring rather by effective adaptation response strategy and the skill in its application (Weber, 2010).

(Rogers, 1989) suggests that the rate of adoption is related to type of innovation decision. He outlines three types; Optional whereby an individual has a choice or no to adopt an innovation, collective whereby a majority needs to be convinced about an innovation and authoritarian whereby a decision has been superimposed upon a community such as in case of water fluoridation.

Communication channels are considered more effective with more complex innovations than mass media channels. Finally, the nature of the community, whether or not it is modern or traditional, and the extent of the change agents' promotional efforts influence the rate of adoption (Vago, 1996; Rogers, 1989). Innovators – Are eager to try out new ideas, are daring, risking and willing to take the consequences for their actions. Early adopters are more integrated in the community than innovators and tend to be more prominent, successful and respected, early majority adopt new ideas just before the average in a community and they tend to be deliberate and they aid in legitimizing innovations although they are seldom leaders, late majority follow after the average community members at times adoption results from social pressures or economic necessity and laggards who are suspicious of innovators and change agents and have traditional values and usually the last to accept an invention.

2.7 Operational definition of terms

Drought

There is no common definition of drought because unlike other types of hazards, drought is a hazard which is difficult to define, since its effects are specific to the affected region.

as well as the affected communities and societies, a universal definition is difficult to develop. However, drought can be defined in a simple conceptual way that it is an abnormally prolonged dry and hot period when there is scarcity of water for the normal needs of the community and the ecosystem (*EEN, 2004*).

2.8 Droughts

There are various types of droughts, which are classified according to their effects. These are; Agricultural drought, Meteorological drought, Socio-Economic drought. And Hydrological drought

2.9 Adaptation

Defined by Burton as the ability of social and environmental systems to adjust to change in order to cope with consequences of change (*Burton, et al., 2002*) Similarly, (*Smith, et al., 2000*) suggest adaptation to be the adjustments made in ecological-social-systems in response to expected or actual climate stimuli, their impacts or effects.

2.10 Coping strategies

Ways of reducing effects of negative event once it has occurred such as household food insecurity.

Farm Family

Household whose livelihood orientation is farming

Farmland Size

Size in acres of household land under cultivation

Farm Size

Land size in acres of the entire household land holding

Household

A unit comprising a group of persons living together, sharing from the same dietary pot and same source

Small-Scale Farmers

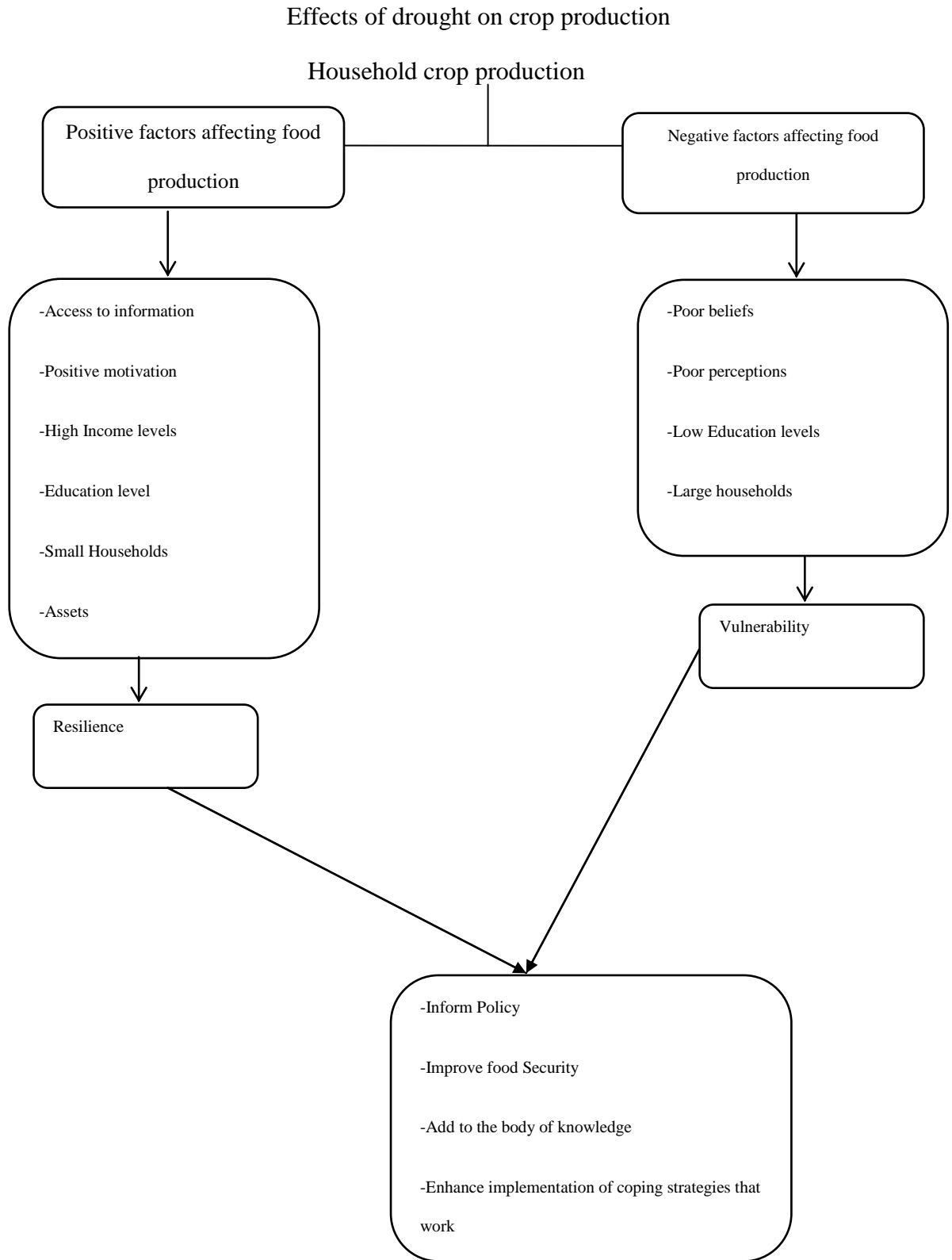
Farmers whose agricultural orientation are mainly subsistence and cultivate land not more than ten acres

Household Food Production

Food crop cultivation and food harvests in household Perceptions

The process by which stimulation of the senses is translated into meaningful experience

Figure 2.1: Conceptual Framework (Author's Own)



CHAPTER THREE: METHODOLOGY

3.1 Introduction

The county which was formerly Makueni has a total population of 883671 people (*census,2009*) with an area of 7968.8 square kilometers and has nine sub-counties namely: Makueni, Kanthozweni, Kilungu Mbooni EAST and west, Kibwezi, Makindu, Nzaui and Mukaa. The three main livelihood zones are coffee/dairy/irrigation, marginal mixed farming and food crops/cotton/livestock. Major crop grown in the county is maize, other crops are cowpeas, beans green grams and pigeon peas.

Google Map of Makueni County.

Figure 3.1: Map of Makueni County



Source (Map obtained from Google)

3.2 Household sampling method

The target population was small scale farmers from Makueni county .The county has a total number of 186,478 households (*Government of Kenya Census 2009*) 160 households were selected as sample size. The farm family household was focused on because they were able to reflect food production and food insecurity in relation to drought in the study area. Household heads or principle caregiver of the household were the responded because of their experience on food production and their decision making responsibility they have in determining the measures undertaken against draught. In cases where the household head were different from the principle caregiver there was the identification of the person responsible for overseeing food production and determining coping strategies.

3.3 Size of the Sample

The sample size was 160 households according to United Nations recommended way of determining household survey. A total of 160 households were selected from four sub-counties namely Kathonzweni, Makueni, Mukaa and Nzaui using simple random sampling technique, In addition focus group discussion and informant interview were done in this areas.

Population size=186,478 households

Margin of error=+/-5%

Confidence Level=95%=Z-score

Standard Deviation=0.5

Sample size=(z-score)²(1-0.5)(0.5)²

(1.96)² 0.5(0.5)(186478 x (0.25)

=323 respondents.

According to United Nations taskforce report on food security of 2008(*UN Report,2008*).When conducting a household survey of a sparsely distributed population, where more time and resources maybe needed to cover a larger sample which was in the case of a researcher 323 respondents, Reducing the number of respondents by half is recommended as it will still meet the sample size for testing and is a representative of the original sample.0.5 of 323 was 160 respondents.

3.4 Procedure used for Sampling

Simple random sampling was applied to determine four sub-counties from a total of eight sub-counties in Makueni County. Samples were obtained from eight pieces of paper. These pieces of paper had the names of the eight sub-counties and were written as follows; Makueni, Mukaa, Mbooni East, Mbooni West, Kilungu, Nzau, Kibwezi and Kathonzweni. The pieces of paper were wrapped, put in a plate, shaken and dropped on the table. Four pieces were handpicked with eyes closed and the names on the pieces of paper confirmed to be Kanthonzweni, Makueni, Mukaa and Nzau .This allowed for variations in the nature of farm family households within the area (*Saunders, 2009*).

The formulae below illustrate the systematic sampling that was done.

Sampling interval=Population size/sample size

$K=N/n$

Multi-stage sampling was applied in this study considering the above mentioned sampling techniques to overcome the problems associated with the area's geographical sparse population. Sparse population in a wide geographical area is a major challenge to

conduct face-face interviews because they are too expensive to conduct and it also takes a lot of time to construct a sampling frame for interviews on the entire area(*Saunders, Lewis and Thornhill,2009*).With the help of extension officer, the researcher chose 40 households from each sub county i.e Kathonzweni, Mukaa, Makueni and Nzai, Clusters were constructed(villages within the sub-county) they were merged to four smaller clusters where 10 households were randomly selected for the survey from each of the 4 clusters within the sub-county .The area agricultural extension officers were purposively selected as key informants because they possess vital information on food production trends in times of drought occurrence as well as agricultural aspects such as land use and sizes of land.

3.5 Variables measurements

Both independent and dependent variables were used in establishing household food production and plan of action employed among small scale farmers in Makueni County in the face of drought.

3.6 Independent Variables

Drought was the independent variable which was clearly illustrated by the researcher on the conceptual framework.

3.7 Dependent Variable

Household food production was the dependent variable. There were 3 domains of the dependent variable as adapted from *WFP's (2006) Household Food Production*

Approach. They are household food security, vulnerability to household food insecurity and household food insecurity

3.8 Data collection and analysis

The data collection exercise employed both primary and secondary data collection. The household farm head was the main respondent for questions on food production, land use, and adaptation measures on drought. In cases where the household head was absent, we considered the principle care giver as the main responded. Elaborations and probing was done where it deemed necessary.

The researcher (I) booked appointments with the area agricultural extension officer to conduct key informant interview with. Upon his/her consent the officer visited at their office by the researcher in Makueni. His response was recorded in form of notes and summaries. Counter checking of filled questionnaires was done every day during the time of the data collection to ensure completeness and clarity of data.

Statistical Package for Social Sciences (SPSS) and excel were used to analyze data for this research Qualitative data obtained was organized into distinct categories, patterns and themes identified. The data was further evaluated and analyzed to determine its accuracy, credibility and usefulness in meeting the objectives of the study.

CHAPTER FOUR: RESULTS

4.1 Introduction

The findings include demographic characteristics of the households, household sources of food, household food insecurity status, coping strategies and perceptions in the event of drought among small scale farmers.

4.2 Household demographic information

The demographic characteristics of the study included, household size, household head, education level, type of housing, cooking energy and sources of livelihood.

4.3 Household size

Sizes of the respondent households are represented as follows (table 1)

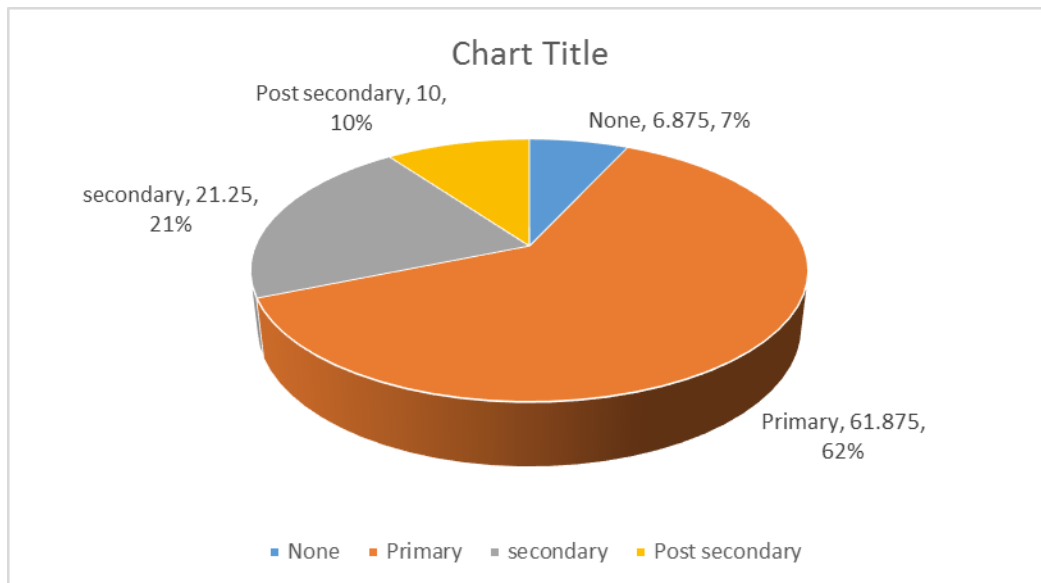
The table illustrates household size by clearly indicating the frequency and percentage of household number of persons

Table 4.1: House Size

Household size		frequency	percentage
1		2	1.3
2		3	2
3		39	24
4		10	6
5		73	46
6		10	6
7		5	3
8		9	5.6
9		6	4
10		3	2.1
Total		160	100

The whole number of people in the 160 households was 966 with a mean of 6.03. A larger number of house families (63.14%) had 5 or less members. This is in reference to *Allem and Shumiye (2007)* A household with a smaller number of individuals is highly unlikely to suffer from food insecurity issues compared to a family with a higher number of individuals due to its limitation to access food especially in the face of drought. According to Makueni County Integrated Development Plan, The Makueni county population has been growing rapidly which is as a result of high fertility which is currently 5.7 per woman compared to the national average of 4.6 per woman(*KNBS,2009*)

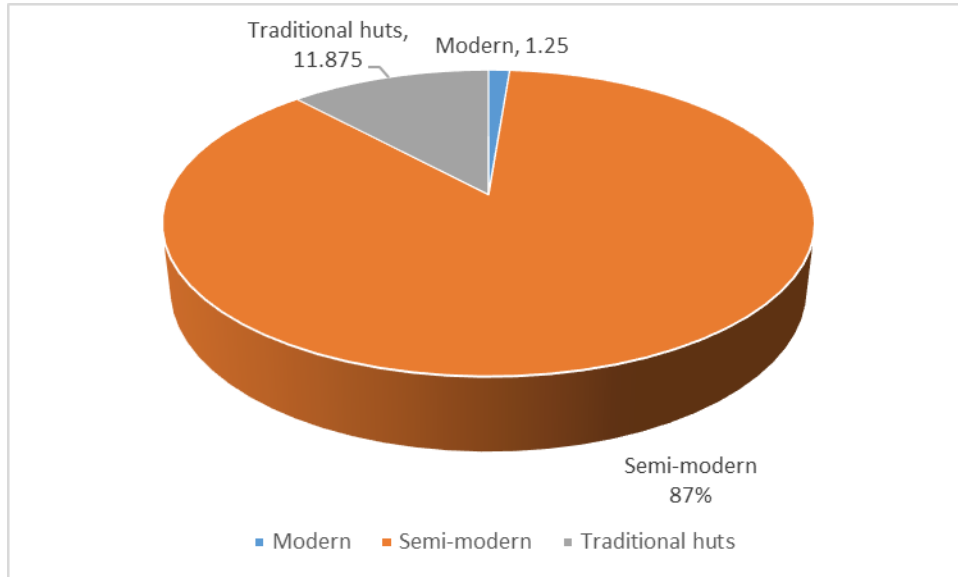
Figure 4.1: Education of household heads level



The household heads were found as follows: No education (6.87%), primary education (61.8%), secondary education (21.25%), and post-secondary education (10%). Majority of the household heads had primary education level. Further, education catalyzes the process of information flow and leads persons to explore different *pathways* of getting

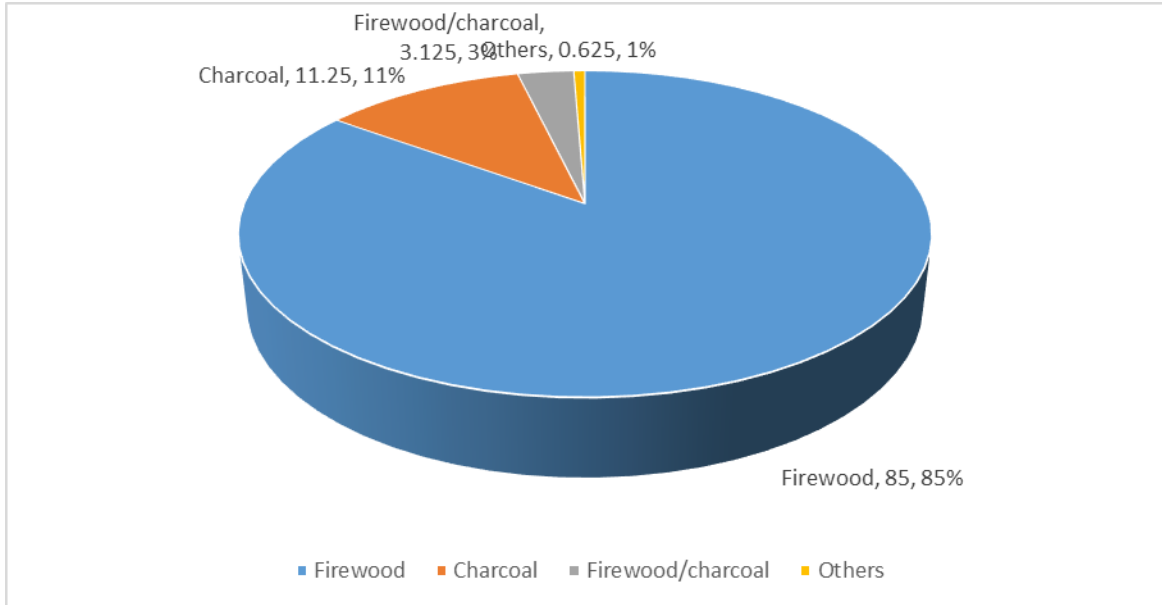
information on food production, security and coping strategies. (Ersado, 2001). Kenya Bureau of Statistics indicate low literacy rates among 17% of the population which has no education (KNBS, 2009)

Figure 4.2: Household type of housing



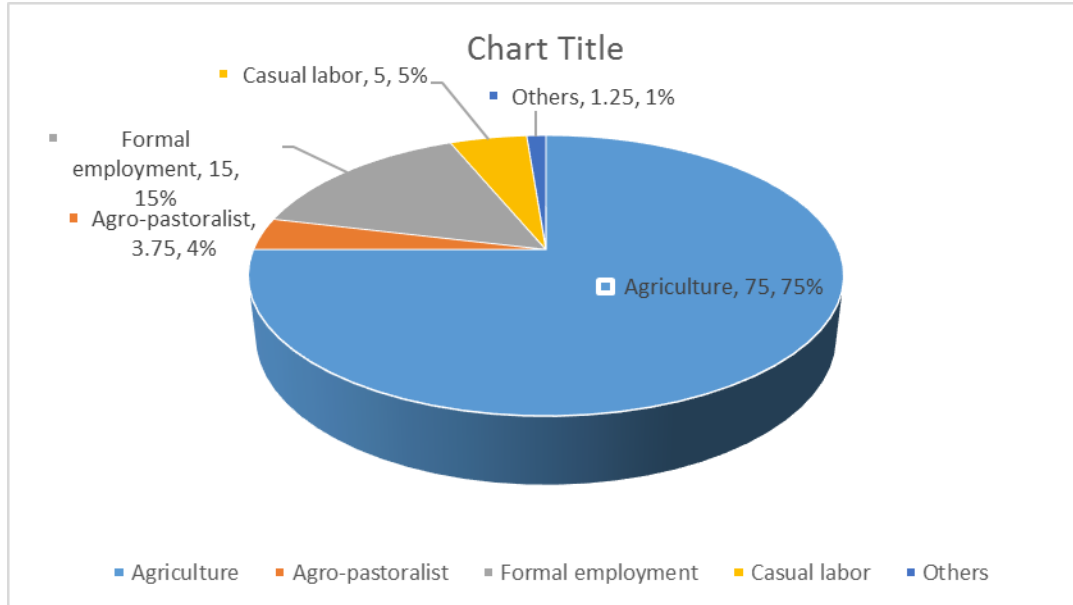
The houses were mostly semi-modern (87%) made of iron sheet roofs and mud walls. The shift to semi-modern houses is attributable to the fact that the community is transitioning from grass thatches to iron sheets. The respondents said that their houses are made of mud walls because mud was naturally available.

Figure 4.3: Household cooking energy



Firewood was the most common source of cooking energy (85%) because it was readily available in the study area. During the dry season, trees and shrubs dry up offering firewood to the households. Charcoal was also used and was prepared from the dry woods. The statistics of the finding is higher than the countries statistics which stipulates that the most common cooking fuel in Kenya is fuel wood used by 63% of Kenya's household(KDHS,2010).Following the findings from the study, the small scale farmers exploited the available trees and shrubs contributing to local deforestation.

Figure 4.4: Household main source of livelihood



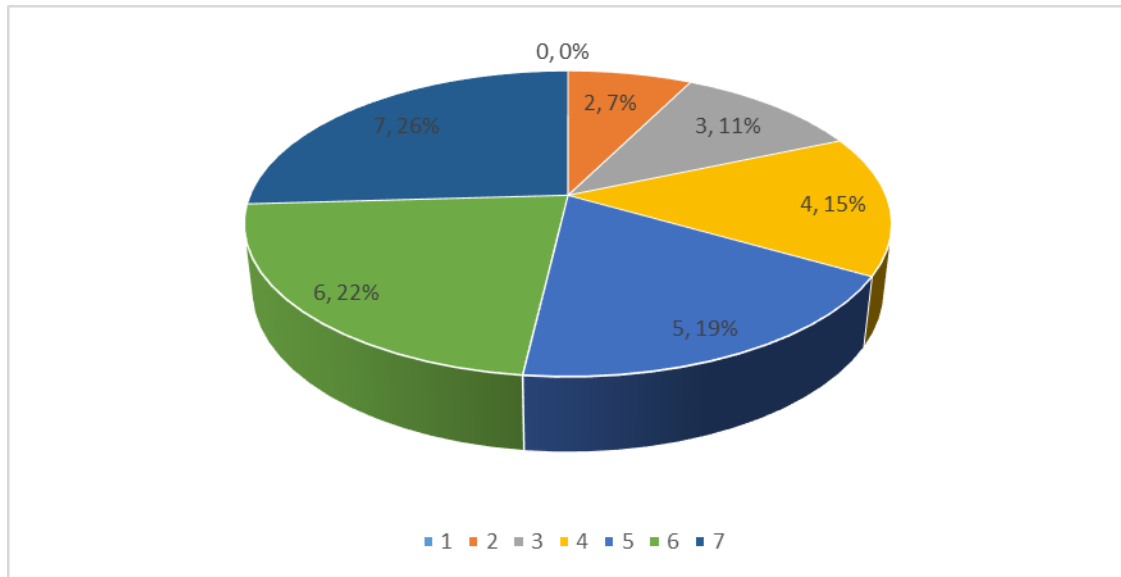
The findings indicate that farming both crops and livestock was the major source of income for the families (75%) and formal employment(15%).Majority of rural households obtain much of their food from the farm (*Kaloi, et al.,2005*).Since the major source of livelihood is agriculture therefore implies own crop production. The result is also likened to that of Makeni County Integrated Development Plan of 2013. 80% of the population relies on Agriculture (*GOK, 2009*)

4.4 food production at the household level

It involved investigating types of crops cultivated in the two rainy seasons of 2014, amounts of harvest, months of household food provision, crop loss mitigation mechanisms and respondent experience with drought and flooding.

Figure 4.5: Size of household farms and farmlands

The following information was given by the respondents



The size mean of household farmland was 1.52 acres. Although there were large cultivation lands, it was found that the respondents did not want to cultivate vast farms which were not capable of managing. (if other variables are held constant)

There is no significant relationship between farm size and food harvested

The null hypotheses stating that there was no significant relationship between farm size and food harvested was conducted by carrying out Pearson correlation test the results are shown below

Table 4.2: Food Harvested/ Farm Size

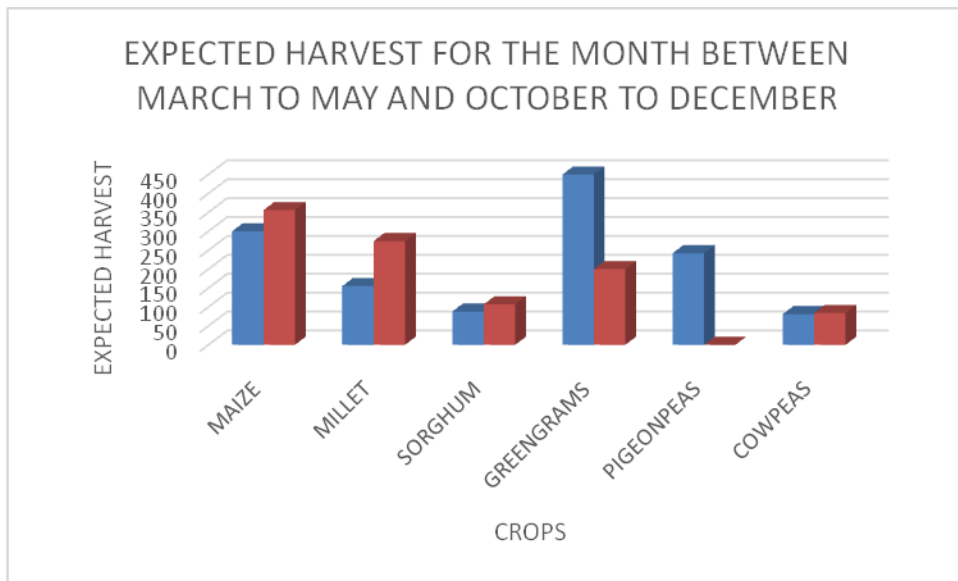
Food harvested/farm size	Pearson correlation(r)	P value
Poor	0.162	0.118
borderline	0.532	0.000
acceptable	-0.030	0.690

The relationship between borderline and farmland size was significant at a correlation of $r=0.532$ at a p value of 0.000 meaning that the larger the farmland size of a household more food harvested. There was no significant relationship between acceptable food harvested and farmland size. An overall 2 tailed correlation test was done on food harvested and farmland size and the correlation obtained was $r=0.299$ and $p=0.000$. This meant that the more the farmland size a household had the more food harvested and this translated to a more food secure household. Following this finding, the null hypothesis was rejected.

4.5 Types of crops cultivated in March/May and October/December 2014.

The respondents were asked to give the estimates in Kgs (kilograms) of the crops they had expected harvested, consumed, and stored and the period the harvests lasted.

**Table 4.3 : Crop Cultivated In March / May And
October/December**



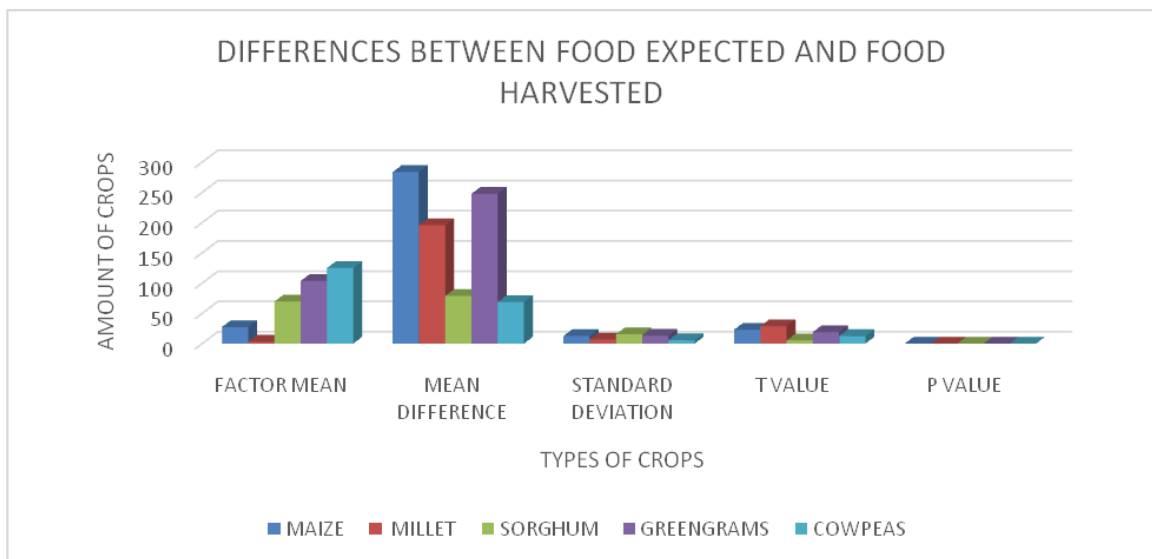
There was a similarity of the type of crops being grown to those listed by the government of Kenya in 2009(GOK,2009) as being grown in Makueni District now Makueni county. Moreover *Gitu (2004)* stipulates that these crops are grown in ASAL areas.

There are no limitations of farmers access to food in the face of drought.

The null hypothesis stating that there is no limitations of farmers access to food in the face of drought was tested by carrying out a 2 tailed t test on food crops expected and harvested as shown below

differences between food expected and food harvested

Table 4.4: Crop Expected / Crop Harvested

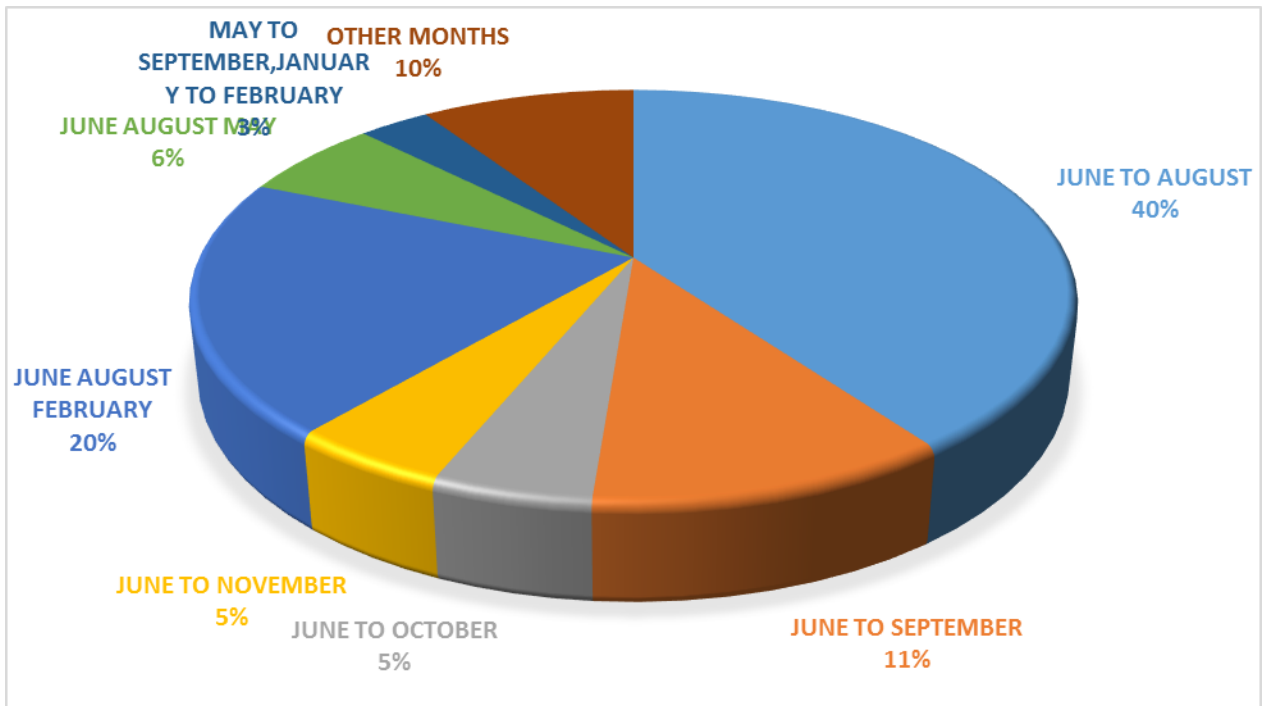


A two tailed test showed, a significance difference of 22.927 at a p value of 0.000 on maize. This shows that there was a difference between maize expected and maize harvested during the season. Millet, Sorghum, green grams and cowpeas showed that there was a significance difference at similar p values with maize. Following these results the null hypotheses was rejected. This is comparable to that of Tharaka Nithi district whose household indicated a decline (Scribd,2013).The decline predisposed the household into vulnerability to food insecurity.

4.5 Amounts of Harvests for Food Crops

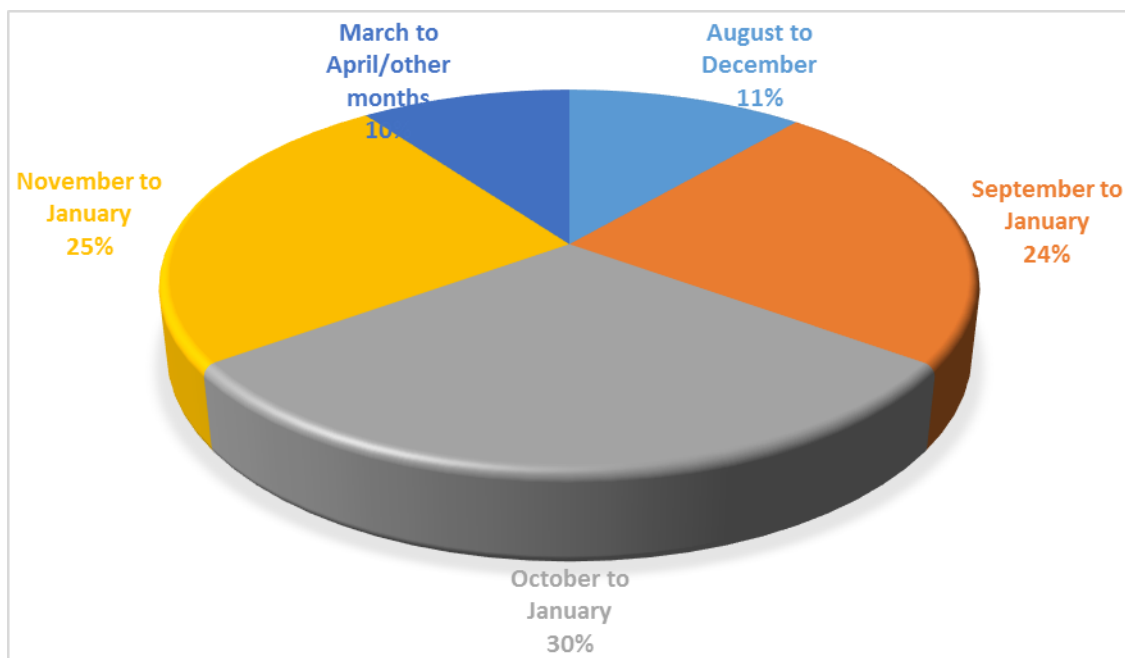
Major cereals produced during the March/May season were maize and millet. Maize was the primary crop cultivated which explains that it was among crops harvested in the largest quantities during the season. In October/December season, crop production was lower than the previous season by a larger extent. The farmers had expected bumper harvest in the season since it was the long rain season. However their anticipation was not realized due to the drought which precipitated harvesting of lower quantities compared to the previous season. According to the results, the households were deemed to be more food secure in March/May season and more food insecure in the October/December post-harvest period. The results are contrary to expectations whereby bumper harvests are expected in the October/December season as opposed to March/May season (GOK,2009)

Figure 4.6: Months of Household Food Provision



June to August (40%). June, August and February had enough food provision at 19%. This Implied that the household food access and availability was good during these month. The findings are substantiated by those of *Government of Kenya (2008)* which indicate that cultivation of crops done boost food security in June to August in Makueni district, and those of long rain assessment report *GOK (2008)* that there is good household food provision among households in Makueni in January and February which are post harvest periods of long rains.

Figure 4.7: Months of Inadequate Food Provisioning



The month interval of inadequate provisioning were November to January at 25% and September to January at 24%.The access and availability of food among households were limited of the period to post harvest season. The findings are substantiated by the Makueni Integrated Development plan of 2013 that says there has been food shortages in Makueni in October to December due to prolonged dry spells beginning in June which are months of no cultivation of food(*GOK,2009*)

4.8 Crop Loss Mitigation

There were various mechanisms employed by households to mitigate crop loss due to erratic rains .Maize, millet and sorghum potential loss was reduced by planting drought resistant varieties. For example 85% of households cultivated drought resistant varieties of maize. Post harvest loss was reduced by dusting food stuffs with pesticides. Green grain borer was mentioned as a common pest that destroyed crops after harvest.

4.9 Droughts and Flooding

When asked whether they had experienced drought in the last two rainy seasons all the respondents said yes and no for flooding. The respondents indicated that in spite of cultivating drought resistant crops, they had experienced a severe drought that had dried their crops. This exposed them to vulnerability of household food insecurity. Droughts increases a community vulnerability to household food insecurity (*Rose, 2008*)

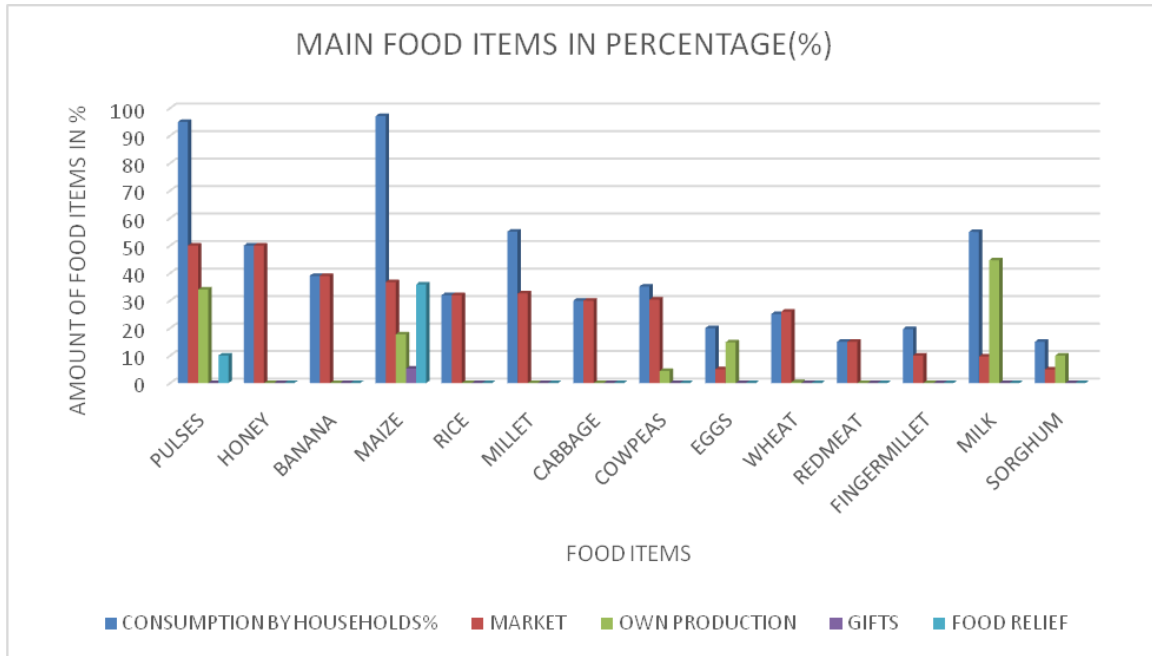
4.10 Household Food Sources

The principle caregiver answered questions regarding household food sources

4.11 Main Sources of Food Items

Were as follows

Figure 4.8: Food Types



Results show that the major source of all food items within households was from market as illustrated. Maize was mainly sources from markets at 36%. The source of Millet was markets at 32.6%. This implies that household did not consume sufficient food from own production which is contradictory to *Mjonono et al 2009* who reports that small scale farmers are the major contributor to household food consumption through own production. This contradiction can be attributed to the seasonality of the study(drought).However the findings tend to agree with the findings in Makueni district in 2011 April which showed that 74.7% of households main source of food was market(*GOK,2011*).Food consumption and food sources are likely to vary depending on the proximity of the harvest(*Aiga & Dhur,2006*).

4.12 Household Food Insecurity status and Maize sources.

The variables were cross-tabulated.

Table 4.5: Status of Food Insecurity

Status of food insecurity		market	Own production	gifts	relief	Total
Food insecure	Frequency percentage	22 30.6%	1 1.9%	0 0	49 67.5%	72 100%
Vulnerable to food insecurity	Frequency percentage	28 45.4%	18 30.3%	8 13.2%	7 11.2%	61 100%
Food secure	Frequency percentage	12 45.2%	13 47.6%	0 0	1 7.1%	26 100%

Maize was selected as it was the main staple food and it acted as an indicator for sources of food. N=49 which was the majority received food from relief as they were likely to be poor therefore unable to purchase maize from the market (*GOK, 2008*). Own production ensured that households were food secure (n=12) and the market. Farming (own production) did not act as the main source of food among majority of the households because their crops did not mature up to yield enough for sustained consumption. These findings are supported by the findings that showed that low crop production reduced the availability of food and exposed farmers to get food from other sources

(*Mjonono, et al.,2009*)

4.13 Adaptation Strategies

Weights 0.1.2.3 and 4 were ascribed for this study as never, hardly, sometimes, often and always respectively. The weights were multiplied by the percentage of their frequencies and then summed up to get scores of every adaptation strategy.

Table 4.6: Coping Strategy

Coping strategies were tabulated to determine frequency and further analyzed and understand the various coping mechanisms employed by small scale farmer

Coping strategy	never	hardly	sometimes	Often	always	total
Use of new seed variety	54	22	50	10	24	160
Change the type of crop cultivated	73	80	7	0	0	160
Introduced irrigation	142	3	4	7	4	160
Migration	153	2	3	2	0	160

Use of new seed variety had the highest score as an adaptation mechanism, followed by introduction of irrigation. The findings are implicative that small scale farmers in Makueni county relied on a variety of adaptation mechanisms to counter their household food insecurity, ;;;;this was further affirmed from the observation checklist where the researcher observed that majority of farmers adapted to draught by use of drought resistant seed variety(70) while only a few(8%) adapted by use of irrigation, there was however a case where households migrated to other regions in search of food and work (28%)

There is no significant relationship between farmer’s attitudes towards drought and their adaptation measures.

The null hypothesis stating that there is no significant relationship between farmer’s attitudes towards drought and their adaptation ability was carried out by carrying out a 2 tailed Pearson correlation test which showed that there was a significant relationship between farmers attitudes towards drought and their adaptation ability (positive

correlation) $r=0.653$ and $p=0.000$ this showed that farmers attitudes towards drought determined their adaptation measure undertaken thus the null hypothesis was rejected

4.14 Common Perceptions by Small Scale Farmers in Makueni County.

The perceptions were done by assessing the magnitude of the answer given by measuring the frequencies of the answer in the study area

Table 4.7: Perceptions

Perceptions	Strongly disagree	disagree	agree	Strongly agree	Not sure	Total
Drought is a natural occurrence	43 26.8%	29 18.1%	23 14.3%	63 39.3%	2 0.13%	160
Drought is an act of God	19 11.8%	56 35%	10 6.2%	69 43.1	6 3.7%	160
Drought is a punishment	121 75.2%	3 1.8%	7 4.3%	23 14.3%	6 3.7%	160
Prayers alleviate drought	8 5%	15 9.3%	71 44.3	65 40.6	1 0.6	160
Climate change causes drought/	23 14.4%	10 6.2%	9 5.6%	112 70%	6 3.7%	160

There is no significant relationship between farmer’s perceptions towards drought and food production.

A chi square test was carried out as shown on table 5.2(2 tailed), the test showed a significant association between farmers perceptions towards drought and food production $\chi^2 = 13.463$, $df=4$ $p=0.009$. Following this findings the null hypothesis was rejected

CHAPTER FIVE: DISCUSSION OF RESULTS, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion Based on Results.

It was found that food crops such as maize millet and green grams were major crops cultivated. Potential loss was mitigated by planting drought resistant varieties. Majority of households had food available during the month of June to August while in October to January food availability was inadequate. Maize was the main food source of household food among households .Market was the major origin of food as majority of the small-holder farmers were unable to produce enough to last for the desired period before the next harvest. The main adaptation mechanism undertaken by farmers during drought was planting of drought resistant variety, which was greatly informed by various projects undertaken by research institutions such as KARI now KALRO, despite that, majority of the house families were still in lack of food.

Majority of the small scale farmers in the County perceived drought to be a natural occurrence at 39% and farmer's perceptions greatly influenced their level and method of adaptation and eventually the status of food security. All the hypotheses were rejected because they all showed significant relationships, differences and associations among the tested variables. Adoption of irrigation was low across all the sites. This may be attributed to water shortage and high initial investment costs required to set up an irrigation system. As a result, the potential of small-scale irrigation is yet to be realized in Kenya.

5.2 Conclusion

The status of food production was lower than expected and was exacerbated by droughts causing a state of severe food insecurity among households. The small scale farmers mainly depended on market as their source of food as opposed to own production which played a supplementary role. Among the main coping strategies identified among smallholder farmers was the use of drought resistant crops making the households resilient to food insecurity to a larger length. The farmers were equally very willing to employ other mitigation measures such as irrigation but they were greatly limited by cost. Although there were development partners and research institutions on the ground working with the farmers to increase crop production, those that focused on irrigation had more impact on crop production than the use of drought resistant variety, These implies that lack of sufficient food is a key issue that needs to be focused on by the government and other development partners, for example majority of farmers planted drought resistant varieties to adapt to drought but they still experienced food shortages it strongly implies that other measures such as irrigation and climate data needs to be availed to farmers in order to mitigate further the effects of drought. This cannot be done without government input as farmers by themselves are greatly limited to access use of other measures of mitigating drought such as irrigation due to the cost and expertise needed.

5.3 Recommendations for Policy

- There is need to increase the capacity of extension officers to include climate change information in their extension work. This will particularly help smallholder farmers

update their knowledge on climate change and vulnerability. This will require a joint effort both by the government and development partners.

- There will be need for strong policy framework for strengthening mitigation measures against the hazards associated with climate change. This will require a participatory approach that incorporates the needs of the farmers and the perspectives of the technical staff.
- The study reveals that most of smallholder farmers in the county barely have a post secondary education; this was clearly observed by the researcher who had to translate the questionnaire to Kiswahili for better understanding of the respondent. Only a few have obtained secondary school education. This low level of education hampers understanding of climate change and acquisition of knowledge particularly on modern agricultural technologies such as use of improved varieties .Considering the low educational levels, efficient communication channels of climate change adaptation messages to different audiences is important. This should be done in simple language which smallholder farmers can understand

5.4 Suggestions for Further Research

The following further research is suggested based on the results and conclusions arrived at by the researcher on the effects of drought on food production in Makueni County.

- A comparative study could be done covering household food consumption patterns and household dietary diversity.
- A comparative study to be done covering a wider geographical location while focusing on farmers who specifically adapted to drought by using Irrigation as a

mitigation measure to find out whether they adapted better and were in a status of food security. This was a strong perception by the researcher that small scale farmers who used irrigation were better adapted to the effects of drought compared to other farmers although it was not a subject of investigation but an observation made by the researcher.

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APPENDICES

APPENDIX I: RESEARCH INSTRUMENTS

RESPONDENT'S INFORMED CONSENT

My name is Rosemary Wanjiku Gichure; I am a master's student at Nairobi University carrying an academic research entitled 'The effects of Drought on Food Production in Makueni County, Kenya. The purpose of this study is academic and I wish to interview you on the same. Am kindly asking for your cooperation during the interview session? I further wish to clarify that the information you give for this interview will be confidential and anonymous.

APPENDIX II: QUESTIONNAIRES

Questionnaire for the household head and the principle caregiver for the study of household food production, smallholder farmer perception on drought and measures undertaken to adapt to drought which will further determine the relationship between food production trends and drought in Makueni County

IDENTIFICATION

County-----Sub County/Village-----

Household code

Interview date----- (dd /mm/yy)

Enumerators Name-----

Respondents Name-----

Mobile Phone Contact-----

Gender (tick) Male Female

Age-----

Education Level (tick) Primary

Secondary

Tertiary

University

None

HOUSEHOLD CHARACTERISTICS

Number of persons in the household-----

Head of household (tick) ----- Male headed household

Female headed household

HOUSEHOLD WEALTH

Does your household own the following items?

Code	Item	Response
1	Type of house (modern, semi-modern, traditional)	
2	Cooking energy (kerosene, cooking gas electricity, other)	
3	Livestock (cattle, sheep, goat, poultry, other)	
4	Mobile Transport Assets (car, bicycle, motorcycle, other)	

<p>5</p> <p>6)Source of livelihood</p>	<p>Sources of income in the last three months</p> <p>(a)sale of livestock</p> <p>(b)sale of livestock product e.g. milk, wool, other</p> <p>(c)sale of fish</p> <p>(d)sale of own crop</p> <p>(e)wage/casual labor</p> <p>(f)salary</p> <p>Please indicate the main source of livelihood for the household</p> <p>(a)Agriculture</p> <p>(b)Pastoralist</p> <p>(c)Agro-pastoralist</p> <p>(d)Formal employment</p> <p>(e)Casual labor</p> <p>(f)Trading</p> <p>(g)Fishing</p> <p>(h)Other</p>	
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HOUSEHOLD FOOD PRODUCTION

Size of farm in acres.....

Size of farm land (area of farm under cultivation)

Types of crops cultivated during the long rains(March /May).....

March/May season	Amount	In kgs	In kgs	In kgs	In kgs	In kgs	months
Crops		expected	harvested	sold	consumed	stored	Duration of post harvest storage
Food crops	Maize						
	Millet						
	Sorghum						
	Finger millet						
	Green grams						
	Pigeon peas						
	Cowpeas						
	Others(specify)						
Fruit crops	Mangoes						
	Oranges						
Cash crops	Coffee/tea						

Did you harvest what you expected?

If not, why?

TYPES OF CROPS CULTIVATED DURING THE SHORT RAINS

(OCTOBER/DECEMBER)

October /December season	Amount	In kgs	In kgs	In kgs	In kgs	In kgs	Months
Crops		expected	harvested	Sold	consumed	stored	Duration of post harvest storage
Food crops	Maize						
	Millet						
	Sorghum						
	Finger millet						
	Green grams						
	Pigeon peas						
	Cowpeas						
	Others (specify						
Fruit crops	Mangoes						
	Oranges						
Cash crops	Coffee/tea						

Did you harvest what you expected?

If not, why?

Besides farm produce, how else do you provide food for your family?

Have you experienced drought in the recent two crop production periods? -----

If yes, in what ways did the drought affect crop production.....

How did you adapt to the drought season?

Which months do your household have enough food?

Which months does your household not have enough food?

Explain the above trend.....

COPING STRATEGIES

Has your household done the following to adapt to drought?

Code	Adaptation Strategy In the Last 2 Seasons	Frequency	Source of Information	Amount of Yield (Increased/Decreased Or Stayed the same)	Explain Trend
	Use of new seed variety				
	Change the type of crop cultivated				
	Introduced irrigation				
	Others (Specify)				
	Others (Specify)				

OBSERVATION CHECKLIST

Study of household food production and adaptation strategies during drought by smallholder farmers in Makueni County.

County.....Sub-county.....

Household Code.....

1 .Size of farmland.....

2. Type of food cultivated in the season.....

3 Type of house.....

4 .Household assets.....

5. Nearest water source.....

6. Presence of water in the household.....

KEY INFORMANT

Key informant interview guide for the county agricultural extension officer for the study of household food production, adaptation measures undertaken by smallholder farmers in Makueni County.

1. What organizations in collaborations with your department are involved in helping small-scale farmers in Makueni County to improve food production?

2. What help do you render to the smallholder farmers?

3. Has the help resulted into any positive change in crop production?
4. What type of drought resistant crops are cultivated in the county?
5. Mention adaptation strategies being undertaken by farmers against drought.
6. What would you recommend as a sustainable solution to food production in the face of drought?
7. Additional comments