**UNIVERSITY OF NAIROBI**

**DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES**

# ADOPTION OF BEE FARMING AS AN ADAPTATION STRATEGY FOR RAINFALL VARIABILITY EFFECTS ON FOOD SECURITY AMONG THE VULNERABLE COMMUNITIES IN KENYA: CASE OF KITUI COUNTY

**BY**

**KARIUKI DAVID MUGENDI**

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**A Research Project Report Submitted in the Partial Fulfillment of the requirement for the award of Masters of Arts Degree in Environmental Planning and Management of the University of Nairobi**

## DECLARATION

I declare that this research project report is my original work and that it has not been presented in any other university or institution for academic credit.

Signature……date……
…….

**KARIUKI DAVID MUGENDI**

C50/63633/2010

**Declaration by the supervisor**

This research project report has been submitted for examination with my approval as the university supervisor.

Signature…….Date…….

Dr. Alice Oluoko-Odingo,
Department of Geography and Environmental Studies,
University of Nairobi.

Signature…….Date…….

DR .BONIFACE WAMBUA
Department of Geography and Environmental Studies,
University of Nairobi.

## DEDICATION

This research work is dedicated to my late grandmother Charity Irimba. I wish you were alive to see me come this far R.I.P. grandma.

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## ABBREVIATIONS AND ACRONYMS

ABD- Agriculture Business Development

ARC- Agriculture Research Council

ASAL- Arid and Semi Ari

$CO_2$- Carbon Dioxide

EFB- European Foul Brood

FSA - Financial Service Associations

ILRI- International Livestock and Research Institute

IPCC- Inter Governmental Panel for Climate Change

KDA- K_ REP Development Agency

KFS- Kenya Forest Service

KSH- Kenya Shillings

KTBH- Kenya Top Bar Hive

MGS Millennium Development Goals

MT- Metric Tonne

NGO- Non Governmental Organization

QTS- Quantities

T/HA- Tonne per Hectare

TARDA- Tana & Athi River Development Authority

UNDP- United Nations Development Program

KGS- Kilograms

Df- Degrees of freedom

## ABSTRACT

Bee farming has become a rewarding and enjoyable occupation with many benefits over other farming enterprises. Although beekeeping in Kenya has practised over the years, the introduction of the improved modern hives in Kenya has grown in the recent past, making bee farming an important enterprise in the livestock sub-sector. The main purpose of the study was to try and examine the viability of adopting modern bee farming as an adaptation strategy for food insecurity menace caused by rainfall variability effects in arid and semi-arid regions in Kenya .The study was carried out in Kitui county because this activity has been practised in the region for a long time and the communities there have the knowledge of bee farming. Among the objectives was to assess the viability of adoption of bee farming as an adaptation strategy for rainfall variability effects on food security among the vulnerable communities in Kenya. This is because despite the fact that bee farming has been practiced in Kitui for a very long time, the communities concerned have continued to depend on food aid and donations. A sample size of 385 bee farmers was selected from the target population, in the three study sites that is Mutomo, Kitui, Yatta and Kitui Central.Only196 respondents turned up during the focus groups meeting which represented about 50% of the sample size population. Primary data and secondary data were used. Descriptive statistics and inferential statistics specifically chi square were used to analyze the data. The study established that, rainfall variability has affected agricultural production in the region, hence the need for an alternative source of livelihood. It was also noted that there are many hindrances and challenges to bee farming in the region such as cutting down of trees for charcoal burning, lack of knowledge on improved bee farming, use of traditional hives hence low honey production and lack of proper marketing for the harvested honey. The chi square test done did show that, modern bee hives were way much better than the traditional hives

in terms of the quality and quantity of honey produced. Modern hives also fetched more income than the tradition hives. The study concluded that the only solution to improved honey production to enhance food security in the region was by adopting modern bee farming. The study made recommendation on adoption of modern bee hives such as Langstroth which did not require atree to hang the hive and hence increased quantity and quality of the honey. It also recommended regular trainings to bee farmers in order to know the different bee species and avoid them that are known to be notorious in absconding.

# CHAPTER ONE: INTRODUCTION

## 1:1 Background Information

Beekeeping in Kenya has been practised over the years. However only 20% of the country's honey production potential (estimated at 100,000 metric tonnes) has been tapped with most of the production coming from the arid and semi-arid lands in Kenya (80% of the country). These areas have high potential for bee farming due to the abundance of bee flora. Areas which do not fall under arid and semi-arid classification have also been practicing beekeeping although most of it has been consumed locally due to the low scale of production. Greater portion (80%) of the honey has been produced from traditional hives hence low quality and quantity of honey produced (Thomas Carrol, 2004).

The introduction of the improved modern hives in Kenya started towards the end of 1960s making bee farming an important enterprise in the livestock sub-sector. This is because bee farming has become a rewarding and enjoyable occupation with many benefits over other enterprises namely: i) Low capital requirement in terms of money and size of land; ii) source of non-perishable food; (iii) requires very little labor;( iv) Can generate many products which are great source of income i.e. honey, beeswax, pollen, propolis, bee venom, royal jelly, bee colonies, bee brood, queen bees, and package bees; v) Encourages environmental conservation; vi) Bees are good pollinators of plants, trees, fruits and crops, thus playing a big role in bio-diversity and improvement of crop yields; and vii) The therapeutic value of most hive products provide remedy for a number of ailments (Apitherapy). (Beginners Guide,2006)

Researchers have observed beekeeping as one of the underdeveloped socio-economic activities that could have high potential for promoting food security in Africa. This is because of the; bees economic value obtained from sale of their products that include; Honey, Wax, Pollen, Propolis, Royal Jelly, and Bee Venom; ii) Support in crop pollination which facilitates high agriculture yield for crop farmers; and iii) Their ability to promote high yield for seeds that develop to new plants which in turn, promotes re-forestation as part of environmental conservation.

It has now been proved true that climate variability, especially rainfall variability is real (IPCC, 2010). Rainfall patterns have become so unreliable, and this has affected food availability, food accessibility, food utilization and food systems stability. This has also worsened on food insecurity issue among the vulnerable and marginalized groups. It has also impacted on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows (Parry & Swaminathan 1992). Agriculture-based livelihood systems that are already vulnerable to food insecurity face immediate risk of increased crop failure, new patterns of pests and diseases, lack of appropriate seeds and planting material, and loss of livestock. These reasons and others triggered the need for this study on adoption of bee farming as an adaptation to rainfall variability effects on food security among the vulnerable communities in Kenya.

This study was carried out in Kitui County among forest communities including marginalized members of local communities who bear knowledge, skills and best practices of bee keeping. The information from the research project will be used to support the communities to adopt improved honey production technologies as an alternative means of securing livelihood. The research focused on the rainfall variability impacts, Bee Keeping as an adaptation strategy, for

optimizing opportunities provided for by honey production and marketing towards improving the resilience of local communities to the impacts Caused by rainfall variability.

A population sample size of 385 bee farmers was targeted although only 53% of the targeted population turned up with key focus on bee keeping groups which was drawn from the population in the county. A prevalence value of 50% was used to determine the sample size, (Bill Godden, 2004).This is because there was no clear information on the studies done in the area to help in determining the sample size. The data was collected using both primary and secondary methods. The data received was analyzed and presented in a form that is easily accessible, this include CD form, and hardcopies

**1.2 Statement of the problem**

Rainfall variability, is rapidly emerging as one of the most serious problems affecting many sectors in the world and is considered to be one of the most serious threats to sustainable development with adverse impact on environment, human health, food security, economic activities, natural resources and physical infrastructure (IPCC, 2007; Huq et al., 2006). Food supplies in developing nations among them Kenya, have been affected more by rainfall variability than the developed nations. (Sinha, Rao & Swaminathan, 1988). Rainfall variability has immensely affected food security among the vulnerable and marginalized groups which mostly rely on agriculture. (Rosenzweig *et al*., 1993), this challenge when combined with the perennial food insecurity, which calls for dependency on food aid and donation among these groups in Kenya, is calling for an alternative source of livelihood among these groups since, rainfall patterns have changed and have become unreliable.

This study focuses on modern bee keeping as an alternative option of addressing food insecurity on one hand and as a rainfall variability adaptation strategy. Although beekeeping is being practised by many marginalized groups in Kenya, it is facing many hindrances, which have greatly contributed to low productivity and inconsistent quality of beehive products *(Pact Kenya, 2010).* A study on bee farming was done in the region by an organization called friends of Kitui in 2009. This organization started a Honey project in Kitui in 2006 to empower women economically. The study did show that the project could not generate enough revenues to the bee farmers and it eventually collapsed. This research will try to identify the major hindrances to the growth of the sector in the region and give appropriate recommendations.

This also necessitated this study in that it helped in identifying the key hindrances and provided useful information to academicians for learning and trainings on bee farming, ministry of livestock which will use the information in their agricultural extension services to the farmers which will go a long way in enhancing apiculture among the marginalized communities in the country to handle the challenges of food insecurity.

### 1.3 Purpose of the Study

The main purpose of the study was to examine the viability of adopting modern bee farming techniques, as an adaptation strategy for the food insecurity menace caused by rainfall variability impact in arid and semiarid regions in Kenya**.**

### 1.4 Research Questions

This study tried to answer the following questions with a view to address their contribution on adoption of bee farming as an alternative source of livelihood.

1. What is the feasibility of adoption of improved apiculture as an adaptation strategy to rainfall variability impact on food security among the marginalized communities in Kitui County?
2. What are the differences between the income generated in selling honey and other bee products from the different bee hive types per household?
3. What is the effect of rainfall variability on agricultural food production among the target groups in Kitui County?
4. What is the role of various stakeholders in the Honey Value Chain and their endeavor to establish ways in which the honey value chain can be strengthened to enhance food security in Kitui County?
5. What are the challenges and hindrances to improved bee farming among the target groups in Kitui County?

### 1.5 Research Objective

The general objective of the study is to assess the viability of adoption of bee farming as an adaptation strategy to rainfall variability effects on food security among the vulnerable communities in Kenya. This is because rainfall unreliability is very pronounced in these regions, as a result agricultural sector has been affected hence an alternative source of livelihoods is being called for.

#### 1.5.1 Specific Objectives

1. To assess the feasibility of adoption of improved bee farming (modern hives) as an adaptation strategy to rainfall variability effects on food security among the marginalized communities in Kitui County.

2. To establish the differences between the number of hives per household by type and the income from honey and other bee products.

3. To determine the effect of rainfall variability on agricultural food production (maize and beans) among the target groups.

4. To find out the role of various stakeholders in the Honey value chain and their endeavor to establish ways in which the honey value chain can be strengthened to enhance food security.

5. To identify the challenges and hindrances to improved bee farming among the target groups in Kitui County.

### 1.6 Research Hypothesis

The study sought to test the following hypotheses:

**$H_o$**: There is no significant difference in food security in terms of honey produced in kilograms among the households who have adopted improved (Modern) bee hives to boost honey production as rainfall variability coping mechanism as compared to those using the traditional bee hives for honey production.

**$H_1$**: There is a significant difference in food security in terms of honey produced in kilograms among the households who have adopted improved modern bee hives to boost honey production as rainfall variability coping mechanism as compared to those using the traditional bee hives for honey production.

**$H_0$:** There is no significant difference in the types and number of hives and honey production, value addition/products and incomes per household.

**$H_1$**: There is a significance difference in the types and number of hives and honey production, value addition/products and income per household.

**$H_0$**: There is no significant relationship in the quantity of maize and beans produced from the agricultural lands and the rainfall received over the eight years in the study area.

**$H_1$**: There is a significant relationship in the quantities of maize and beans produced in kilograms from the agricultural lands and the rainfall received over eight years in the study area

### 1.7 Justification of the Study

Beekeeping in Kitui and other marginalized communities in Kenya is largely based on traditional methods with a very small percentage of farmers practicing modern bee keeping. This has greatly contributed to low productivity and inconsistent quality of beehive products? Lack of information about beekeeping is a common problem in Kenya and other African countries, and has heavily resulted to the named challenge (Pact Kenya, 2010). The county of Kitui is very vulnerable to rainfall variability. It is among the Arid and semiarid regions in Kenya. Other regions include Garissa, Mbeere, parts of Baringo, Mt. Elgon, East Marakwet districts Narok North, Koibatek districts and Taita/Taveta, districts Kitui County is semi-arid with very erratic and unreliable rainfall. Most parts of the region are hot and dry throughout the year resulting to very high evaporation rates. Rainfall is distributed within two seasons yearly and varies from 500-1050mm with about 40% reliability.

Low agricultural productivity and erratic rains have resulted in perennial food shortages in the district. For instance, in 2005, the average yield of maize was only 0.06 tonnes per hectare while total cereal production was a paltry 6,661 Metric tonnes as compared to the district estimated annual demand of 82,839 Metric tonnes. Consequently, Kitui relies heavily on food supplies from other districts to meet its food needs for the better part of the year (CBS, 2003a). With the exception of maize and beans, the markets supply the bulk of food consumed in the mixed farming livelihood zone, which supports about 57% of Kitui's population. This county is a representative of many arid and semi-arid parts of this country, Africa and the world at large. This called for an alternative source of livelihoods as the above challenges are compounded by the global climatic changes. Lack of proper formal and technical education is also a big challenge among the target groups.

According to UNDP (2001) adult literacy rate was at (62.8%) in Kitui .Illiteracy may challenge learning about new technology. Since the level of education has an influence in people's attitudes, knowledge and practices towards environment and all aspects of life. This study focused on rainfall variability impacts. It focused on bee keeping as an alternative option of addressing food insecurity on one hand and as a rainfall variability adaptation strategy. Lack of information about improved beekeeping is a common problem among the marginalized communities in Kenya and other African countries.

The study provided information to enhance apiculture in the country as an adaptation strategy to rainfall variability. It also helped in determining; the major challenges that are facing bee farming among the marginalized communities in Kenya and helped in coming up with the appropriate recommendations that will go along in improving bee farming in response to the

negative impacts on food security caused by the rainfall variability. The findings of the research did show that there is a need to come up with policies guiding bee farming in the country since there are no established policy structures. The national bee policy of 2009 needs to be implemented and this will protect the welfare of the farmers. The research findings also indicated that there is a need for coordination by all the stakeholders starting with the National honey council to help in putting marketing structures in place .The recommendations on adoption of improved bee farming, watering the apiaries, planting indigenous trees and avoiding charcoal burning will go a long way in helping the community involved researchers, in helping the communities in developing the bee sector in the regions. Academicians will use the findings of the research in teaching on apiculture in institutions of learning hence disseminating knowledge

### 1.8 Scope of the Study

The study involved assessing the current state of beekeeping in Kenya with the case study of Kitui County. The study assessed and analyzed the status of bee keeping in Kitui Central, Mutomo, and Kitui Yatta in terms of: number of bee keepers, types and number of hives in use. Honey production quantities and other bee farming products; the form in which they, are sold; market size, availability and capacity.

The study also assessed the existing beekeeping facilities, income generated by beekeeping activities, existing stakeholders, Current challenges faced by the industry and identified key constraints and opportunities for beekeeping in the region and made recommendations for increased beekeeping and participation of micro enterprises in the sector

## 1.9 Definitions of Terms

**Apiculture -**The science and art of bees and bee farming.

**Rainfall variability-** Refers to shorter term (daily, seasonal, annual, inter-annual, several years) fluctuations in rainfall.

**Food accessibility-** Refers to both the availability of healthy foods within a community and how easily residents can access those foods from the market (WFO, 2009).

**Food Availability -**Sufficient healthy foods that fulfills the dietary needs and food preferences for living an active and healthy lifestyle (WFO, 2009).

**Food insecurity -W**hen people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active, healthy life. It may be caused by the unavailability of food, insufficient purchasing power or the inappropriate distribution or inadequate use of food at the household level.

**Food Security-** It refers to a household's or country's ability to provide future physical and economic access to sufficient, safe, and nutritious food that fulfills the dietary needs and food preferences for living an active and healthy lifestyle (WFO, 2009).

**Food utilization-** Refers to: a) households' use of the food to which they have access, b) individuals' ability to absorb nutrients – the conversion efficiency of food by the body (Food and Agricultural Organization, ` 2009).

**Land degradation-** Decline in the productivity of land until it is biologically useless.

**Migration-** is where there is seasonal movements of whole honey bee colonies, leaving no brood behind in the nest. (Beekeeping Manual, 2006).

**Queen-** The fertile female bee that lives in a honeybee colony or hive; the mother of bees in the hive (National beekeeping policy, 2009).

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

The study addresses bee farming as an alternative source of livelihood among the arid and semi-arid communities in Kenya with a case study of Kitui due to food insecurity menace caused by rainfall variability. The literature review looked at the bee farming in the world generally with a focus in the developed world, then it looked at apiculture in Africa ,then Kenya and finally in Kitui county .The literature review looked at the development of bee keeping in Kenya, bee species found in Kenya and ,the type of bee hives used. The other area that the study looked at was the impact of rainfall variability on agricultural production, hence an alternative source of livelihood. The literature review also looked at the world wide challenges facing the bee farming industry.

## 2.2 Bee Keeping

Beekeeping is the art of managing bees in order to obtain honey, beeswax and other bee Products for both food and income (and sometimes medicine).Bees are reared in bee hives. A hive is the box or container where the bees live. Beekeeping can be carried out by men and women of any age. It is also an ideal activity for groups such as women's groups, youth groups, men's groups, church groups etc. as an income generating activity. Beekeeping requires little space and compliments other farm activities. It does not need good soil (Carroll, 2006). There are about 20,000 different bee species in the world. Most of them solitary or live alone. A few species of bees are kept to produce honey (Florence. 2009).

Beekeeping in the whole world now is progressively becoming a very important supplementary economic activity for most rural households particularly in arid and semi-arid areas where crop Agriculture is not sustainable. Despite the enormous potential and significance of the beekeeping industry in many countries of the world there are constraints that should be addressed to further develop the industry (National bee policy, 2009). Apiculture in many parts of the world is practised using traditional methods with a very small percentage especially in developing countries practicing modern bee farming. Lack of information on improved bee farming has been identified as the major hindrance for the full potential of apiculture in many countries of the world (Lalika, M.C.S. &Machangu, J.S, 1998)

### 2.3 Economic importance of honeybees

The value of honey bee pollination to worldwide agriculture has been estimated to be about 215 billion dollars (Gallai et al., 2009). Besides their role as pollinators of many horticultural, vegetable and field crops as well as wild flowers, honey bees are the source of honey and other hives products such as propolis, royal jelly, venom and beeswax. The worldwide production of honey totals over a million tonnes, yielding an exchange market worth over US$ one billion (FAOSTAT, 2009).

#### 2.3.1 Plant pollination

Pollinators strongly influence the ecological relationships, ecosystem conservation and stability of the genetic variation in plant communities. Over 35% of crops and 60 to 80% of wild plant species rely on the activity of pollinators (Klein et al., 2007). Honey bees are among the major pollinating insects that play an important role in guaranteeing yield and quality for a number of horticultural, field and vegetable crops. They are also the most economically important

pollinators of crop mono cultures worldwide (Watanabe, 1994). Without the activity of these insects, yield of some fruit, seed and nut crops would decrease by over 90% (Southwick and Southwick, 1992). It is undoubted clear that any decline in the pollinator populations will compromise agricultural production and consequently the economy.

### 2.3.2 Honey and other hive products

Since, humans first began keeping bees; their principal aim has been the harvest of honey. In 2005, the worldwide honey production exceeded the 1.4 Million tonnes mark (FAOSTAT, 2009) with about 64.5 Million beehives in 2008 (FAOSTAT, 2009). Other products of the hive include pollen, brood, propolis, royal jelly, venom and beeswax. The world production of beeswax exceeds 61.2 thousand tonnes (FAOSTAT, 2009). Less than a half kg of beeswax, containing about 450,000 wax scales, is enough to make 35,000 hexagonal cells, which may store up to 10 kg of honey.

Beeswax also has many uses worldwide, including the production of candles, cosmetics, electronics, lubricants, leather and fabric preservatives, polishes, inks and paints, models for dentistry and beer. Cosmetics represents one of the largest beeswax user industry while an important portion of the by-product is still recycled within the bee industry to produce the foundation for new honeycomb and queen cell cups. Propolis is used in the attachment of combs to the top and sides of the hive, as well as for filling cracks, reducing the size of the hive entrance and embalming intruders. (Genersch, 2010.)

The pollen, queen and worker bees jelly has always represented an appreciated nutrition source in human societies since ancient times. Both by-products are also used in various cosmetics, lotions and dietary supplements. An interest in collecting and commercializing bee venom for

therapeutic uses has been emerging in recent years. In addition, commercial beekeeping increased the interest in other hive products, i.e., the queen and worker honey catastrophic causes. (Johannesmeier, 2001). Beekeeping contributes to incomes as well as food security through provision of honey, beeswax and pollen as food and Propolis, bees' venom and royal jelly in medicine. It also contributes to seed and food production through crop pollination and conserves the natural environment. (Klein*et al.*, 2007)

### 2.4 Bee Keeping in the Developed World

Bee farming has been practised in the developed countries for many centuries. In Europe there are known to be at least 700 bee species, but only one, *Apis mellifera*, is managed for honey production. According to the European Commission Communication on Honeybee Health (COM (2010)714 final), the number of beekeepers in the EU is estimated to be approximately 700,000, keeping around 15 million hives. Around 97% are non-professional beekeepers, who account for approximately 67% of EU hives (Brown M.J.F. & Paxton R.J., 2010).

Bee keeping on a small scale is widely recognized as being uneconomic. However, it is still very widely practised. Fluctuating prices, market access, counterfeit products, labor and costs with other inputs needed in beekeeping activities all have a strong influence on the honeybee population. Beekeeping is also influenced by globalization, with honey production becoming more concentrated in Asia, Africa and South America. Decline of honey bee colonies have been reported mainly in central Europe, but the situation is not universal, since in Mediterranean countries increases have been observed over the past decades (Richards, 2001).

In Australia there are around 673,000 registered hives producing not only honey and beeswax but also live bees (queens and package bees), and other products such as pollen and royal jelly.

Around 467,000 hives are operated by beekeepers with a minimum of 200 hives, and these are considered to represent the commercial industry. It is estimated that an average of at least 30,000 tonnes of honey are produced each year in Australia, with nearly 45% of this total coming from beekeepers resident in NSW. Between 9,000 and 12,000 tonnes of honey are exported each year (Capilano Annual Report, 1996). The gross value of production over all sectors of the industry is estimated as being between $60 and $65 million per annum, of which $49 million comprises honey production. As expected from hive registration data, NSW beekeepers contribute around 44% of this total value of production (Manning, 1996).

In USA beekeeping was traditionally practised, with some ingenious farmers building wood hives with easily removable tops (caps) so that chunks of honey could be removed without killing the colonies until 1852, when L. L. Langstroth, a Congregational minister from Pennsylvania, patented a hive with movable frames that is still used today. The principle upon which Langstroth based his hive is the space kept open in the hive to allow bees passage between and around combs. This space is about three-eighths of an inch wide; space that is less than this is sealed with propolis and wax, while space wider is filled with comb. Before this time hives were either Greek bar hives or leaf hives that allowed the beekeeper to inspect the comb. Langstroth is called “the father of modern beekeeping (Anderson, 1969).

Modern methods of beekeeping came very rapidly following Langstroth’s patent. Other inventions soon followed that made large-scale, commercial beekeeping possible. The invention of the centrifugal honey extractor in 1865, and its subsequent improvements, made it possible for large-scale production of extracted honey. After World War I, however, with better highways and increased use of motor vehicles and more efficient methods of colony management and

honey handling, commercial beekeepers throughout the United States were able to expand the size of their businesses **(**Affleck, 1941).

By 1957, Anderson (*1969*) estimated that 1,200 professional beekeepers operated 1,440,000 colonies in the United States. By that time, hobbyists had a few colonies, the part-time beekeepers kept from 25 to 300 colonies, and the commercial beekeeper had up to several thousand colonies. Some U.S. beekeepers have owned as many as 30,000 colonies. Today Bee keeping in U.S.A has been generally commercialized. Artificial insemination of queen bees, that is, controlled mating, is being used commercially to a limited extent today in U.S.A (Pellet, F. C, 2008**)**

**2.5 Bee keeping in Africa**

Africa has vast potential for honey production which currently is under-exploited, despite the potential most of the honey is exported from outside Africa with South Africa importing and exporting to the other countries in the region, the organization of beekeepers is weak and has to be strengthened. Many countries still use the indigenous knowledge of bee keeping (IFAD, 1997).According to Lalika and Machangu (2006), in Tanzania for example Smallholder beekeepers in Tanzania have rich indigenous knowledge of beekeeping. They also have good knowledge of different types of hives, bee smokers and honey containers. In terms of hive types, it was found that most smallholder beekeepers use local style gourd hives. The reason is that they are cheaper than other types of hive and are locally available. The gourd hive is one of the oldest items of indigenous equipment and has been adopted in areas of Tanzania where alternative materials for hive making are scarce.

Split log and bark hives are also used by smallholder beekeepers in Lindi division, over 95% of hives used by smallholder beekeepers in Tanzania are of this type. In the study villages, split log and bark hives are made by tree debarking, thus several trees are destroyed. However, split log and bark hives are locally considered to be the most convenient because of the abundance of Miombo woodlands, which provide easily obtainable and suitable longevity, low cost, and the indigenous knowledge of hive making.

Bee farming too has been adopted in Botswana. According to the research conducted by Total Transformation Agribusiness (Pty) Ltd and recorded in the journal, Africa's Renewal, Botswana s are traditionally honey hunters. Domestic beekeeping only started in the last 30 years with the aim of diversifying Botswana's vibrant economy, which is dominated by minerals. Many of the beekeeping projects are managed by groups, while only a few are individually owned. On average producers keep only one colony of bees at a time (Adjare, 2000).

Beekeeping is advantageous for rural livelihoods as production costs are low and also one does not necessarily need to own land for this practice. In the last 5 years, the Ministry of Agriculture in Botswana has trained about 1000 people in beekeeping, but only 500 are actually engaged. This drive shows the Ministry of Agriculture's commitment to the diversification strategy as outlined in the National Development Plan. Viability of beekeeping projects has been proved and this will contribute immensely in the fight against rural unemployment, which in some areas is estimated at 60 % *(David*.J, 2009).

According to C. Riechert (2004), apicuture in Malawi is facing a number of challenges key among them are lack of civic education and technical training among the small-scale farmers which has hindered improved production of bees products in the country.

Other challenges include deforestation and lack of existing international market. Traditional methods are therefore being used in the apiculture industry in the country. Other countries in Africa that have adopted bee farming include Mozambique, South Africa, and Switzer land among others.

According to beekeeping situational analysis by Rosario Matavele TTA's Associate Consultant, Apiculture in Mozambique is majorly potent in the southern and central part of the country. However Rosario noted that there is a great potential for development of beekeeping activity in Mozambique that has been less explored (Ashley, C. 2000). To attain and to explore maximally the potential that exist, a program with concrete strategies and proposal should be designed and implemented in order to improve the actual production systems that will finally lead to increased quality and quantity of production of honey, better marketing and information systems as well as the overall management (Farrington ,2001).

South Africa has made strides in Apiculture as compared to many African countries. It is almost in the same levels with the developed world according to a report given in 2006 by Total Transformation Agribusiness consultants (TTA'S) on Beekeeping in South Africa. Registration of all persons with hive colonies in South Africa is mandatory as specified in the Government Notice R1674 of 24 December 1998 under the Agriculture Pest Act 36 of 1983. Registration involves supplying the name and postal address, and paying the registration fee. Every registered beekeeper is allocated a registration number (African Renewal journal, 2009)

This number must be displayed clearly and legibly on all hives and all apiary sites of the owner. The Beekeeping industry in South Africa is made up of three sectors: The commercial beekeepers who are about 50 and hobbyists who are about 2 950, all in all with about 150 000 hives nationally. The third sector is that of emerging beekeepers in the second economy. These beekeepers at present operate in groups motivated largely by the Agricultural Research Council (ARC) and some NGO's. While there appears to be no growth any more in the commercial beekeeping sector, the beekeeping emerging from the second economy is growing quickly in response to the promotional work done by the ARC and other organizations (Du Toit, 2007).

The commercial beekeepers operate on large commercial lands, while the emerging beekeepers use small pieces of land due to previous historical limitations. Therefore, for the emerging beekeeper to assume the size attained by the commercial beekeepers, he or she must use commercial farms. Honey production in the commercial sector in South Africa has been stagnant suggesting that the current shortfall for honey which has been met by imports will continue to exist while growth in demand for honey is increasing. Currently the majority of smallholder bee farmers are from historically disadvantaged groups (Johannesmeier M.F, 2001).

In other words these are black farmers who did not take part in beekeeping in the first economy or commercial beekeeping. The recent study by Agriculture Research Council (ARC) focused on beekeepers in the second economy in South Africa. This involved 32 beekeeping projects with about 96 beekeepers in 7 provinces with the exception of the Western Cape and Northern Cape. The ARC targets to establish 5000 beekeepers in this sector. The significance of this study is that it represents 93% of smallholder beekeepers within the South African Beekeeping Industry with the exception of those beekeepers outside the ambit of the ARC (Schehle. 1996).

Most of these farmers are located in rural areas with the highest number in the Eastern Cape. These smallholder beekeepers have less than 10 years of beekeeping experience. According to the ARC study, 60% of the smallholder beekeepers have less than 5 years beekeeping experience. Most beekeepers are not affiliated to any provincial or national beekeeper association or structure. The majority of the beekeepers are between the ages of 30-40, while a considerable number is in the age range below 30 years.

All of these beekeeping projects were set up by grant funding and donations from the ARC, the Government's Poverty Relief Program and local municipalities. The existing beekeeping training in South Africa has a number of weaknesses; it is not accessible to all beekeepers due to costs associated with it. For example at the Grahams town Brewery to train 10 people in Beekeeping Level 2 costs R36, 272\ including the price of an extractor. In most cases this money has to be paid upfront prior to the commencement of training. For a long time training of beekeepers has been the domain of white commercial beekeepers belonging to associations. All in all South Africa is far much ahead in apiculture compared to many African countries (Allsopp, Veldtman, & de Lange, 2008).

Finally on bee farming in Africa, looking at bee farming in Switzerland, the country has not yet been fully developed apiculture to optimize its potential. This is despite the declaration of this sector as an important agro-business enterprise for rural development. There is a National Bee-keeping Association called Lujilo LweMaswati. This comprises members from bee-keepers from the entire country (African Renewal, 2008).The group has a national executive committee which should co-ordinate and promotes all beekeeping in the country. This entails facilitating training for aspiring bee-keepers and assisting in developing markets for the honey. This committee

should have representatives from all the four regions in the country which should facilitate communication and feedback between the national body and the regional membership. An economic analysis indicated that the benefits from the local honey production are high. The existence of a wide natural environment and the prevailing market price can ensure that the farmer derives a meaningful income from this venture. It was established that using the local top bar hive, a farmer can derive a net income of approximately E600 (US$85.70) per hive. If the farmer manually processes the honey his net income increases. (Shackleton*et al.,* 2008).

Approximately Each hive generates an income of E900 (US$120.85). This implies that if the small-holder farmer is developed to manage at least 20 hives, he can possibly derive a net income of over E18, 000 (US$2, 417.00) in year. This income can further be enhanced through the introduction of the Langstroth hive which is more productive. This is a meaningful income stream that can significantly contribute to the standard of living for the family (African Renewal, 2008).

## 2.6 Bee keeping in Kenya

### 2.6.1 Historical background and development of bee keeping in Kenya

Beekeeping has traditionally been practised in the country over a long time. Many communities keep honeybee colonies using baskets, pots, gourds, logs and rock crevices as beehives while other communities are honey hunters. However the traditional methods of beekeeping have overtime made the management and utilization of honey and other hive products less viable. Honey and other hive products among these communities bear important cultural significance especially during traditional ceremonies such as marriages where honey is used for dowry

payment. Honey is also used as food, medicine, preservative and sweetener (Beginners guide Manual, 2006).

In the 1950s, there was an attempt by the government through the Veterinary Department to introduce modern beekeeping mainly to communities who were already practicing the art, in an effort to improve the technical capacity of beekeeping, the colonial government initiated a training programme where two hundred honey and beeswax inspectors were trained and a number of demonstration centers established in various parts of the country. However due to the inadequate training of these inspectors all demonstration apiaries and refineries had curtailed their operations by 1964(National Beekeeping Policy, 2009).

From 1967 to 1969, the government received a grant of 8,000 sterling pounds from development partners and Freedom from Hunger Council of Kenya to carry out a feasibility study to determine the viability of beekeeping as an enterprise especially in drier areas of the country. On the basis of the survey carried out, in 1971 the Kenya government requested for bilateral assistance from the Canadian government to establish a beekeeping section within the Ministry of Agriculture.

The mandate of the beekeeping section was to develop a viable beekeeping industry through; training, research, equipment design and development, promotion of markets through establishment of cooperatives and honey refineries. The National Beekeeping Station was established in 1982 to effectively implement the mandates of the section. Overtime the beekeeping section has grown into a division within the department of livestock production. The introduction of structural adjustment programs in the 1980s liberalized the agricultural sector and

encouraged the private sector to participate in the development of the beekeeping industry (National Bee Keeping Policy, 2009)

### 2.6.2 Current status of bee keeping in Kenya

With the introduction of modern beekeeping technologies (such as improved beehives and accessories, protective clothing and honey processing equipment as well as bee colony management) the industry has shown major development in various aspects and is now an important component of the livestock sector (Bee policy, 2009). The industry provides income to beekeepers, persons employed formally in equipment manufacturing and hive products processing and packaging. Indirectly the industry contributes to employment creation in confectionery, pharmaceutical, brewing, cosmetics industries and other service providers such as retailers, transporters and suppliers of packaging materials. Honey is an important food component in nutrition as a source of energy, protein, vitamins, minerals and amino acids. Additionally, honey has medicinal properties and serves as a food preservative (Sessional paper 2, 2009).

There has been progressive growth in production of honey, beeswax and beekeeping equipment. The national honey and beeswax production is currently estimated at 14,653 and 140 metric tonnes (2007) respectively valued at ksh 4.43 billion per annum. The country has an annual estimated honey and beeswax production potential of about 100,000 and 10,000 metric tonnes respectively. Despite this huge potential the country is unable to meet its current local market demand for honey and beeswax which is estimated at about 15,000 metric tonnes. The deficit is met through imports (49.932metric tonnes of honey in 2008) while the country exported 7.579 metric tonnes of honey in the same year (National beekeeping policy, 2009).

Beekeeping in Kenya can successfully be carried out in about 80 percent of the country. It is especially suitable in the semi-arid areas where other modes of agriculture are not very possible. Beekeeping contributes to incomes as well as food security through provision of honey, beeswax and pollen as food and propolis, bee's venom and royal jelly in medicine. It also contributes to seed and food production through crop pollination and conserves the natural environment (Thomas .C, 2006). Watson ILRI (International Livestock and research institute) in 2008 did a research in Lochori and Kaptir villages of Turkana Kenya, noted that the principal constraint to expanding honey production has been lack of free modern beehives.

Several individuals stressed that there was little money to buy modern beehives, even though they insisted that honey production was profitable. Lack of market for the honey and lack of storage facilities too were major challenges. On the whole, however, beekeepers in both Lochori and Kaptir believed that honey production was profit table and that there was still plenty of scope to expand the number of beehives on communal lands. Beekeepers from Kaptir added that honey production was stable and enabled communities to survive droughts that had catastrophic impacts on livestock production. This sentiment is echoed by numerous commentators, including Field (2005) and ICIPE (personal communication), who are currently involved in an intervention aimed at promoting profitable honey production in Pokot and Turkana as part of their CABESI Project.

According to a study done and published by ILRI (International livestock and research institute) in 2009 on Sustainable Food security with beekeeping in coast region of Kenya beekeeping was practised in many parts of the region in traditional ways. As a result of this the product was limited. For many farmers that passed through generation there is a traditional way of

beekeeping. By transferring the existing traditional methods used to modern ways there a chance to be rich. Beekeeping can be practised in small area with limited money. According to some findings, beekeeping will help to those who are young and no land.

### 2.7 Types of bee hives used in rearing bees in Kenya

A hive is the box or container where the bees live. There are 3 major types of hives in Kenya .These are:-

- Log hives (traditional) hives
- The Kenya Top bar Hive (KTBH
- Langstroth hives.

**(a) Log (traditional) hives**

**Plate 2.1; a log hive hanged on a tree in Kitui Yatta**

These are the most commonly found hives in Kenya. A log hive is a tree trunk cut and hollowed or cut into two parts length wise. They are normally made from hard wood. There are also mud-baskets types. These hives are cheap to make and are made locally. They are placed on top of trees hence little disturbance or theft. Log hives though have many disadvantages, the fact that they replaced on tree they are easily attacked by honey badger (wild cat).

Honey harvesting is difficult leading to destruction of combs, brood and killing of bees. The harvester can easily fall off from the treetop and this can cause serious injuries. Honey quality is low due to mixing of brood, and honey combs given all combs in the hive are harvested at once and compared to Kenya top bar hive honey production is low. Another disadvantage of these hives is that mature hard woods are felled to make the hives. Feeding of bees during dry period is not possible hence possibility of absconding by the bees and due to the fact that the hives are placed on trees attacks by insects e.g. safari ant is high (Thomas, 2006)

**(b) Kenya Top Bar Hive (KTBH)**

**Plate 2.2: KTBH hives in Mutomo in Kitui**

This is a common hive in Kenya. It has 26 top bars spaced at 3.2cm from one bar tongue (tip) to the next bar tongue (tip). This distance is called bee space. The bars are 29cm long Thomas Carroll (2006). These hives have many advantages key among them is that; It is easy to check for ripe honey, in that one can remove the bar and check. No larvae combs are destroyed during harvesting since every bar is harvested at a time. It holds 26 combs, hence many combs for honey according to the number of top bars.

The honey from KTBH is generally clean hence high market value. The other advantage of these hives is the fact that it is easy to manage the bees during scarcity of flowers and dry weather. Food for bees and water can be provided during such adverse conditions. It is also easy to harvest the propolis and good wax. The Use of soft timber in making the hives lowers the cost of their production and they are also readily available. Hives are hanged 1m above the ground hence it is easy to harvest honey. During the dry periods (death periods) when flowers are scarce 5 honeycombs are left in the hive for the bees to feed on hence preventing absconding of bees (colony)and finally the hives keep swinging and cannot easily be attacked by honey badger (Beginners Guide manual, 2006).

Although the KTBH have many advantages, they still have numerous disadvantages. These hives are easily invaded by carpenter bees and beetles which destroy brood and these honey beetles also make the hives dirty. Specialized skills are needed to construct the hives and these skills are not readily available everywhere. If the apiary is not properly protected (fenced), bees are prone to disturbance by livestock and people and hence they may be stung. The hives are hung too low and can be easily stolen too (The Beginners Guide manual, 2006).

**(c) Langstroth hive**

This is a fairly modern hive. It is becoming popular among farmers. It is very ideal for bee keeping. It has two parts: Brood chamber and Super chambers it also has two types of boxes, one at the top and another at the bottom covered with a wire that acts as a queen excluder. Brood chamber: This is where the queen bee lays her eggs. It is restricted from moving to other chambers by the queen excluder. Super chamber: Honey is logged at this chamber. The queen does not go into this chamber.

The combs are formed on the frames and not bars as in KTBH. During harvesting frames with honey filled combs are removed and harvested using centrifugal equipment. It produces high quality honey hence fetching high prices in the local and export market. High honey yields are possible since combs are not destroyed; approximately 120kg per hive per harvest.

Although Langstroth hives are the most modern bee hives being used, they have a number of disadvantages too. They have the highest initial costs as compared to the other two types since require skilled manpower to make and also a centrifuge machine used for refining honey is needed hence skills for operating the machine are needed and also this calls for extra expenses . They can easily be attacked by predators (insect and other pests) and can easily be stolen since it is placed low (Carroll, 2006).

**Plate 2.3**: **Langstroths hives model in Kitui Yatta**

### 2.7.1 Bee species common in Kenya

There are many different species of bees in the world. Most of them solitary or live alone.A few species of bees are kept to produce honey. In Kenya the most important species is called the honeybee or *Apis mellifera*. This is the species of bee that is familiar to everyone. Within this species there are a number of races of bees in Kenya which have their own particular characteristics. We have *Apis mellifera scutellata, Apis mellifera monticola, Apis mellifera yeminitica (nubica) and Apis mellifera littorea*. (National Bee policy, 2009**).**

1. *Apis mellifera yemenitica* (formally *A. m. nubica*): This is the smallest race in Africa. It has the most slender abdomen and the largest yellow abdominal color band of all African races. It most withstands and survives drought conditions by excessive migration. It is mostly found in the northern parts of Kenya.

2. *Apis mellifera scutellata* the bee is highly aggressive and has a great tendency to reproduce and migrate. It is found in plains and their high reproductive rate is attributed to massive flowering, which occurs in the plains just before the rains.

3. *Apis mellifera littorea*: The bee inhabits the low lands of the Kenya Coast. It does not migrate as much as scutellata. It has a tendency to rear brood throughout the year due to availability of forage along the coast (National bee policy, 2009)

4. *Apis mellifera monticola*. This bee is called the mountain bee. The bee inhabits places where the sun is frequently obscured by clouds and mist and ground frosts at night. It is the largest bee in Africa. It has a tendency to reduce brood rearing at the first sign of forage decline and may not migrate. It is less productive and less vicious. Found in Meru and Mt. Elgon. (National bee policy, 2009).

The *A. m. monticola* bee species tends to be in the highlands and are more docile. We probably have these around the Molo area.

The *A.m.scutellata* which is a smaller and more aggressive bee are found in the lowlands of Kenya. In our immediate vicinity we have in Baringo District **(**National bee policy, 2009**).**

### 2.7.2 Bee Keeping in Kitui

According to a research work done by Paul Maundu Mwilu, (K-Rep Development Agency), beekeeping in Kitui is almost as old as human settlement in this part of Kenya. Honey from Kitui used to be well-known: for many years the Tana and Athi Rivers Development Authority (TARDA), a regional government agency, processed it and guaranteed a market for beekeepers. But in 2003 this service was run down because of political interference, and the processing unit was moved to another area.

Without a viable market, local beekeepers could no longer make a profit, and the quality of their honey deteriorated. Lower quality meant lower prices: while TARDA used to pay KSh 100 ($1.25) per kilogram, traders would pay only KSh 30 ($0.38). Rather than selling at such prices, many producers consumed their honey at home, sold it to local brewers, or gave up producing altogether. For many producers, honey was their second most important source of income (after goats), but even when prices were good, many survived on less than $0.50 a day
(Mwilu, 2004).

Their situation had become desperate. KDA reviewed the demand for services by each of the chain actors, and then designed a series of financial and technical services to build a new chain. With Danida's Agricultural Business Development programme, farmers were mobilized into groups and were trained on the various aspects of group dynamics and the basic principles of beekeeping as a business. Farmers with previous rudimentary skills in hive management were identified for further training to qualify as providers of this service.

The existing local traders were selected and recruited into the programme. It was realized they lacked market information and record-keeping skills, among other things. Baraka Agricultural College, a training institute based in Molo, in Kenya's Rift Valley province, trained the hive makers, producers and traders on production techniques. The traders in turn train groups of producers on how to maintain their hives and improve the quantity and quality of honey. KDA trained the producers and traders on financial management and business development, and built the capacities of staff and board members of the financial services associations. The new chain began operating in 2007 (Paul, 2007).

The KDA project trained the hive makers on how to fit the traditional log hives with "queen excluder" – a mesh that stops the queen from laying eggs in the honeycombs, so preserving the honey. This is a much cheaper option than modern hives, which were being widely promoted, even though they are not necessary to produce good-quality honey. The project also trained the hive makers how to make modern hives; the beekeepers choose the hives they want. These producers have between 10 and 200 hives each, with which they produce honey and other products such as propolis and pollen (used as medicines) and beeswax. By December 2008, around 2,000 farmers, including 500 women, were producing honey as a business venture. The peak production season is between January and April, during the dry season following the October rains. The beekeepers were organized in groups of between 20 and35. These groups collect the crude honey and sell it to the collection centers.

Because the honey is bulked, it fetches a better price than before. The collection centers are owned by the producers through shareholding. These buy honey, remove foreign matter, grade and bulk it, and store it before selling it to traders. By December 2008, there were 10 collection centers, each serving around 20 producer groups (Maundu, 2004). The project trained the traders who used to buy low-quality honey from the beekeepers. These traders now buy bulk honey from the collection centers, and press and centrifuge it to separate the honey from the honeycomb. They then deliver the honey to the final processor. A majority of the traders are women; many of them are widows. There are 50 traders in the four regions of the county served by the project.

Under a new national government, TARDA restored its honey processing activities. It buys the honey from the traders for final processing and packaging. It pays traders KSh 150 ($1.88) per kilogram of honey, compared to KSh 120 ($1.50) offered by others. One disadvantage is that

TARDA cannot pay for the honey immediately upon delivery – making an alternative system of payments necessary. TARDA packs the honey and sells it to local retailers in Kitui and nearby towns, as well as to food processors, herbalists and pharmaceutical companies. Some companies also export the honey. Consumers include households, hospitals and hotels Because Kitui is a dry district, it has very limited business opportunities and high risks, and is not an attractive location for financers (CBS, 2003a). Extended periods of donor programmes have left residents expecting handouts rather than loans they have to repay.

### 2.7.3 The honey market chain in Kitui County

The honey market chain in Kitui began with thousands of beekeepers who produce honey using traditional log hives. The honey value chain is shown in the diagram below. Studies commissioned by ABD (Agriculture Business Development) on the honey sector in Kitui have revealed that lack of appropriate financial products is a major constraining factor to the smooth functioning of the honey market chain in Kitui.

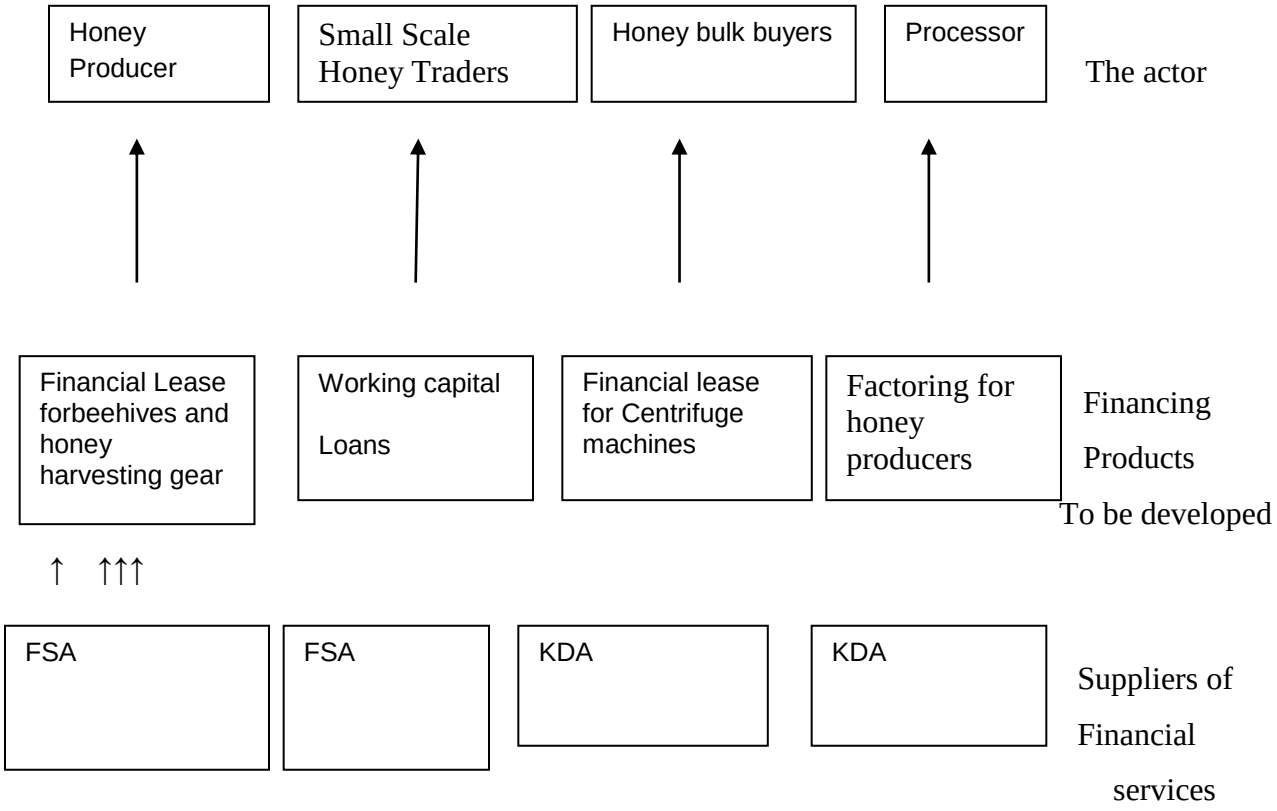



**Figure 2.1: The honey value chain**

**Source: Drought monthly bulletin for November 2011 Kitui District.**

Despite the fact that TARDA restored the processing of the honey in Kitui, the potential for the honey in the region still remains unexplored. This is evidenced from the fact that, Kitui relies heavily on food supplies from other counties to meet its food needs for the better part of the year. (CBS, 2003a). This has necessitated the carrying out of this study, to identify the major hindrance of apiculture growth in the region

## 2.8 Impacts of Rainfall variability on Food Security, Availability, Accessibility, and Utilization

### 2.8.1 Rainfall variability and Food Security

Studying the correlation of environmental factors with poverty can aid in designing poverty alleviation projects. Changing environmental factors related in part to rainfall variability have already had an impact on household food security for the many Kenyans who would benefit from reliable forecasts, increased water availability, and improved soil fertility to sustain their livelihoods.

In some places, rainfall variability has been implicated in decreased water resources, which has had a cascading effect: increased trekking distances and water costs; more competition for declining water supplies; failed crops; increased food prices; earlier livestock migrations; weaker livestock, predisposing them to disease; and food insecurity as families are left without milk and animal products (KFSSG 2008).

Its effects on agriculture will be more pronounced in medium and low potential zones than in zones of high agricultural potential (Majule AE, 2008). The distribution of poverty across Kenya varies from one province to another. Each province offers a unique blend of environmental, geographical, and infrastructure characteristics, which in turn influence poverty levels. Certain environmental factors can contribute to poverty alleviation. Poor households rely heavily on expenditure-saving, labor intensive activities for their subsistence and survival, such as collecting water and fuel wood or grazing animals on common lands. Common property resources or open access lands are important sources of livelihoods for the poor, providing them

with a variety of goods, which can include food, water, fuel, fodder, bamboo, resin, gum, oils, construction materials, honey, medicinal plants, and spices, among others (CBS, 2003).

Many poor households depend on their local environments for food security. Generally, food security depends on food availability and stability, accessibility, and use. Poor soils and low agricultural productivity, lack of control over land management, and competition from other users are some of the conditions that threaten household food security. Food security is closely related to the achievement of a number of other MDGs: for example, poor nutrition is implicated in more than half of all child deaths worldwide (Jolly, 2001). This shows gains to be made by addressing food security which will contribute in reducing child mortality.

Over 36 per cent of all the rural poor Kenyans live on marginal lands or areas that are particularly vulnerable to environmental degradation, such as floodplains, coastal areas, and degraded hillsides. Depending on such lands for food can render poor people vulnerable to periodic hunger. Environmental hazards and extreme events, such as droughts, floods, forest fires, and landslides, are more damaging in marginal and degraded ecosystems and the poor living there are least able to cope with their impacts. (Omolo A.etl, 2010).

Given that a large portion of Kenya is semi-arid with high temperatures and low precipitation, frequent droughts, water scarcity, and unpredictable rainfall variability will have the largest impacts on people living in these regions. The agricultural sector, which relies on predictable rainfall and temperatures, will suffer the most since it directly or indirectly supports 80 per cent of the population and agro-based industries support much of Kenya's economy (Kabubo-Mariara, 2007). Kenya's high dependence on natural resources, its poverty levels and low

capacity to adapt, and the existence of other significant environmental stress make it highly vulnerable to the impacts of rainfall variability.

The impacts of rainfall variability are linked with the achievement of key national development objectives: poverty, food insecurity, health threats, environmental degradation, and loss of natural resources. Credit constraints, poverty, and a lack of information, however, remain significant obstacles to adopting both short- and long-term adaptation measures. There is a critical need for governments to support rainfall variability adaptation strategies, including monitoring its variability and disseminating information to farmers. Farmers will need to improve management approaches, including Land use diversification; water harvesting, recycling, and conservation; and the irrigation and shading and sheltering of crops (Kabubo-Mariara, 2007).

### 2.8.2 Rainfall variability and food availability

Wild foods are particularly important to households that struggle to produce food or secure an income. A change in the geographic distribution of wild foods resulting from changing rainfall and temperatures could therefore have an impact on the availability of food. Changes in climatic conditions have led to significant declines in the provision of wild foods by a variety of ecosystems, and further impacts can be expected as the world climate continues to change.

For the 5 000 plant species examined in a sub-Saharan African study (Levin and Pershing, 2005), it is predicted that 81 to 97 percent of the suitable habitats will decrease in size or shift owing to rainfall variability. By 2085, between 25 and 42 percent of the species' habitats are expected to be lost altogether. The implications of these changes are expected to be particularly great among communities that use the plants as food or medicine. Constraints on water availability are a

growing concern, which rainfall variability will exacerbate. Conflicts over water resources will have implications for both food production and people's access to food in conflict zones (Gleick, 1993). Prolonged and repeated droughts can cause loss of productive assets, which undermines the sustainability of livelihood systems based on rain fed agriculture. For example, drought and deforestation can increase fire danger, with consequent loss of the vegetative cover needed for grazing and fuel wood (Laurence and Williamson, 2001). In Africa, droughts can have severe impacts on livestock.

### 2.8.3. Potential impacts of rainfall variability on food access

Food is allocated through markets and non-market distribution mechanisms. These factors include income-generating capacity, amount of remuneration received for products and goods sold or labor and services rendered, and the ratio of the cost of a minimum daily food basket to the average daily income (Gwambene b, 2007). Non-market mechanisms include production for own consumption, food preparation and allocation practices within the household, and public or charitable food distribution schemes.

For rural people who produce a substantial part of their own food, rainfall variability impacts on food production may reduce availability to the point that allocation choices have to be made within the household. A family might reduce the daily amount of food consumed equally among all household members, or allocate food preferentially to certain members, often the able-bodied male adults, who are assumed to need it the most to stay fit and continue working to maintain the family

Non-farming low-income rural and urban households whose incomes fall below the poverty line because of rainfall variability impacts will face similar choices. Urbanization is increasing

rapidly worldwide, and a growing proportion of the expanding urban population is poor (Ruel et al., 1998).

Allocation issues resulting from rainfall variability are therefore likely to become more and more significant in urban areas over time. Where urban gardens are available, they provide horticultural produce for home use and local sale, but urban land-use restrictions and the rising cost of water and land restrain their potential for expansion.

### 2.8.4. Potential impacts of rainfall variability on food utilization

Nutritional value: Food insecurity is usually associated with malnutrition, because the diets of people who are unable to satisfy all of their food needs usually contain a high proportion of staple foods and lack the variety needed to satisfy nutritional requirements. Declines in the availability of wild foods, and limits on small-scale horticultural production due to scarcity of water or labor resulting from rainfall variability could affect nutritional status adversely. In general, however, the main impact of rainfall variability on nutrition is likely to be felt indirectly, through its effects on income and capacity to purchase a diversity of foods. Increased incidence of water-borne diseases in flood-prone areas, changes in vectors for climate-responsive pests and diseases, and emergence of new diseases could affect both the food chain and people's physiological capacity to obtain necessary nutrients from the foods consumed. Vector changes are a virtual certainty for pests and diseases that flourish only at specific temperatures and under specific humidity and irrigation management regimes.

These will expose crops, livestock, fish and humans to new risks to which they have not yet adapted. They will also place new pressures on care givers within the home, who are often

women, and will challenge health care institutions to respond to new parameters (De wet N., 1999).

Where vector changes for pests and diseases can be predicted, varieties and breeds that are resistant to the likely new arrivals can be introduced as an adaptive measure. A recent upsurge in the appearance of new viruses may also be climate-related, although this link is not certain. Viruses such as avian flu, Ebola, HIV/AID and SARS have various implications for food security, including risk to the livelihoods of small-scale poultry operations in the case of avian flu, and the extra nutritional requirements of affected people in the case of HIV-AID. The social and cultural values of foods consumed will also be affected by the availability and affordability of food.

The social values of foods are important determinants of food preferences, with foods that are accorded high value being preferred, and those accorded low value being avoided. In many traditional cultures, feasts involving the preparation of specific foods mark important seasonal occasions, rites of passage and celebratory events (IPCC, 2010). The increased cost or absolute unavailability of these foods could force cultures to abandon their traditional practices, with unforeseeable secondary impacts on the cohesiveness and sustainability of the cultures themselves. In many cultures, the reciprocal giving of gifts or sharing of food is common. It is often regarded as a social obligation to feed guests, even when they have dropped in unexpectedly. In conditions of chronic food scarcity, households' ability to honor these obligations is breaking down, and this trend is likely to be reinforced in locations where the impacts of rainfall variability contribute to increasing incidence of food shortages (Ruel et al., 1998).

Food safety may be compromised in various ways. Increasing temperature may cause food quality to deteriorate, unless there is increased investment in cooling and refrigeration equipment or more reliance on rapid processing of perishable foods to extend their shelf-life. Decreased water availability has implications for food processing and preparation practices, particularly in the subtropics, where a switch to dry processing and cooking methods may be required. Changes in land use, driven by changes in precipitation or increased temperatures, will alter how people spend their time. In some areas, children might have to prepare food, while parents work in the field, increasing the risk that good hygiene practices may not be followed (Levin and Pershing, 2005). This therefore calls for a diversified source of livelihood hence adoption of bee farming among the marginalized communities in Kenya.

### 2.8.5 Challenges Facing Bee Farming

Although, their importance in the natural ecosystem and for agriculture, their production of value-added by-products, for human consumption or commercial and therapeutic uses, honey bees populations have suffered a dramatic decline in recent years due to a number of a biotic and biotic constraints. Abiotically, honeybee health is negatively affected by the intensive use of pesticides and fungicides in agriculture (Fletcher and Barnett, 2003; Barnett et al., 2007) and the chronic exposure to pesticides needed to combat the parasitic mite Varroa destructor. Destruction and fragmentation of natural and semi-natural habitats as well as the intensification of agriculture and change in landscapes and crops biodiversity had dramatically affected honeybees and other pollinators (Larsen et al., 2005; Cane *et al.*, 2006). In terms of biotic stress, honey bees are the targeted host of many bacteria, mites, fungi, protozoa and viruses.

**Beekeeping practices**: Increased urbanization and suburban sprawl, combined with an increasingly intensification of agriculture worldwide have decreased available apiary sites. As a result, the total number of colonies has been decreasing although, difficult to ascertain. Facing this challenge, beekeepers seek alternative sources of income by leasing their colonies for the pollination of horticultural, field and vegetable crops that are entirely dependent on the activity of bees. This practice has tremendous negative impacts on the nutrition of bees and their habitat causing a variety of stresses related to nutrition, colony staging and transport (Van Engels drop et al., 2008).

**Pesticides:** Most intensive agricultural systems have recourse to the use of a number of pesticides to control pathogens and pests. When used, insecticides cause major losses in the populations of honey bees (Laurent & Rathahao, 2003). In systems, where bees are required for pollination, a careful management is required to minimize these losses. During growing season, bees poisoning symptoms due to acute insecticides exposure such as an increase in bee death can be seen at the entrance of the colony (Faucon *et al.*, 2002).

Other alterations in the bee's behavior and sense of orientation can also been detected (Decorate *et al.*, 2004). For instance, a wide spread loss in bee colonies was reported in France in recent years and have been ascribed to the effect of nicotine-like insecticide i.e., Imidacloprid (Rortais et al., 2005). Because of its low mammalian toxicity, high effectiveness and high mobility in plant and mammalian tissue, it is often used as systemic insecticide for the control of sap-sucking insects in crops, as well as blood-sucking insects in companion animals (Tomizawa & Casida, 2003). There is an ongoing debate about the chances of this happening to a degree that bees are being considerably endangered.

Some studies report residues of Imidacloprid in the nectar and pollen at levels that are potentially dangerous to bees (Chauzat *et al.,* 2006). In the contrary other experimental assays, consisting of feeding Imidacloprid to bee colonies in syrup or pollen at amounts likely to be found in the field, have shown no significant differences in terms of development and survival of colonies between the Imidacloprid-treated and non-treated control. The authors reported also that the exposure of bees to pollen from corn plants treated with the Imidacloprid did not have any significant effect on their longevity (Faucon *et al.,* 2005).

**Disease**s: Honey bees are affected by a large number of parasites and pathogens. The American foul brood (AFB), the most economically devastating disease and potentially lethal to infected colonies and European foul brood (EFB) caused by Paenibacillus larvae and Melissococcus plutonius, respectively (Forsgren, 2010; Genersch, 2010), are widely distributed. There is also a fungal disease of the brood that is due to Ascosphaera apis (Aronstein and Murray, 2010). All these microorganisms have a certain preference for larvae and pupae, where they induce distinctive symptoms, in comparison with adult bees seemingly not-affected.

The parasitic mite Varroa destructor was also reported to infest brood cells and to phoretically live on adult bees (Rosencrantz *et al.,* 2010). Under heavy mite infestations, an accelerated rate of death becomes obvious among the colonies. A protozoan, Nosema apis, is known to infest the guts of adult bees and to cause dysentery and early decline of adult workers, especially when the infestation is at its highest level.

A new Nosema species, N. cerana, has been recently identified from the Asian hive bees *Apis cerana* (Chen *et al.,* 2009) and has now been found also on *A. mellifera* in Europe (Fries, 2010). Most adult honey bees carry symptom less viral infections (Chen and Siede, 2007; Ribiere,

2010). However, under conditions of stress caused by poor nutrition, inclement weather, or parasitism by V. destructor or N. apis (Yang and Cox-Foster, 2005; Yue and Genersch, 2005), viral infection can overpass the non-detectable threshold, causing symptoms in adult bee

## 2.9 Theoretical Framework

### Adoption of Bee Farming as an adaptation strategy to rainfall variability Effects on Food Security in Kenya

The study was guided by Sustainable Livelihoods Theoretical Framework (DFDI, 1996) According to this framework, poverty reduction interventions should focus on empowering the poor to build on their own opportunities, supporting their access to assets, and developing an enabling policy and institutional environment. This approach tends to place people and their priorities at the center of development, trying to understand the differences between groups of people and working with them in a way that is appropriate to their current livelihood strategies, social environment and ability to adapt.

The livelihood approach dates back to the contributions of several scholars between the mid-1980s and the early 1990s as a new way of thinking about the objectives, scope and priorities for development. Its emergence had all the qualities of a classic "paradigm shift" (Soles bury, 2003).Therefore, livelihoods approaches are basically participatory. Moreover, they try to balance economic, institutional, social and environmental sustainability. Last, but not least, livelihoods approaches recognize the dynamic nature of livelihood strategies and people's flexible responses to changing situations. In this context the issue of rainfall variability is a real problem and it has and is affecting totally the issue of food security among the marginalized

communities in Kenya. These are communities that have been depending on agriculture for their livelihoods.

The rising temperatures and the unpredictable rainfall variations have immensely contributed to poor agricultural production hence adding to the existing problem of food insecurity in the regions. This calls for an adoption of a different source of livelihood hence the need for the study on Adoption of bee farming as an adaptation measure to rainfall variability effect on food insecurity.

The study will provide useful information to the bee farmers and policy makers towards improved bee farming methods. According to the sustainable livelihoods framework, the vulnerability context within which people pursue their livelihoods includes trends (for example, economic or resource trends), shocks (for example, conflict, economic shocks, natural shocks, etc.), seasonal fluctuations in prices, production, health, employment opportunities etc. These factors can have a direct impact on people's assets and on the options available to them to pursue beneficial livelihood strategies. The vulnerability context of poor people's livelihoods is usually influenced by external factors outside their direct control and is dependent on wider policies, institutions and processes to support people in order for them to be more resilient to the negative effects of trends, shocks and seasonality, development policy-makers and practitioners can support people's access to assets and help ensure that critical policies, institutions and processes are responsive to their needs (Ashley and Carney, 1999).

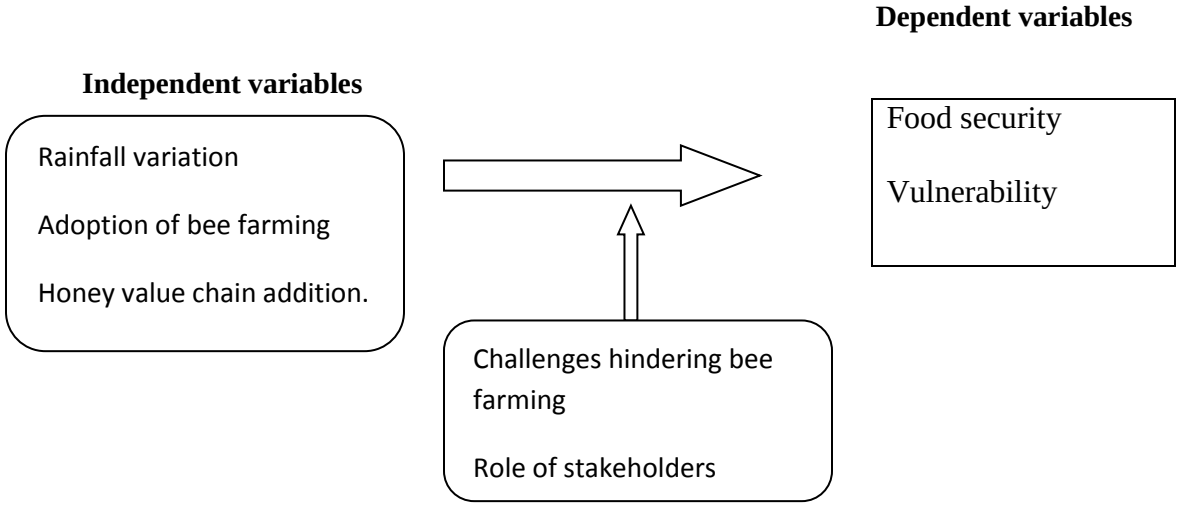
The study will also help in identifying the shortcomings of the policy makers and institutions in the effective adoption of bee farming as an adaptation strategy to rainfall variability on food

insecurity menace in Kitui County. Livelihood approaches have proved to be valuable in analyzing complex trends such as rainfall variability and situations in which a key objective is to strengthen people's overall resilience as the future becomes more uncertain – and linking these to practical action; (Clark and Carney, 2008)

### 2.9.1 Conceptual Framework

The study combined a Sustainable livelihoods theoretical framework **2.9** above ,a conceptualized framework on how variables affects each other Figure 2.9.1, a conceptual framework on Honey Value Addition and Cost Reduction -transforming raw honey into a form desired by the customer for food and hence can fetch income to the bee farmers and create employment during the honey value addition and cost reduction processes and Hyogo Framework for action Which specifically recognizes the need to "promote food security as an important factor in ensuring the resilience of communities to hazards, particularly in areas prone to drought, floods, cyclones and other hazards that can weaken agriculture-based livelihoods and more serious for vulnerable and marginalized communities.

**Figure 2.2 showing how rainfall, improved bee farming and honey value addition affected food security and other factors affecting the system**




**Source: study design 201**3

### 2.9.1.1 Honey Value Addition and Cost Reduction

1. The study will made use of a value addition and cost reduction approach by applying a value chain analysis on the above research questions

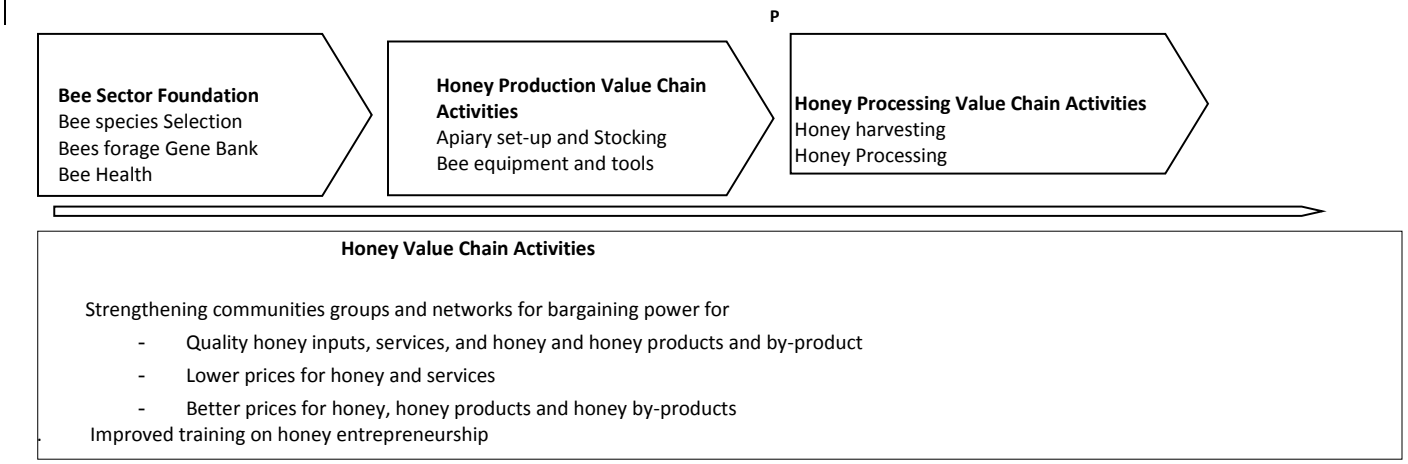
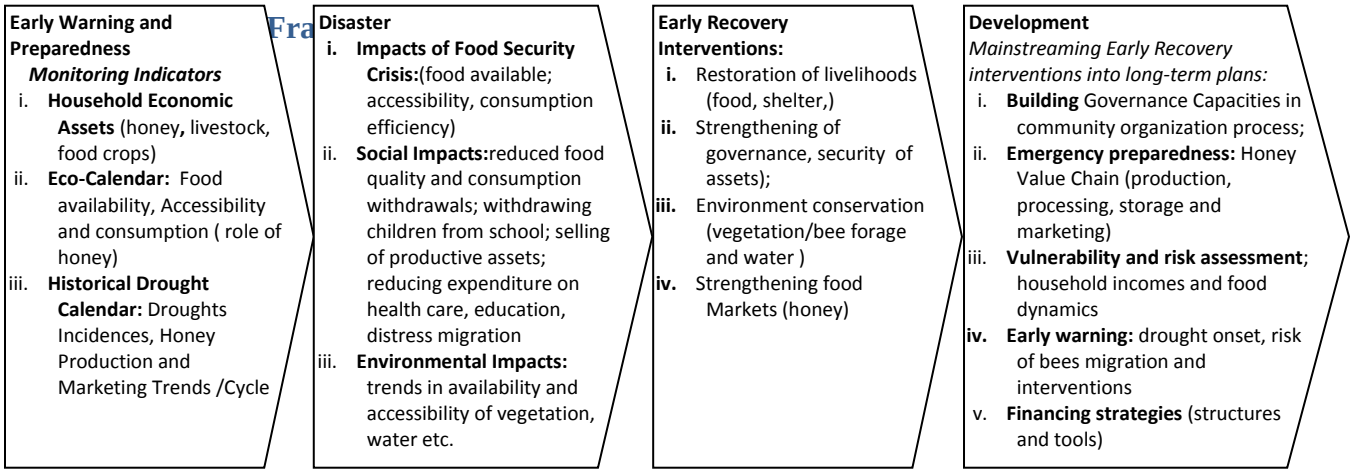



**Figure 2.3 Honey Value addition and Cost Reduction**

**Source: National Bee Keeping Policy, 2009.**

### 2.9.1.2 Hyogo framework for action.

Recognizes the need to; "promote food security as an important factor in ensuring the resilience of communities to hazards, particularly in areas prone to rainfall variability.




**Source: Adopted from World Disasters Report, International Federation 2004**

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1 Introduction

This section delineates the background of the study site, source of the data, study design sample size and sampling techniques, methods of data collection and methods of data analysis. Both descriptive survey design and case study survey design were used and questionnaires were used to collect data from the farmers who had the knowledge on the beekeeping on the activities and key informants from the bee keeping groups. The study sought to obtain data on the rainfall variations for the last eight years and the impact on maize and beans production, The production of honey from the traditional bee hives and modern bee hives and the income generated from both, the major stakeholders in the bee industry in Kenya and the challenges facing bee farming in general in Kitui.

## 3.2 Study Area characteristics

The area of study was Kitui County. Kitui County is in Eastern province of Kenya. It is one of the 47 counties in Kenya. It borders Machakos and Makueni counties to the west, Mwingi to the north, Tana River to the east and Taita Taveta to the south. . Kitui has a population size of 1,012,709 people. The Constituencies in the county are Mwingi North, Mwingi Central, Mwingi South, Kitui West, Kitui Rural, Kitui Town, Mutitu, and Kitui South. The selected areas of study are the three administrative areas of the formerly Kitui district. These are, Kitui Central, Mutomo and Kitui Yatta.

Nine bee-keeping well established groups, three from each region were interviewed. The county of Kitui is very vulnerable to the impact of Rainfall variability; it is among the ASAL counties in

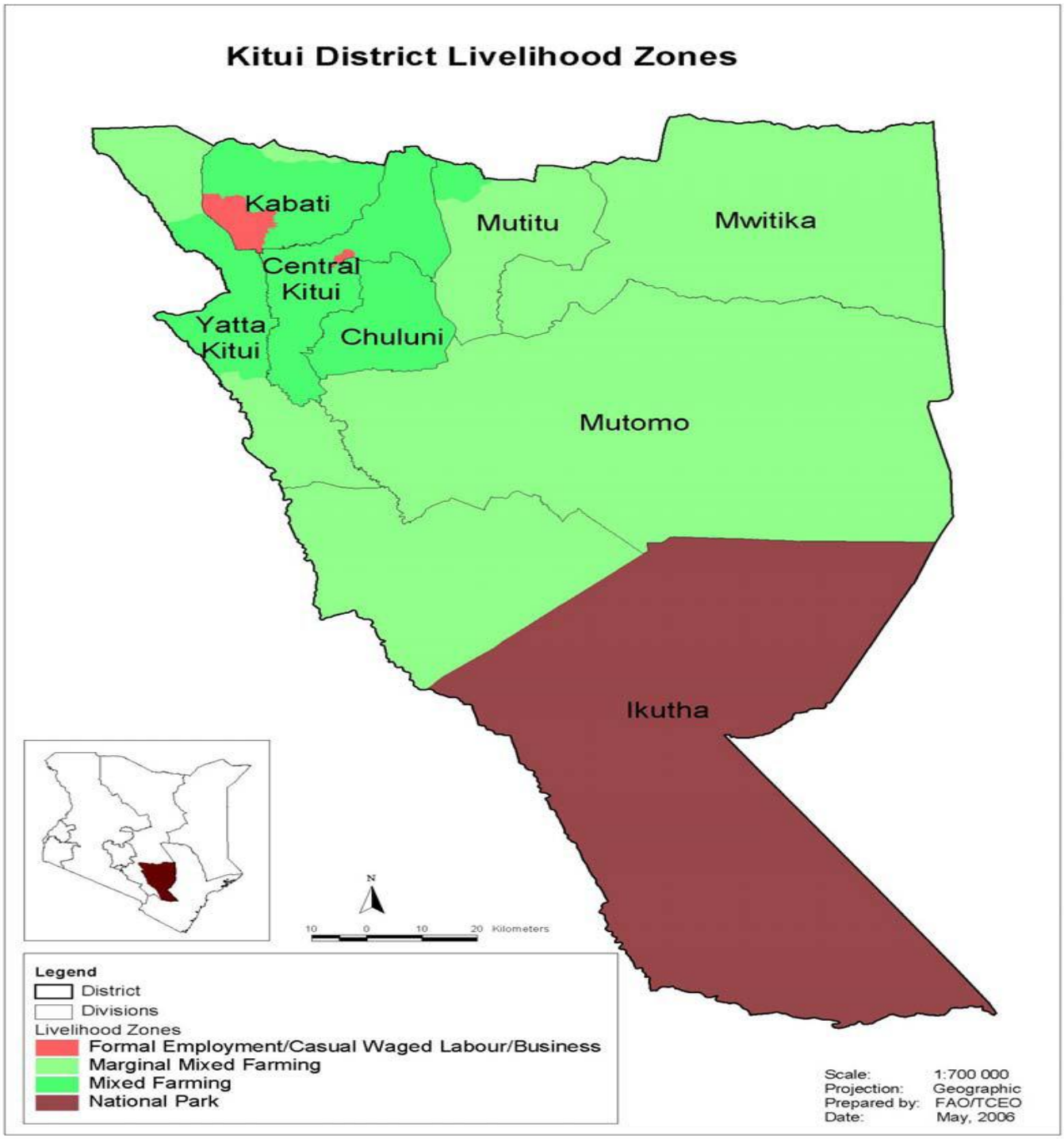
Kenya. Kitui County is semi-arid with very erratic and unreliable rainfall. Most parts of the district are hot and dry throughout the year resulting in very high evaporation rates. Rainfall is distributed within two seasons yearly and varies from 500-1050mm with about 40% reliability.

Low agricultural productivity and erratic rains have resulted in perennial food shortages in the district. For instance, in 2005, the average yield of maize was only 0.06T/ha while total cereal production was a paltry 6,661 metric tonnes as compared to the district estimated annual demand of 82,839 metric tonnes. Consequently, Kitui relies heavily on food supplies from other districts to meet its food needs for the better part of the year (CBS, 2003a).

Apart from maize and beans, the markets supply the bulk of food consumed in the mixed farming livelihood zone, which supports about 57% of Kitui's population. This county is the representative of many arid and semi-arid parts of Kenya. This calls for an alternative source of livelihoods as the above challenges are compounded by the global climatic variability. Lack of proper formal and technical education is also a big challenge among the target groups.

According to UNDP (2001) adult literacy rate was at (62.8%) in Kitui .Illiteracy may challenge learning about new technology. Since the level of education has an influence in people's attitudes, knowledge and practices towards environment and all aspects of life. The fact that bee farming has been traditionally practised in the region for a long time also provided the necessary information for the study.

**Figure 3.1: Map of Kitui District**




**Source: Drought monthly bulletin for November 2011 Kitui district by, ministry for development of Northern areas and arid areas.**

### 3.3 Source of Data

The study made use of primary data, and secondary data which provided the required information for analysis. The source of the secondary data included: Review of related beekeeping policies, baseline survey, research programmes, project reports and internet. Primary methods included field Interviews with the bee keeping farmers, focused groups discussions, with bee keepers and consultative meetings with relevant stakeholders along the honey value chain and observations.

The required data for partial budgeting, such as prices of improved box hive, pure beeswax and accessories and data on Maize and beans production for the last eight years were collected from the District Agricultural research development office. Honey yield, price, feed cost, labor cost and traditional hive cost were collected from key informants of the bee keeping focused groups. Due to the geographical spread of the sample, research assistants were used to help in the data collection in the three regions.

### 3.4 Study design

A combination of case study design and descriptive survey design were used. Descriptive survey is a method of collecting information by interviews or administering a questionnaire to a sample of individuals (Orodho,2003).It is used when collecting information about people's opinions, habits or any of the variety of education, social or economic issues(Orodha and Kombo 2002).

The study design is not restricted to fact findings but may often result in the formulation of important principles of knowledge and solution to significant problems. Since the study encompassed administering questionnaires and interviews and looking into formulation of principles that would be a solution to the problem of food insecurity among the marginalized and vulnerable communities in Kenya and this qualified descriptive and case study design to be used.

A case study design seeks to describe a unit in detail in context and holistically. It is a way of organizing educational data and looking at the object to be studied as a whole. In a case study a great deal can be learned from a few examples of the phenomena under study (kombo, 2003). The use of this design is justified by the fact that bee farming as an adaptation strategy to rainfall variability impact on food security is being investigated in Kitui County which is a representation of many arid and semiarid regions in Kenya such as Garissa, Mbeere, parts of Baringo, Mt. Elgon, East Marakwet districts Narok North, Koibatek districts and Taita/Taveta.

**3.5 Sample Size**

Since there was no clear data on the size of population of the current bee keeping farmers in the region, prevalence value of 50% was used to determine the sample size by the usage of Wright-Fishers equation formulae as shown below. (Bill Godden, 2004)

$$n=\frac{z2pq}{e2}$$

Z=standard variant (1.90)

P=prevalence (assumed proportion=0.5)

q= (1-p=0.50)

n=Sample size

e=confidence interval=0.05

$$n = \frac{(1.96\times1.96\times0.50\times0.50)}{0.05\times0.05}$$

n=385

A population sample size of 385 individuals with knowledge on bee keeping from the three administrative regions was targeted with 128 respondents from each region.

The number of the respondents that turned up in total was 195 which were about 50% of the targeted population sample of the members of the bee keeping groups. The table below shows the geographical distribution samples and respondents.

**Table 3.1 Geographical representation of respondents**

| **Region** | **Sample size** | **Number of respondents who turned up** | **Percentage response** |
|---|---|---|---|
| **MUTOMO** | 129 | 95 | 74% |
| **KITUI CENTRAL** | 128 | 52 | 40% |
| **KITUI YATTA** | 128 | 48 | 37% |
| **TOTAL** | **385** | **195** | **50%** |

**Source: Field data 2013**

Interviews from the selected areas of studies were conducted focusing on the importance of beekeeping and problems associated with it and recommended interventions being discussed. Key stakeholders in the bee farming industry in the region were interviewed on their role in the honey value chain additional analysis.

### 3.5.1 Sampling technique

The study made use of probability Stratified sampling technique. This technique of stratification is often employed in the preparation of sample designs because it generally provides increased accuracy in sample estimates without leading to substantial increases in costs. Stratification does not imply any departure from probability sampling – it simply requires that the population be divided into subpopulations called strata and that probability sampling be conducted independently within each stratum. The sample estimates of population parameters were then obtained by combining information from each stratum from the three study sites (Kish, 1987, p. 34).

The three study sites namely Mutomo,Kitui Central and Kitui Yatta were purposively sampled and typical case sampling was used .Purposive sampling is a sampling technique where the researcher targets groups of people believed to be reliable for the study. Typical case sampling uses one or more households to provide a local profile (L.A Tromp, 2006).

A disproportionate stratified sample design was used to sample the bee keeping groups in every site and simple random sampling was used to draw samples of the individuals from the groups to be interviewed. Since this design is associated with the use of different probabilities of selection, or sampling fractions, within the various population (strata (Kish, 1978:92). The variables for stratifications in this study were the size of the bee keeping groups and the age of the group. The categories under the size of the group were large group with more than 40 members and small groups with less than 40 members .Under the age of the group the categories here were old group with more than 5 years and the new groups with less than 5 years. The study made use of the strata with the categories

large and old. Three bee keeping (groups (strata) were selected in each region and simple random sampling was used to pick on the three groups per study site.

Kitui County is a bee farming zone in Kenya and is still known to have high levels of food insecurity. The criteria for sampling the region therefore included:

1. Incidences of recurrent rainfall variability related droughts (agricultural and meteorological droughts).
2. Potential of honey production within the county and major challenges facing apiculture.
3. Number of farmers using improved bee hives in the county and those using traditional hives.

The findings were comprehensive and representative of the average position across the region as a reasonable sample of respondents were selected and involved in each of the three study regions.

**3.6 Data collection techniques**

Varying participatory information gathering techniques were applied during this study. The key methods used were: Group discussions (facilitation meetings) with farmers and other stake holders. Formal and informal interviews with individuals and group of persons were conducted. Informants under this category were farmers of the various bee keeping groups, Government institutions and non-governmental organizations.

All sessions were conducted in the local language and Kiswahili. A few enumerators who have know-how on bee-keeping and the knowledge of the study regions were recruited and trained to help in collecting the data using the questionnaires under the supervision of the

researcher. The researcher monitored the enumerators during the data collection. The purpose of the survey was clearly explained to all informants. Meetings with the Government Officials were conducted through direct interviews; and one-on-one basis. Furthermore, project sites of group's members or individuals were visited for both observations and direct interview on one-to-one base. Questionnaires were administered to individual farmers of the various bee keeping groups and key informants of these groups especially in getting the data on income for the five years period since they keep records. Observation of the various types of the bee hives in the apiaries was made and photographs taken as shown in chapter two. Since it would have been cumbersome and very tiresome to interview individual farmers in their household group discussions turned up to be the best option. This is because the researcher was able to get the needed information in one sitting. The information that called for filed records was accessible too from the key informants of these groups**.**

**3.7 Data Analysis**

Data collected was coded and computed using SPSS version 17.0 computer software**.** Data analyses refer to examining what has been collected in a survey and making deductions and inferences. (Denold, Delno, Tromp, 2006). Both descriptive and inferential statistics were used. The qualitative data was analyzed by a quick impressionist summary which involved summarizing key findings, explanation interpretation and conclusion. This was used in analyzing objective number (4) and objective number (5).

The quantitative data was analyzed using chi square statistics. Chi square which is an inferential statistics used to test the significance of differences between two or more groups. (Deno, 2006) was used to analyze specific objective number one (1), two (2), and three in that the benefits of improved modern hives (Langstroth) versus those of traditional bee hives (log

hives) was compared on the basis of differences in the amount of honey produced for the last five years in the region and the income generated from the two categories of hives and the amount of rainfall received across the years versus maize and beans harvested. In objective number three the variation of rainfall for the last 8 years was examined and the implication on maize and beans production in the region.

The differences in the quantities of maize and beans produced versus rainfall variations across the eight years period was analyzed. The Chi-square test was used to test the three hypotheses. While chi-square does have limitations such as the test does not give much information about the strength of the relationship, it has a number of advantages that qualified its usage in this study. One of the largest strengths of chi-square is that it is easier to compute than some statistics. Also it can be used with data that has been measured on a nominal (categorical) scale. It can also be used to see if there is a "difference" between two or more groups of participants for example in this case one is able to see the difference in maize and beans production when rainfall amount is high and when its low, in honey production from the two different types of hives and income generated from the traditional bee hives and modern bee hives. Strength is that chi-square makes no assumptions about the distribution of the population. Other statistics assume certain characteristics about the distribution of the population such as normality.

The data was presented in table forms, and graphical representations. The results from the study were packaged into user friendly materials such as multimedia CD and hardcopies.

### 3.8 Study Limitations

The region was quite expansive and the bee keeping groups in these regions were far apart hence it took close to a month to collect the data. The data was collected in the month of March 2013 and the county was totally flooded hence communication and transport was a

challenge. This delayed the data collection process hence delay in the completion of the study project. Getting information from district agricultural officers was cumbersome due to their busy schedule. Lack of data records on honey production and income generated by the farmers for the last five years. The fact that bees stings human beings and it has also bee documented that they kill livestock some farmers in the region discourage apiculture.

Research assistants and enumerators came in handy in helping on data collections in the regions. The floods subsided in the month of April this helped in enhancing the movements. To get the information from the agricultural officers. Appointments were done and follow up for the ones that bounced were done. The records for individual farmers' production for the last five years and the income generated from them were gotten from the records of the beekeeping groups they belong to. This took time because a large number of individual farmers were interviewed. The issue of bees stinging human beings and livestock was a hard one to manage but farmers were advised to fence the apiaries and to install the hives away from the cattle sheds.

## CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION

### 4.1 Introduction

The chapter presents the data analysis, presentation and interpretation on the findings of viability of adoption of bee farming an adaptation strategy to rainfall variability on food insecurity effect. The data collected was collated and reports produced in form of descriptive tables and graphical representations.

### 4.2 Challenges Facing Bee Farming in Kitui.

**Table 4.1 Commonly Experienced challenges in the study region.**

| **Challenges** | **Total Number of farmers experiencing the problem** | **%** |
|---|---|---|
| • Deforestation activities in the area.<br>• .Burning of charcoal causing bees to abscond. | 120/195<br>110/195 | 61%<br>56% |
| • Low honey production due usage of traditional bee farming methods and equipments such as log hives.<br>. | 150/195 | 76% |
| • Lack of proper processing, packing and marketing methods.<br>• Lack of capital | 140/195<br>150/195 | 72%<br>76% |

There were a number of challenges facing bee farmers from the three sites of study. These challenges have hindered bee farming growth in the county of Kitui despite the fact that it is one of the oldest activities in the region according to this study. The production of honey is at a low level due to low knowledge in the industry and lack of capital to run the enterprise. This is a major challenge sited by over 70% of the farmers interviewed. Most of the people use KTBH and Traditional hives contributing to low quality & quantity of the honey produced. Production from KTBH & Traditional hives ranges between 3-5kg per hive per season while the few who have Langstroth produce about 20 kg per hive per season.

The harvesting should be two seasons per year which varies with the climatic variability notably rainfall variations in the area hence now a day's most of the harvesting is one season per year. The harvesting method used is traditional smoking resulting to low quality honey due to honey pollution by the excessive smoke. It also kills bees promoting absconding of bee colonies. The study noted harvesting from the traditional hives is done at night affecting honey quality. Those with Langstroth harvest anytime of the day giving high quality honey

Honey is processed locally using a bucket and a sieve for draining liquid honey from combs. Other people process it very poorly by mashing everything together including pollen, nectar, combs and larva reducing the quality of honey. Common mode of packaging in the area is use of plastic bottles. Glasses were reported to be bad in case of a break or a crack which could be very hazardous. Use of metallic containers was reported to be hazardous also in case of rust development. The community has no co-operative society for marketing of their honey but they have user groups instead. They serve a local market only since the demand of honey is too high with very low supply.

It was also noted that processing of the honey was done very poorly by mashing everything together including pollen, nectar, combs and larva reducing the quality of honey. These problems were cited by 72% of the farmers interviewed as note in Table 4.1 above. Variations in the climatic patterns have affected honey production due to variations in the flowering trends of nectar & pollen producing plants. Water demand was also noted to be a challenge due to perennial drought season in the region. Agro-chemicals usage is a major threat to honey production in some areas since farming is the primary activity of the area with bee keeping as a secondary activity.

The community has a challenge of keeping the colonies due to the high rate of absconding of colonies. Varoa mites were reported as the worst threat to the bees since it fed directly on the honey lowering the production. Deforestation was also noted to be a big threat in the area due to high rate of charcoal burning. This has reduced the number of pollen & nectar producing plants lowering the honey quantity produced in the County. As noted from the table 4.1 above, 56% of the farmers interviewed lamented of this challenge.

> Many farmers were willing to adopt the modern Langstroth bee hives but as noted 76% of them had lack of capital as a major challenge hence they had stack with the traditional bee farming methods. Stealing of the honey from the hives was also noted as a challenge. The common disasters such as stings and injuries associated with bees were also noted as major challenges. One man in one of the villages in Mutomo village was reported to have died recently from bee stings and injury. Another report was given of five goats being stung to death, an event that provoked the owner to kill all the bees with hot water.

Swarming bees were also reported as a threat to the children due to the poor apiary siting.

### 4.3 Effect of Rainfall variability on food production

In addressing objective one of the study, the findings were as follows. According to district agricultural officers in the three administrative regions of Kitui County that is Mutomo, Kitui central and Kitui Yalta rainfall has been very unreliable for the last eight years.(see Figure 4.1) This has made it difficult for the communities living here to depend on agricultural production of maize and beans hence need for an alternative source of livelihood. The average annual production for maize and beans in the county according to District development plan of 2004/2008 was way much below the quantity that may be needed to feed the population hence the need to adopt improved bee farming methods.

**Table 4.2 average Annual production of maize and bans**

| Type of maize and beans | Quantity in Metric Tonnes(MT) | Demanded amount for consumption in Metric Tonnes(MT) | Size of land in hectares |
|---|---|---|---|
| Maize | 12.420 | 52589 | 70 000 |
| Beans | 5.400 | 3000 | 23640 |

**Source: Field data 2013**

**Table .4.3 showing the Average amount of rainfall received for the last eight years and the total production of maize and beans during that period from the three areas of study.**

**Table 4.3 Average rainfall Vs. maize and beans production in Kitui Yatta ,Kitui Central and Mutomo.**

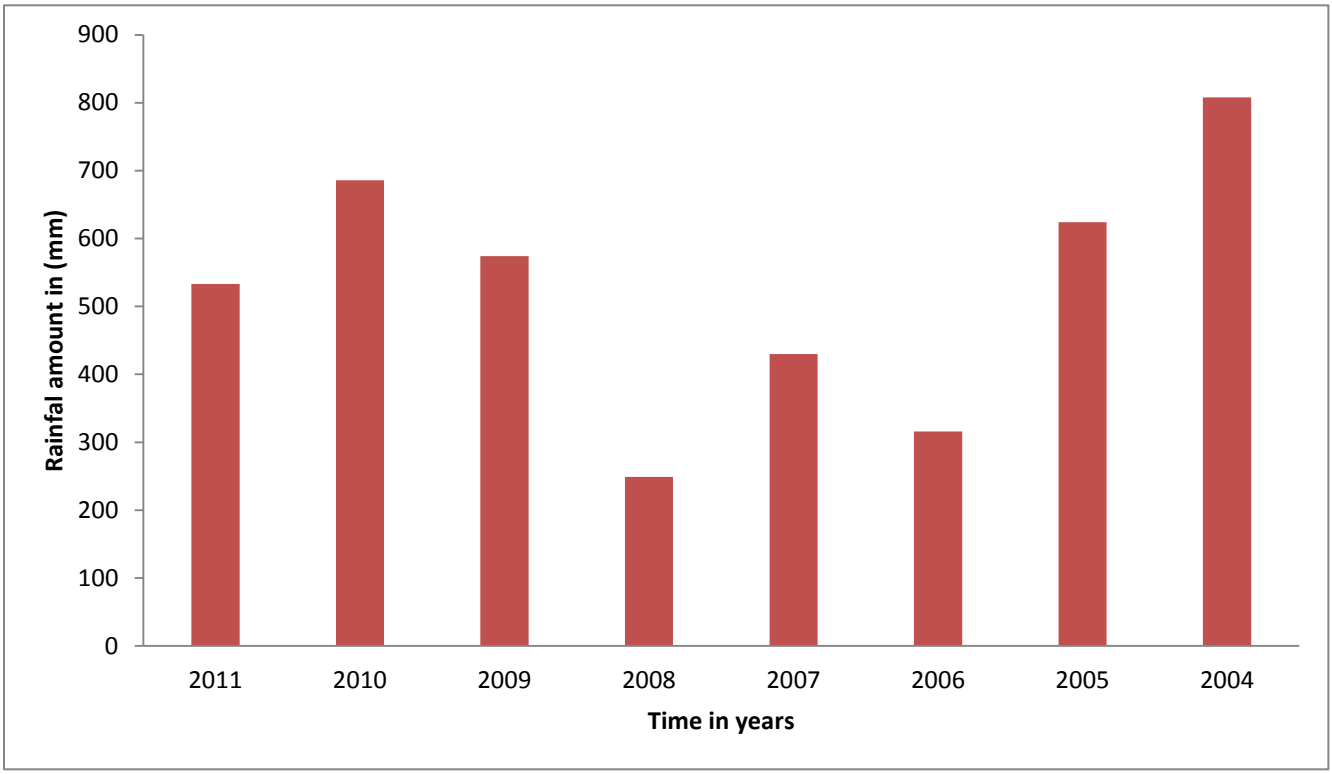
| Year | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|---|---|---|
| Rainfall(mm) | 533 | 686 | 574 | 249 | 430 | 316 | 624 | 808 |
| Maize production in (00's )kgs | 10,000 | 12000 | 11000 | 6000 | 9000 | 7000 | 11000 | 14000 |
| Beans production in (00's)kgs | 20 | 30 | 25 | 0 | 0 | 0 | 27 | 50 |

**Field data: 2013**

According to the district agricultural officer in Mutomo and Kitui Central, Agricultural development in Kitui just as in other marginal lands is problematic due to low rainfall. Crop production as noted from the Table 4.4above was unevenly distributed with high yields during the years the rainfall amount was and vice versa when the rainfall was low. The county has been experiencing crop failure of almost 90% thus rendering the majority of people in the district +destitute and in dire need of food. The people of Kitui are engaged in various economic activities for their livelihoods. Whereas the majority is engaged in agriculture, livestock keeping still remains the income earner in the district and especially in the drier area.

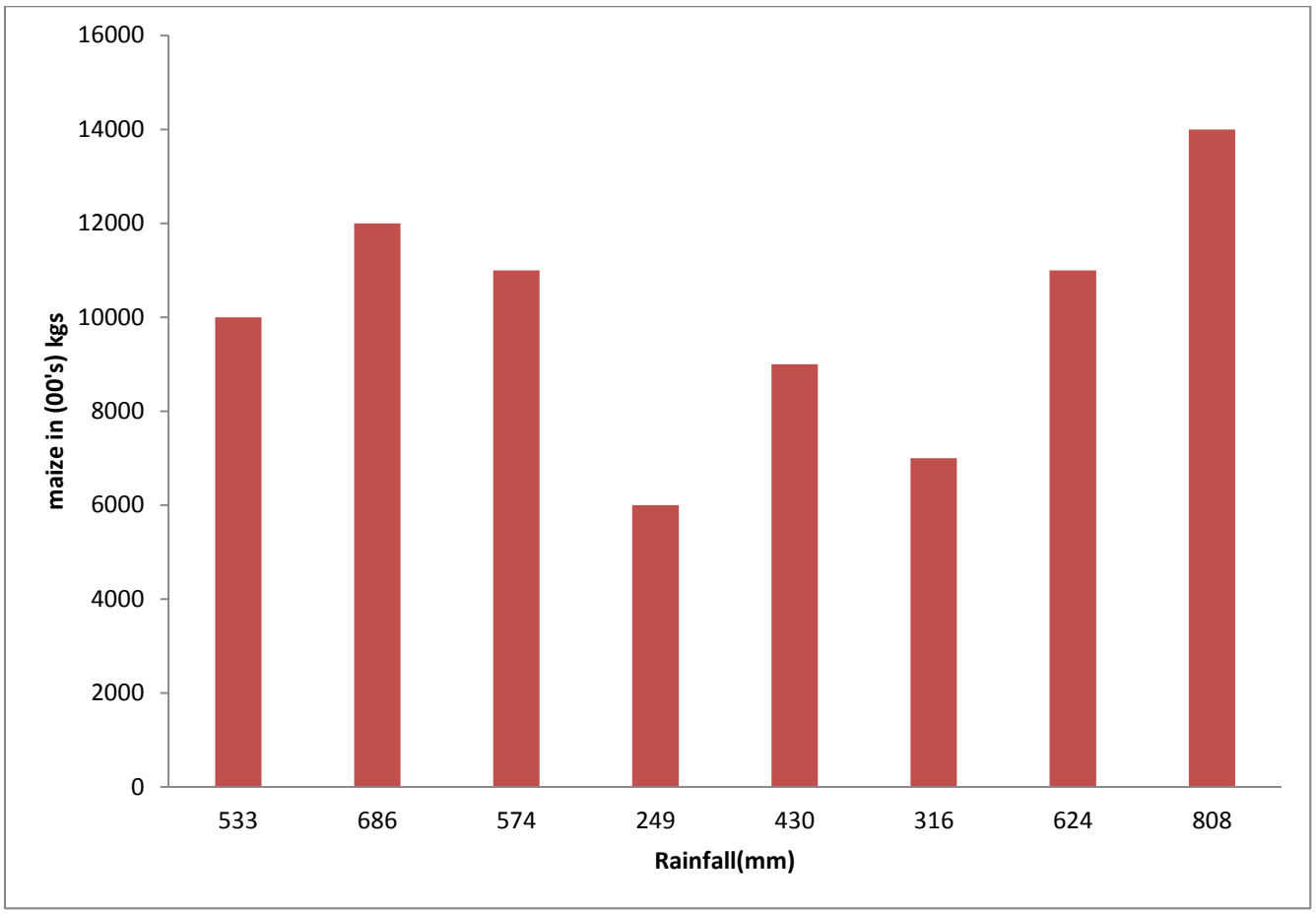
People practice mixed farming because livestock acts as a buffer during poor rain seasons. Most of what is harvested is consumed domestically, and there is hardly any net surplus. The county is famine-prone; whatever is produced has to be supplemented with external food aid to avert starvation. Charcoal burning and sales has gone up considerably and this has resulted to deforestation.

**Figure 4.1Graph showing rainfal variations over the years**



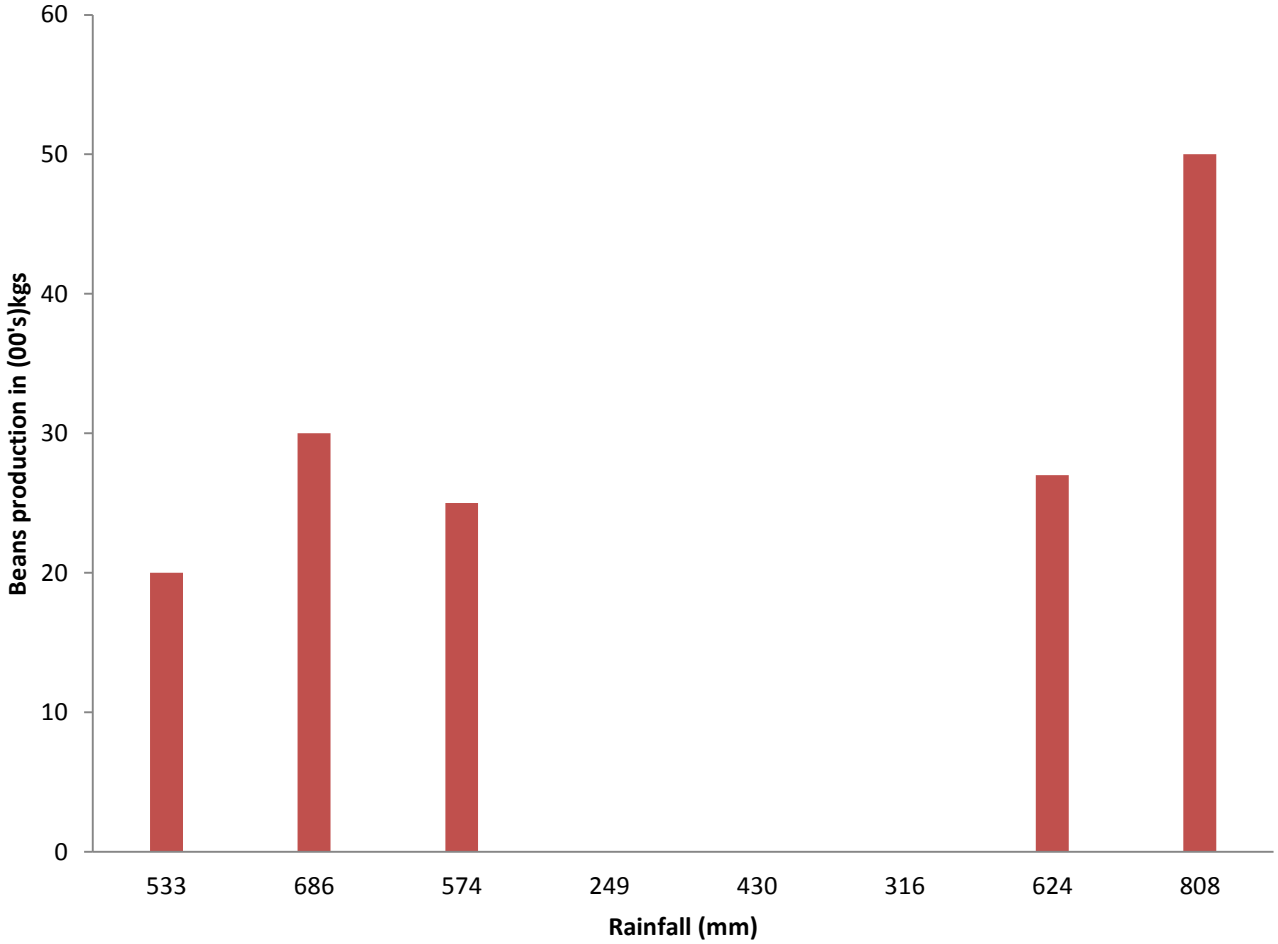

Source: Field data 2013

**Figure 4.2: Graph showing maize production (00's)kgs vs Rainfall (mm)received.**




**Source: Field dataScale on y axis; 1:2000**

**Figure: 4:3 Beans production with rainfall**




**Field data:2013**

Crop production requires enough rainfall .From the graphs above its very clear that the increase in rainfall amounts led to the increase in maize and beans production. A certain crop grown in a sunny and hot climate needs more water per day than the same crop grown in a cloudy and cooler climate. This could explain the reason why in the years 2006 to 2008 the production of beans was insignificant in the region. There are, however, apart from sunshine and temperature, other climatic factors which influence the crop water need. These factors are humidity and wind speed. When it is dry, the crop water needs are higher than when it is humid. In windy climates, the crops will use more water than in calm climates.

The highest crop water needs are thus found in areas which are hot, dry, windy and sunny. The lowest values are found when it is cool, humid and cloudy with little or no wind. (FAO Irrigation and Drainage Paper 24 "Crop Water Requirements).From the figures 4.2 and 4.3 above

It is clear that the crops requires higher amount of water. This is evidenced by maize and beans production in the three study regions, perhaps due to the reason given by(FAO Irrigation and Drainage Paper 24 "Crop Water Requirements)

## CHI-SQUARE ANALYSIS

The study used chi square to test the null hypothesis. Under chi-square, if the calculated value is greater than the value at the significant level alpha (α) 0.05 then, the null hypothesis is rejected

**Table 4.4:1 Rainfall (mm) Maize production in KGS**

| **Chi-square test** | **Value** | Df |
|---|---|---|
| Pearson Chi-Square | 6.935 | 1 |

**Table 4.4.2: Rainfall (mm) * Beans production**

| **Chi-square test** | **Value** | **df** |
|---|---|---|
| Pearson chi square | **6.932** | **1** |

Chi-square analysis of the differences between the maize and beans production and rainfall amount across the years in the three regions at 0.05 levels was significant. Pearson correlation chi square-value for the maize and rainfall (mm) was 6.935 and that of rainfall (mm) and beans was 6.932.This indicates that the Pearson correlation chi square values were greater than the chi square value at the significant level of 0.05 (df, 1) which is 3.84, hence the hypothesis that There was no significant relationship on the amount of rainfall received and the quantity of maize and

beans produced was rejected. This implies that there was a significant relationship between the rainfall amount and maize and beans production. This is evidenced from the graphical representation in that when the rainfall amount was high then the maize and beans production too was high and vice versa. The patterns of annual rainfall variability and fluctuations in maize and beans production were presented graphically as shown in figure 4.1 and 4.2 above in order to gain a better insight into rainfall-crop production relationships. It is important to note here that consideration of production of maize and beans will be more appropriate than yield in investigating the influence of rainfall variability, because the latter can miss out impacts of extreme climatic conditions involving severe droughts that might lead to abandonment of planted areas prior to harvest.

As can be seen from the results in Table 4.6, households experiencing high annual rainfall variability are more likely to have a lower value of riskiness corresponding to their crop production. In particular, the coefficient for annual rainfall variability indicates that if the coefficient of variation decreases by 1 unit, the riskiness of the overall crop production decreases by 4.3067. Similarly, negative and significant coefficient of the coefficient of variation of annual rainfall indicates that lower levels of rainfall variability lead to lower crop production.

In food crop production, rainfall and temperature serve as the most important determinant factors in which the amount, duration and distribution pattern of rainfall either directly or indirectly just as temperature increase or decrease affect the types of crop grown, the farming systems, the growing season and the farm operation. The shift from agriculture to bee farming can thus be due to the fact that family members are the most important source of agricultural labor, and the impact of unreliable rainfall, hence farmers will adopt bee farming as a strategy.

Overall, these results are in line with the findings by Haile (2007) and Dercon et al. (1996), in that crop choice is highly responsive to risk environments in Africa. Comparing our results with Haile (2007), the coefficients of rainfall are much higher, perhaps due to the fact that Haile's analysis does not take into account the intercrop dependencies the way our study does. Although several studies have assessed the link between weather variability (and change) and crop productivity, their analyses have been limited to assessment of single crops, which leaves out the intercropping effects on a farm.

The study findings that agricultural cereal production at a farm level is highly responsive to rainfall variability and that the choice of high risk-high return crops is hampered by weather uncertainty have important policy implications. First, development initiatives aimed at encouraging need to focus on boosting modern bee farming techniques that can enhance poverty eradication in Kitui County. Furthermore, given the impacts of rainfall variability on small holder agriculture, bee farming can effectively target areas where rainfall patterns are uncertain.

The essence of crop production is supposed to increase expected yield and the overall income of households. However, actually quantifying to what extent riskiness of crops leads to a gain in productivity (and to what extent that gain is compromised by weather uncertainty) merits further analysis. Furthermore, there will be costs associated with different selection, if households decide to change their crop composition in response to weather variability or other reasons, such as acquiring new seeds, learning new techniques, and adapting their plots and cultivation methods to new crops. This explains the importance of bee farming since it's just improving from tradition way of farming to the modern.

### 4.4 Feasibility of improved bee farming (modern hives) as an adaptation strategy to rainfall variability effects on food insecurity menace

The frequency distribution in table shows that a good number (54%) of middle aged farmers (21-40 years) are involved in modern bee keeping while a large proportion of traditional bee keepers (62%) constitute the aging population. We can deduce that the gradual exposure of modern techniques of bee keeping to the young influence their choice of the method while the aging population remained loyal to the method they long understood.

**Table 4.5 distribution of modern and traditional bee farming across groups**

| **Variables** | Modern hives | | Traditional Hives | |
|---|---|---|---|---|
| | No of people | Frequency% | No of people | Frequency % |
| **AGE(years)** | | | | |
| 0-20 | 10 | 15 | 20 | 15 |
| 21-40 | 35 | 54 | 30 | 23 |
| 41 and above | 20 | 31 | 80 | 62 |
| **Gender** | | | | |
| Male | 40 | 62 | 90 | 69 |
| Female | 25 | 38 | 40 | 31 |
| **Education level** | | | | |
| No school | 15 | 23 | 65 | 50 |
| Primary | 15 | 23 | 40 | 31 |
| Secondary | 28 | 43 | 25 | 19 |
| Tertiary | 7 | 11 | | |
| **Marital status** | | | | |

| | | | | |
|---|---|---|---|---|
| Single | 15 | 23 | 10 | 8 |
| Married | 40 | 62 | 80 | 61 |
| Divorced | 10 | 15 | 20 | 15 |
| Widower | - | - | 10 | 8 |
| Widowed | - | - | 10 | 8 |

The gender distribution showed that the practice of bee keeping is somewhat gender sensitive given the larger (62% and 69%) proportion of male than females (38 and 31%) bee keepers who practised both modern and tradition bee keeping respectively. This shows that majority of the people generally are practicing traditional bee farming. Bee keepers without basic education constitute majority (50%) of bee keepers in the traditional bee keeping system. This can be adduced to the simplicity of bee keeping material which is locally available. The need for basic educational knowledge so as to learn the intricacy of modern bee keeping was evidence in high proportion of secondary school leavers (43%) who practised the modern bee keeping. Those who had tertiary education were not seen to be actively in bee farming. Only 11% of the sample population was seen to practice bee farming. This could be probably due to the fact that they have other sources of livelihood hence bee farming is not a priority. The distribution of bee keepers according to marital status revealed that the largest proportion (50%) of bee keepers both modern and traditional is married this could be as a result of available labor even in the apiaries.

It's evident from the study that majority of the farmers in Kitui County who are practicing g bee farming are using traditional logs bee hives. This is a great challenge as it was noted from the study in that the quantity of the honey produced was low and of poor quality as compared to modern bee hives in this case Lang troth and KTBH. The most notable trend in the three areas of study from the different bee keeping groups was that farmers who had adopted

modern hives were having few log hives and them that were using the traditional hives were having one or very few modern hives indeed.

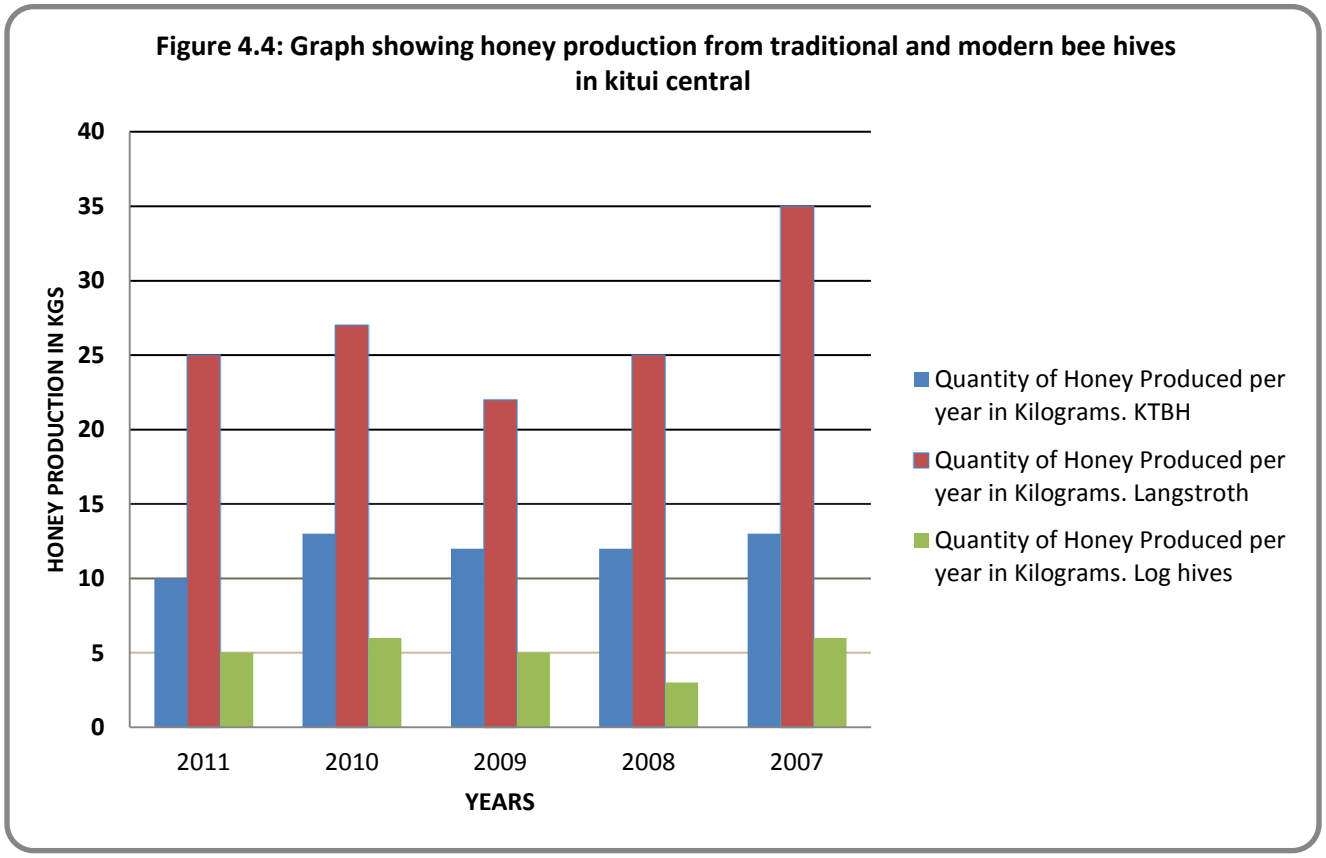
The tables 4.8, 4.9 and 4.10 below shows the average production of honey from key informants of different bee keeping groups from Kitui Yatta, Mutomo, Kitui central and graphical representation.

**Table 4.6 average honey production in Kitui Yatta**

| | Types of Bee hives | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|
| Quantity of Honey Produced per year in Kilograms. | KTBH | 10 | 13 | 12 | 12 | 13 |
| | LANGSTROTH | 25 | 27 | 22 | 25 | 35 |
| | LOH HIVES | 5 | 6 | 5 | 3 | 6 |
| | | | | | | |

**Source: field data 2013**

**Figure 4.4: Graph showing honey production from traditional and modern bee hives in kitui central**



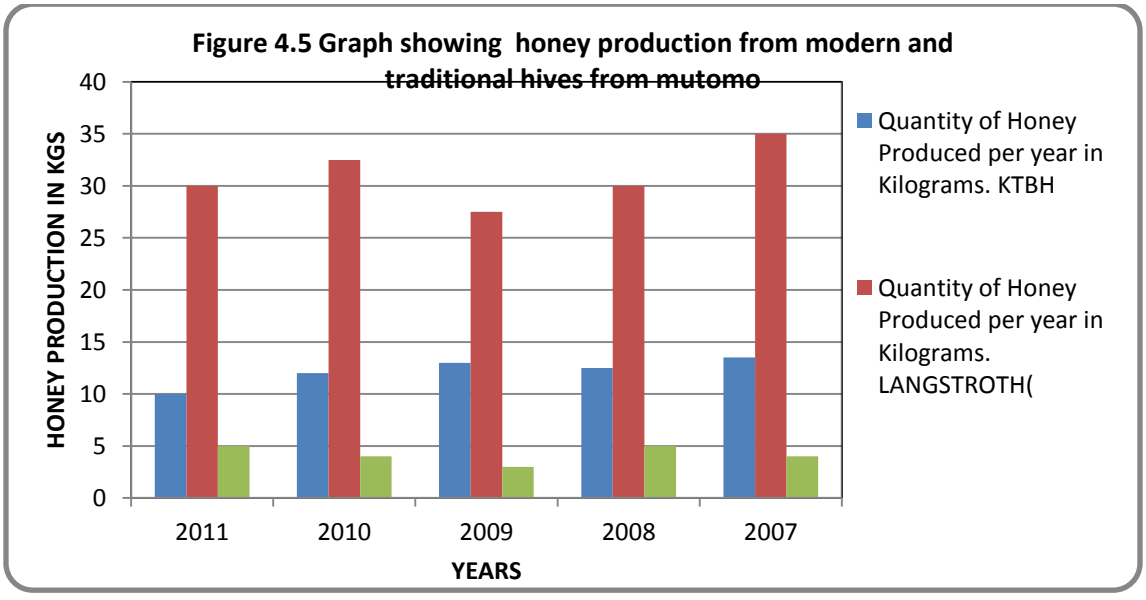

**Source:field data 2013**

**Table 4.7 Average honey production in Mutomo**

| | Types of Bee hives | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|
| **Quantity of Honey Produced per year in Kilograms.** | KTBH | 10 | 12 | 13 | 12.5 | 13.5 |
| | LANGSTROTH( | 30 | 32.5 | 27.5 | 30 | 35 |
| | LOG HIVES(15) | 5 | 4 | 3 | 5 | 4 |

**Source: field data 2013**

**Figure 4.5 Graph showing honey production from modern and traditional hives from mutomo**




**Source: Field data 201**

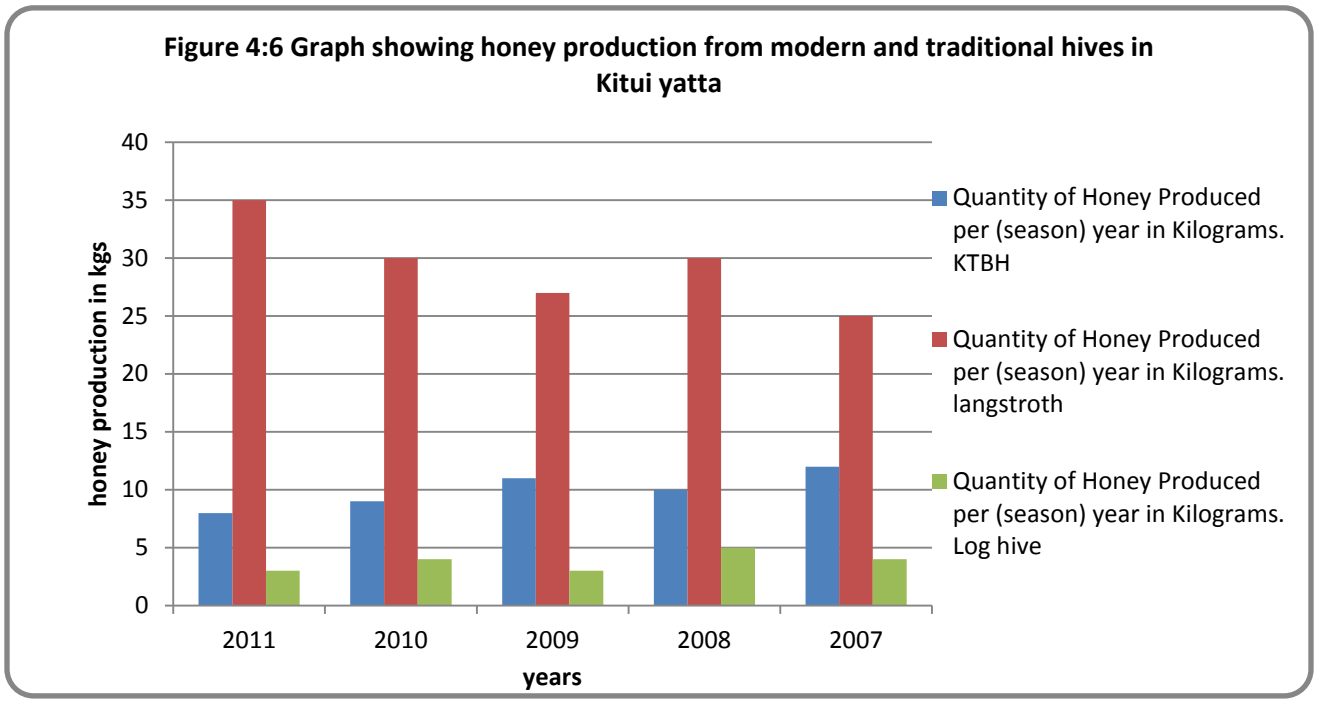
**Table 4.8** Average honey production in Kitui Yatta

| | Types of Bee hives | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|
| Quantity of Honey Produced per (season) year in Kilograms. | KTBH | 8 | 9 | 11 | 10 | 12 |
| | LANGSTROTH | 35 | 30 | 27 | 30 | 25 |
| | Log hive | 3 | 4 | 3 | 5 | 4 |
| | | | | | | |

**Source: Field data 2013**

Average Honey production from Langstroth modern of Wiwanoi was Kitungulu beekeeping group in Kitui Yatta per annum.

**Figure 4:6 Graph showing honey production from modern and traditional hives in Kitui yatta**




**Source: Field data 2013**

The amount of honey produced from traditional log hives was less compared to the honey produced from the modern hives. On average a traditional log hive produces an average of 5kg of honey per season and the KTBH produces an average of 10 kg per season. The farmers who have adopted the modern Langstroth bee hive produce an average of 25 kilograms of honey per season. This was depicted in the three regions of study among the farmers of the bee keeping groups that were interviewed. This could explain the reason why bee farming despite the fact that it has been practised in Kitui for so many years it has not developed hence it's not a fully fletched source of livelihood. This is because as noted 62% of the people interviewed are using traditional log hives hence low production of honey.

**Table 4.13 Chi-square Analysis of the Relationship between modern (Langstroth and KTBH) and traditional (log) bee hives**

**Table 4.9 chi square analyses on honey produced from the modern and tradition bee hives**

| Chi-square test | Value | Df |
|---|---|---|
| Pearson Chi-Square | **4.92** | 1 |

**Source: Field data**

Chi-square analysis of the Relationship between modern (Langstroth and KTBH) and traditional bee hives at 0.05 level was significant. Pearson chi square-value was 4.92 .This means that the Pearson chi square value is greater than the chi square value at the significant level of 0.05,(df,1) which is 3.841, hence the hypothesis, that there is no significant difference in quantity of honey produced from the modern hives and that produced from the traditional hives was rejected. This implies that modern bee farming techniques can provide advantages to create

higher yields for farmers. Modern beekeeping also includes production of beeswax, bee collected pollen, bee venom, royal jelly, propolis, as also of package bees, queen bees and nucleus colonies. All these are possible only with a proper management of bees, utilizing the local plant resources and adapting to the local climatic conditions. This is not the case in Kitui since only honey is harvested for commercial purposes.

Modern beekeeping makes heavy use of beekeeping equipment and honey processing plant. This results in high efficiency and also ensures the quality of the processed honey. Given that seasonal management of bee colonies varies in different parts of the country, modern techniques can thus provide farmers with special management techniques like queen rearing, migration for honey production or for colony multiplication, which the beekeeper takes up after he gains sufficient knowledge and experience in handling bee colonies. If fully adopted modern bee farming will definitely be a good adaptation strategy to rainfall variability effects on food security in the arid and semi-arid regions. This is because it will provide a reliable source of livelihood since as shown by this study agriculture cannot be depended upon any more.

## 4.5 Income generated from the honey and other bee products from both the traditional and modern bee hives

**The tables 4.10,4.11and 4.12, below shows the income generated from the three types of hives** by bee keeping groups from Mutomo,Kitui central and Kitui Yatta.

**Income in Ksh. generated from selling honey and bee products (wax) from different types of bee hives.**

**Table 4.10 income of Nduundune bee keeping group Mutomo**

| Year/Income In Ksh. | 2011 Ave Total income | 2010 Ave total. income | 2009 Ave. total income | 2008 Ave. total income 2009 | 2007 Ave. total come | Average. No of hives | Average. Total income for the 5 yrs. |
|---|---|---|---|---|---|---|---|
| **Log hives** | | | | | | | |
| **Honey** | 1800 | 2400 | 2200 | 1850 | 2450 | **8** | 2140 |
| **Wax** | Nil | Nil | Nil | Nil | Nil | **Nil** | |
| **KTBH** | | | | | | | |
| **Honey** | 3200 | 3600 | 3800 | 4000 | 4400 | 5 | 3800 |
| **Wax** | | | | | | | |
| **Lang-stroth** | | | | | | | |
| **Honey** | | | | | | | 14800 |
| **Wax** | 12000 | 15000 | 16000 | 17000 | 14000 | 3 | |

Source: Field Data 2013

**Income in Ksh. generated from selling honey and bee products (wax) from different types of bee hives per annum**

**Table 4.11 Income generated by farmers of wiwanoi wa kitungulu bee keepers Kitui Yatta**

| **Year/Income In Ksh.** | **2011 Average Total income** | 2010 Average Total income | **2009 Ave.total income** | **2008 Ave.total income** | **2007 Ave.total income** | **Ave no. of hives** | **Ave.income For the five years** |
|---|---|---|---|---|---|---|---|
| **Log hives** | | | | | | | |
| **Honey** | 2800 | 3000 | 3600 | 4000 | 4200 | 14 | 3520 |
| **Wax** | Nil | Nil | Nil | Nil | Nil | | |
| **KTBH** | | | | | | | |
| **Honey** | 3600 | 5000 | 4800 | 5000 | 4600 | 6 | 4600 |
| **Wax** | Nil | Nil | Nil | Nil | Nil | | |
| **Lang-stroth** | | | | | | | |
| **Honey** | 20000 | 18000 | 21000 | 18000 | 22000 | 4 | 19800 |
| **Wax** | Nil | Nil | nil | Nil | Nil | | |

**Source: Field Data 2013**

**Income in Ksh. generated from selling honey and bee products (wax) from different types of bee hives per annum**

**Table 4.12: Income generated by farmers of manzuki bee keeping groups of Kitui Yatta**

| Year/Income In Ksh. | 2011 Total income | 2010 Ave.Total income | 2009 Ave.Total income | 2008 Ave.Total income | 2007 Ave.Total income | Ave. No of hives | Average incor For the five ye |
|---|---|---|---|---|---|---|---|
| **Log hives** | | | | | | | |
| **Honey** | 3000 | 3000 | 2400 | 4000 | 3600 | 12 | 3200 |
| **Wax** | NIL | NIL | NIL | NIL | NIL | | |
| **KTBH** | | | | | | | 4500 |
| **Honey** | 5000 | 4600 | 3800 | 5200 | 3900 | 7 | |
| **Wax** | Nil | Nil | nil | Nil | Nil | | |
| **Lang-stroth** | | | | | | | |
| **Honey** | | | | | | | 16000 |
| **Wax** | 15000 | 16000 | 14000 | 18000 | 17000 | 3 | |
| | Nil | Nil | Nil | Nil | Nil | | |

**Source: Field Data 2013**

From the table s above and the summary table below it is very clear that only the farmers who are using modern bee hives Langstroth are able to harvest a substantial amount of honey hence they are able to sell some to earn some income

**Summary table 4.15** showing the average income generated per individual farmer of different bee keeping groups from the three regions of study of Kitui County

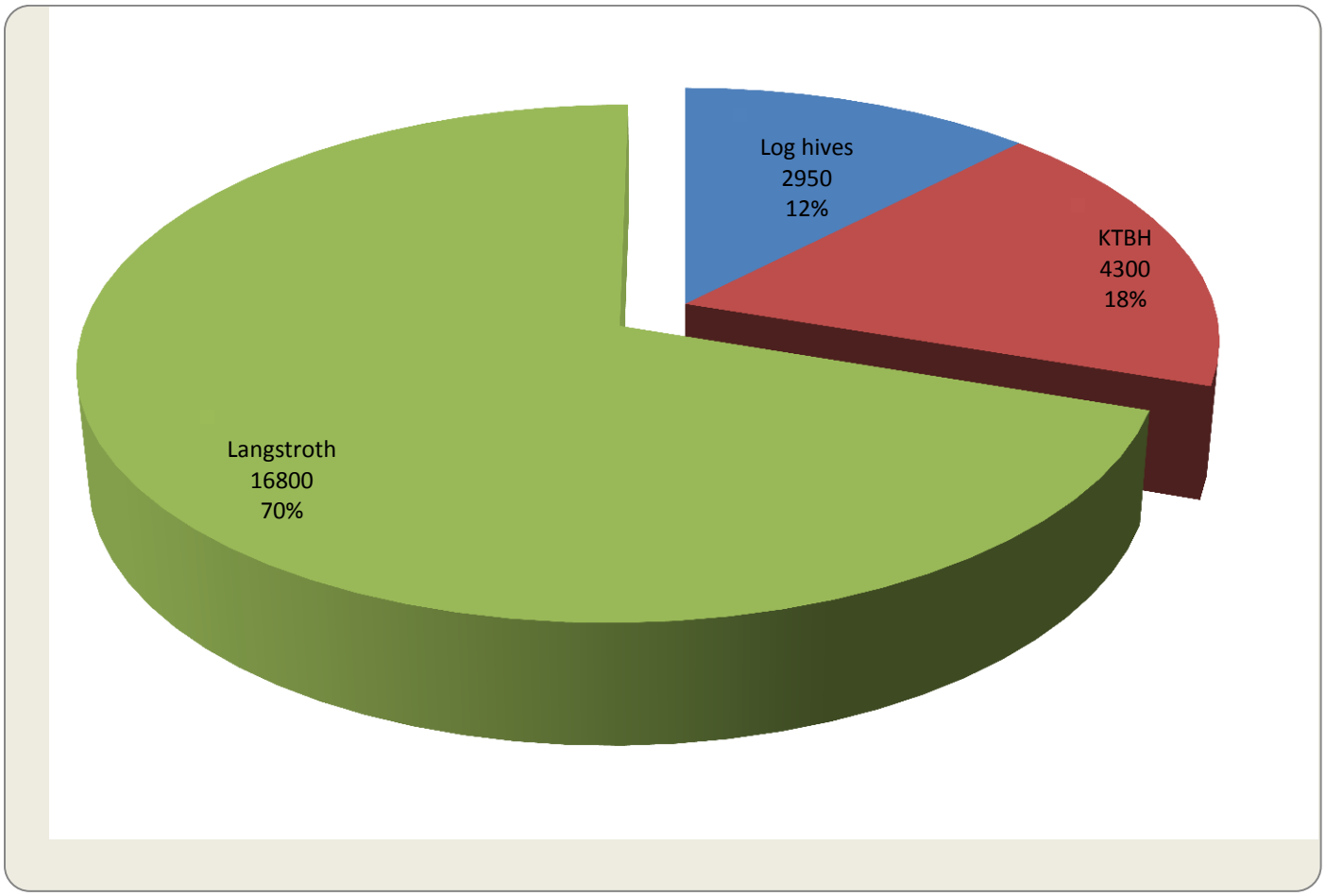
**Table 4.13 summary of average income from the study regions**

| Type of hive | Average no of hives | Average income generated from the three regions of study |
|---|---|---|
| Log hives | 9 | 2950 |
| KTBH | 6 | 4300 |
| Langstroth | 3 | 16800 |

Source: field data, 2013

The study shows that for the period between 2007-2011, the farmers who were interviewed from the region of study i.e., Mutomo Kitui Yatta and Kitui central from the different bee keeping groups made an average of 2950 ksh per year from an average of 9 log hives.4300 ksh from KTBH with an average of 6 bee hives and 16800 ksh from the Langstroth bee hives. This was after deducting all the expenses including setting up of the apiaries. The challenge again was the fact that in most cases they harvest season was only once per annum due to the challenges already mentioned.

**FIGURE 4:7 PIE CHART SHOWING AVERAGE INCOME GENERATED FROM THE THREE TYPES OF HIVES IN THE STUDY AREA**




**Source: field data 2013**

Langstroth hives, after getting the average income of all the interviewees using different types of the hives for five years in the three regions, had the biggest share of 70%.KTBH had 18% and the traditional log hives had 12 %.This was arrived at by getting the average number of hives each farmer had as shown in the **Table 4.13** above. It is very clear that Langstroth bee hives will offer the best alternative in adopting bee farming as an adaptation strategy to rainfall variability effect on food insecurity menace. This will not only provide an alternative source of

livelihood but create employment to the ever growing population in the region and other arid and semi-arid regions in the country.

### 4.5.1 Chi Square Analysis on the Variations of the Income Generated from the Traditional bee hives and modern bee hives.

**Table 4.14 chi square analysis on income generated**

| Chi-square test | Value | df |
|---|---|---|
| Pearson Chi-Square | **5.41** | **1** |

This test shows you that there is a` significant difference between the income generated from the traditional bee hives (log hives) .The Pearson chi square value was 5.41 at( Df,1), This value is greater than the chi square at the significant level 0.05 which is 3.841 .This means that the null hypothesis that there is no significant difference in the amount of income generated from the modern hives and traditional hives was rejected. The implication is that there is a significant difference in the income generated from the modern bee hives and that generated from traditional bee hives. From the results, is clear that while traditional bee farming methods are still in use and relevant to the community, the income generated from the traditional bee hives is very low as compared to that generated from modern bee hives (Langstroth).

Nearly all of the beekeepers who took part in this study are conscious of the benefits of keeping up to date with the latest husbandry advice. This openness to new ideas is striking and is driven by a widespread awareness. The beekeepers interviewed for this study do not have a strong sense that there is such a thing as ‘good practice’ in beekeeping. Therefore, introducing

modern techniques in bee farming can be one effective way of influencing beekeepers to adopt better husbandry of their bees. Compared to crop production which as shown by the study cannot be relied upon due to rainfall variability, the modern bee farmer may thus benefit from improved production risk management by eliminating concerns about significant pest damage; investing money on buying seeds and other inputs then everything drying up.

### 4.6 The stakeholders working along the honey value chain in Kenya

**Table 4.15 stakeholders working in honey value chain in Kenya**

| Name of Stakeholder | **Level of operation (National, Regional, County)** | **Role With Respect To value chain** | **Available information** | **Contacts: (Location, Phone, Person)** |
|---|---|---|---|---|
| **Kenya Honey Council** | National | Production, Promotion Branding Placement | An umbrella body representing different stakeholders in the Kenya beekeeping sector. | - P.O. Box 271-00606 - Sarit Centre, Nairobi Telephone: (254) (0)20 4183120 |
| National Beekeeping Station | National | Technical and regulatory role (Production, Processing, Marketing) | Check out for its library, bee equipment, and advice. | Apiculture and Emerging Livestock Division Ministry of Livestock and Fisheries Development Lenana P.O. Box 34188-00100 Nairobi Telephone: (254) (0)20 564302 |
| **Honey Care Africa** | Regional | Processing, Promotion Advertisement Branding Packaging | Trains in commercial bee keeping, Purchase, package and market honey and beeswax. | P.O BOX 24487-00502 Jamhuri park Muringa avenue -Nairobi Tel/Fax: (254)203874448/50 |

| | | | | |
|---|---|---|---|---|
| Bee Support | International | Promotion | Undertakes promotion of beekeeping for development. | Email: micha_el@dds.nl |
| African Union | International | | Has interesting collection of beekeeping books in its library. | Maendeleo ya Wanawake House – Nairobi |
| Christian aid international | international | Value addition | Christian Aid is a charity and company limited by guarantee registered in England and Wales: | England and Wales: 35 Lower Marsh, London SE1 7RL. AACC Compound, P. O. Box 138644- 00800, Westlands, Nairobi, Kenya. Telephone: +254 20 444 8641 |
| **Bees Abroad** | International | Value Addition | British based beekeeping development organization that Provides education and technical advice in beekeeping and suitable business skills in Africa and elsewhere. | P.O. BOX 2058, Thornbury Bristol BS35 9AF Telephone:0117 230 0231 |
| **African Beekeepers Limited - Kenya** | National | Processing, Promotion | Deals with bee products and supplying inputs such as beehives, suits, smokers and extraction equipment. | Go-down, Road A, Industrial Area, P. O. Box 3752 - 00506, Nairobi, Kenya. **Tel:** +254 020 551 834, **Cell:** +254 722 700 226, **E-mail:**bees@africanbeekeepers.co.k |
| | | | | |
| ICIPE | National | Production | Has a | P.O. Box 30772-00100 - Nairobi |

| | | | | |
|---|---|---|---|---|
| (International Centre for Insect Physiology and Ecology) | | Value Addition | commercial insect section dealing with beekeeping | Telephone: (254) (0)20 8632000 / Fax: (254) (0)20 8632001/8632002 |
| General Plastics Limited | National | Value Addition Packaging | Supplies plastic jars and lids for packing honey. | P.O. Box 10032 - Nairobi Industrial Area near Hillock Inn Telephone: (254) (0)20 530032/3/4/5 |
| Baraka Agricultural College - | International -East Africa | Advertisement Production Processing Marketing | Contact for bee equipment, advice, training courses, honey, and beeswax marketing | P.O. Box 52 - Molo Telephone: (254) (0)51 721091/ Email: baraka@sustainableag.org |
| Ruai Beekeeping Cooperative Society | National | Advertisement | Collective marketing of bee products in Kenya. It markets up to 8 tonnes of honey per year | P.O. Box 8 – Naru Moru |
| Self-Help Development International Kenya | Regional | Promotion | Currently promotes beekeeping in the Gilgil area | 2nd Floor, Catholic Diocese of Nakuru Building Stadium Road off Kenyatta Avenue Telephone: (254) (0)51 2212291 Email: kenya@shdi.org |
| Strengthening Informal Sector Training and Enterprise (SITE) | Regional | Promotion | Deals in training and support to beekeeping and bee equipment | Jabavu Road, Nairobi Telephone: (254) (0)20 2718155 |
| Catholic Diocese of Kitui | Regional | Production, | Used to Deal with training and supporting beekeeping in | P.O. Box 119-90200 Hospital Road; Kitui , Kenya Phone: +254 (044) 22844 Fax: +254 (044) 22675 |

| | | | | |
|---|---|---|---|---|
| | | | the region as a different source of livelihood. | E-Mail: info@dioceseofkitui.org |
| **Kitui Honey Refinery** | Regional | Processing | Processes of honey and create insights on the apiculture management | *Box 883-90200, Kitui*<br>Tel: +254204422866 |
| Kerio Valley Development Authority | Regional | Production, | Deals in training and support to beekeeping | *Managing Director*<br><br>*KVDA Plaza*<br>*Oloo street Eldoret*<br>*P.O.Box 2660 Eldoret 30100*<br>*Telephone:(053) 20 633661-4*<br>*Fax: (053) 20 63365*<br>*Email: info@kvda.go.ke*<br>*orkvda@kenyaweb.co* |

## STAKEHOLDERS FUNCTIONING AT DIFFERENT LEVELS OF HONEY VALUE CHAIN IN KENYA

**Table 4.16: levels of operation of the stakeholders**

| LEVEL OF OPERATION | STAKEHOLDERS | NUMBER | % |
|---|---|---|---|
| **International** | Christian aid international | **5** | **33%** |
| | Bees abroad | | |
| | Bee support | | |
| | African union | | |
| | Baraka agricultural college-east Africa | | |
| **National** | African beekeepers ltd Kenya | **5** | 33% |
| | ICIPE | | |
| | General plastics ltd | | |
| | Ruai Beekeeping co-p society | | |
| | Ministry of agriculture & livestock | | |
| **Regional** | Catholic diocese of Kitui | **5** | **33%** |
| | Kitui refinery | | |
| | Strengthening Informal sector Training and Enterprise(SITE) | | |
| | Self-development international Kenya | | |
| | Honey care Africa | | |
| | TOTAL | **15** | |

The Kenyan honey sector is constrained by a number of different factors that hold it back from achieving its potential. According to research conducted by Kenya honey council and Christian AID international in 2012 one issue regularly cited by market actors at the market forums was the lack of any coordination across the sector. This manifests itself in a number of problems and issues.

There is no mechanism for the generation and dissemination of market information. As a result market linkages are difficult to develop, transaction costs are high for market actors and the

development of business support services is constrained. Overall this has held back the development of the sector and limits investment at all levels.

-The sector lacks a unified voice and has limited ability to influence Government as a result. As a result institutional and policy constraints are difficult to tackle.

Since April, 2012, Kenya Honey Council has been engaged with Christian Aid as a facilitator, in an intensive stakeholder's participatory process which crystallized into the Kenya Honey Project. The aim of the initiative is to put in place market development interventions that contribute toward the development of an efficient, well run, thriving and growing honey sector that provides income and opportunities across the market chain. As shown in the **table 4.16** above, stakeholders at the international level, national level and regional level are well represented in Kenya with 33% representation at all levels. What is lacking is the mechanism for the generation and dissemination of market information that will go along creating market linkages between regional, national and international level.

As noted from the study, some of these institutions need to be strengthened for them to be fully effective. This is evidenced by Kitui refinery whose work in value addition in the region is not being felt because refining is a major challenge in the region. Catholic diocese of Kitui too is no longer vibrant as it used to be in promoting the sector and many of the farmers interviewed pointed out that bee farming was actually on the decline. Other honey products such as wax, propolis and combs are not so much considered as a source of income, hence the need of the stakeholder's intervention in enhancing modern bee farming.

# CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION

## 5.1 Introduction

This chapter is a summary of the findings, discussions, conclusions and recommendations on the adoption of bee farming as an adaptation strategy on rainfall variability effects on food in security among the vulnerable communities in Kenya.

### 5.1.1 Challenges Facing Bee Farming in Kitui County

Bee farming is experiencing challenges at all levels of value addition in the county of Kitui. This is why serious interventions need to be done to develop the sector in the region as an alternative source of livelihood. At production level the farmers need to be provided with capital and the necessary skills to adopt modern bee keeping methods. Improved harvesting methods and capital to buy the packaging materials too need to be provided. There needs to be put in place policies to ensure marketing of the honey from the region, at national level and even international levels. The challenge of advertisement too needs to be handled to add value to the hone from the region. If overcome then bee farming will very well stand out as a mitigating strategy to rainfall variability impact on food security in the region.

### 5.1.2 Effect of Rainfall variability onmaize and beans production

The study emanated from observations and concerns that Kenya has been experiencing a rapid decline in food security due to rainfall variability over the years (Kabubo-Mariara 2007). It considered Beekeeping (Apiculture) being a key enterprise that can improve food security, household incomes, and conservation of biological diversity leading to improved resilience from marginalized communities against negative impacts from rainfallvariability and extreme weather variability.

As noted in Table 4.4, 4.5 above, rainfall patterns have been very unreliable in Kitui**.** Prolonged droughts, resulting in more occurrences of dust storms that damage grasslands, seedlings and other crops, has made this region to depend on food aid for along a time, hence a call to strengthen other forms of livelihoods apart from agriculture.

For instance according to the district agricultural officer, in 2005, the average yield of maize was only 0.06T/ha while total cereal production was a paltry 6,661 metric tonnes as compared to the counties estimated annual demand of 82,839 metric tonnes. Consequently, Kitui relies heavily on food supplies from other districts to meet its food needs for the better part of the years

### 5.1.3 Feasibility of improved bee farming (modern hives) as an adaptation strategy to rainfall variability effect on food insecurity menace.

As noted in the study 62% of the bee farmers are above the age of 41 years and they are practicing traditional bee farming methods by the usage of log hives and only a small percentage are using the modern hives. This has made bee farming as noted not to develop in the region and actually start declining. This one as noted in chapter four is a major challenge to the quantity and the quality of the honey produced. Them that are below the age of 41 years a bigger percentage

54% have adopted the modern bee farming hives such as Langstroth and the output in terms of quantity and quality and income generated is higher.

Although not all in these bracket who are involved in apicuture.This justifies the reason as to why modern hives should be encouraged in bee farming. There are a number of environmental factors that support the industry in the regions. These include presence of Acacia plants which is a drought resistant plant, location of the study regions near the Tsavo national park which is a bee swarming route. These factors from the selected areas of study are generally common in the entire county. In conclusion from the study above bee farming as an alternative source of livelihood it's a cost effective undertaking in the region. Having deployed other strategies of water collection to ensure whole year round availability of water for the bees and the fact that there is the Presence of much pollen and nectar producing plants in the area the activity can be improved. The fact that the Soil of the area being an arid and semi-arid region is poor to support agricultural undertaking compounded by unreliable rainfall makes bee keeping as the only feasible undertaking.

### 5.1.4 Comparative analysis of the Income generated from the honey and other bee products from both the traditional and modern bee hives

The Pie chart on **Figure 4.6** in Chapter four above shows very clearly that modern hives (Langstroth) generated higher income, followed by KTBH and finally the traditional log hive. The Chi square analysis and test also justifies that modern hives in this case Langstroth generate higher income than KTBH and the traditional log hives. This shows that there is need of adopting modern bee farming as an alternative source of livelihood.

### 5.1.5 Role of stakeholders in the honey value chain addition analysis in Kenya.

There are basically three levels of stakeholders that play different roles as shown in table 4.20 above. At the national level there is the Kenya honey council which should act as the apex organization that can represent its interests and can drive market development and influence Government. There is a serious need for key actors to have a better understanding of the potential of the honey market and how it can be developed. This may include an understanding of how Government can collaborate in practical ways with market actors to drive market development. The Kenya honey council should constitute a major contribution to ensuring an increased commitment from Government to the funding of extension services and to ensure that market development efforts in the sector were aligned with devolved government systems. This will go a long way in enhancing bee farming activity in the region.

## 5.2 Conclusion

From the study it's very clear that rainfall cannot be relied upon in supporting agriculture in the county which as shown by the livelihood map, depends mostly on farming hence an alternative source of livelihood is being called for. Bee farming because of existence of arid and semi-arid trees such as acacia is feasible. Traditional bee farming which has been practised in the area for a long time cannot be relied upon anymore since its output as shown in the study is not able to provide a sustainable livelihood. There is a need to adopt modern bee farming methods and hives as shown in the study it yields sufficient honey and good income generation per year. Modern bee farming has not been embraced in the region but the few who have embraced are yielding good harvest.

As seen from the study there lacks proper coordination among the stakeholders in honey value addition chain analysis in Kenya. The Kenya honey council needs to put systems in place

to even provide market for the local farmers. There is a need of the stakeholders including the government providing trainings to the farmers on the modern beekeeping techniques.

There is also a need for financiers such as K-rep bank who used to fund bee farming projects in the regions in the last decade ,and others including the government to come on board again and help in managing the financial challenge which as shown by the study is a major challenge. In conclusion bee farming is a feasible project as an adaptation strategy to rainfall variability effects on food insecurity in arid and semi-arid regions in Kenya especially the county of Kitui.

**5.3 Recommendations**

There is a lot that's needs to be done to help in improving apiculture in arid and semi-arid regions in Kenya, especially Kitui County. Many farmers as noted from the study are using primitive traditional methods in honey production, processing and storage. The study recommends trainings organized on good apiculture practice i.e. good production, processing and storage methods. As it was noted from the study 62% of the bee farmers above the age of 41 years are using traditional hives, the study recommends farmers have Langstroth hives provided to them or have they trained on how to make their own Langstroth hives. This is because the output in these hives is higher. Get trainings on proper sitting of apiary to avoid disasters such as stings and injuries.

The study also recommends establishment of more water collection and conservation structures in order to the manage dry seasons. Planting of more indigenous bee plants around the apiaries will assist to avoid absconding of bees. Provision of more indigenous bee plants seedlings to the community can be done through initiating indigenous tree nursery. The study

also recommends fencing of the apiaries to keep of all the pests including human beings. There is a need to establish policies and laws against stealing of honey from the hives. Initiating some feeding measures for the bees during the dry season e.g. come up with feeding buckets containing sugary water and finally the study recommends establishment of good communication networks to inform the national market when honey is available in the area.

Bee sector in Kenya needs a central apex organization as noted earlier that can represent its interests and can drive market development and influence Government. The organization can also be responsible for ensuring that mechanisms exist for the generation and dissemination of market information. This organization in this case is the Kenya Honey Council. This organization would constitute a major contribution to ensuring an increased commitment from Government to the funding of extension services and to ensure that market development efforts in the sector were aligned with devolved government systems.

Capacity building programme for Kenya Honey Council which could include: Development of an organizational structure that allows two way feedback across the sector; development of a business model that promotes organizational sustainability; governance and management development; advocacy support and planning.

There is a need to develop information dissemination platforms this includes price and market linkage information to connect buyers and sellers and to enable producers to obtain optimal prices. Enterprise directories: that facilitates networking, collaboration and market linkage across the sector. Quality assurance information (e.g. certification schemes for equipment producers) that reduces transaction costs and enables provision of business support services.

### 5.3.1 Recommendations for further study

Although the study looked at the viability of adopting modern bee farming in mitigating food insecurity as a result of rainfall variability impact and the challenges hindering apiculture, it would be important to look into details the impact of rainfall variability and climate variability at large on bee farming and what can be done about it.

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**APPENDIX 1: QUESTIONNAIRE: For key informant of bee keeping groups and district agricultural officers.**

**Basic Data**

1. Questionnaire Number……
2. Name: ……
3. Name of the village of origin……
4. Name of the bee keeping group.…….
5. Contact: Mobile …….
6. Age in years…….
7. Education Level (specify the final class)
    1. Primary: [ ]
    2. Secondary: [ ]
    3. College: [ ]
    4. University: [ ]

8. Gender:
    1. Male [ ]
    2. Female [ ]
9. Marital Status: (tick where appropriate):
    1. Married [ ]
    2. Single [ ]
    3. Divorced [ ]
    4. Separated [ ]
    5. Widowed [ ]
10. Occupation:
    a) Civil servant [ ] Specify……..
    b) Business lady/man [ ] Specify……..
    c) Farmer [ ] Specify……
    d) Student [ ] Specify……
    e) Other [ ] ……

11. Average income per month? ----------

**Impact of rainfall variability on food security (District agricultural officers).**

12. Has there been variation in the rainfall patterns reliability for the last 8 years?

13. Which year did this variation on rainfall patterns begin in the region?

14. For the last 8 years how has the rainfall variations affected the quantities of the maize and beans(maize and beans) production ----------

| Year | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|---|---|---|
| Rainfall(mm) | | | | | | | | |
| Maize production in bags. | | | | | | | | |
| Beans production in bags | | | | | | | | |

**Feasibility of bee farming in mitigating food insecurity (Farmers who are members of the bee keeping groups hence can access the records from the chairman)**

15. How many hives do you have?

    KTBH-------- Langstroth---------- Log hive----------

16. How much honey in Kilograms. have you been harvesting per hive per year for the last 5 years from the different kinds of hives that you have?

    **<u>Amount of honey in Kilograms. Produced for the last five years.</u>**

| YEAR | TYPES OF BEE HIVES | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|
| Quantity of honey produced in a year in KGS. | KTBH | | | | | |
| | LANGSTROTH | | | | | |
| | LOGHIVES | | | | | |
| | | | | | | |

17. Have you been taking some of the honey for food? 1. Yes [ ] 2. No [ ]

18. How much of the harvested honey have you been using for food? ----------

19. For how many days would 1kg of honey take you? ----------

    **Income generated from the honey and the honey products (Households who are members of the beekeeping groups)**

20. Do you have any honey in store meant for your food? ----------

21. If yes, how much---------- and how many days can it take you? ----------

22. Do you sell honey to earn some income? 1. Yes [ ] 2. No [ ]

23. If yes, what is the average income that a kilogram of honey can fetch……

**24.** On average how much income have you been fetching from selling honey and other bee products such as wax for the last 5 years from each of the bee hives types that you have?

**Income in Ksh. generated from selling honey and bee products (wax) from different types of bee hives.**

| Year/Income In Ksh. | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|
| Log hives | | | | | |
| KTBH | | | | | |
| Langstroth | | | | | |

**Role of stakeholders in the honey value chain & role in strengthening food security (Agricultural officers)**

25. Who are the current stake holders involved in the honey value chain in this area and in Kenya generally?----------
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**26.** What are the roles of the above named stakeholders towards enhancing food security?

| **STAKE HOLDERS** | **ROLES** |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**27. Challenges and hindrances to improved bee farming**

What challenges and hindrances are you facing in practicing bee farming ----------
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