ASSESSMENT OF BEEKEEPING AS AN ADAPTATION STRATEGY AGAINST IMPACTS OF CLIMATE CHANGE IN IRAMBA DISTRICT

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CERTIFICATION

The undersigned certifies that he has read and here by recommends for acceptance by the Open University of Tanzania a dissertation entitled: ***"Assessment of Beekeeping as an Adaptation Strategy Against Impacts of Climate Change in Iramba District",*** in partial fulfillment of the requirements for the Degree of Master in Environmental Studies (Management) of the Open University of Tanzania.

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Dr. Josephat A. Saria

(**Supervisor**)

……

Date

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DECLARATION

I, **Ziwa Elia Yohana**, do hereby declares that this dissertation is my own original work and that it has not been submitted and will not be presented to any other university for similar or any degree award.

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.....

Date

DEDICATION

This work is dedicated to my family, my wife Paulina Sikazwe and my sons John, Samson and Augustino. Also to the young brother Dr. Michael Ziwa, father Henry Ziwa and late mother Brandina Frances Kiegezo, whose presence in my life creates desire to work harder and pursue higher studies. Also this work is dedicated to stakeholders who deal with beekeeping and Environmental Conservation.

ACKNOWLEDGEMENT

This dissertation work comes to completion. I would like to express my appreciation to different individuals who have assisted me in various ways until it can now be presentable, first, as a pre requisite document for my Master's Degree and second, before the work can be exposed for the public consumption.

First, I lift up my hands to the Almighty God to thank Him for sustaining me with the abundance of good health and insights during the course of my studying at the University and specifically during its preparation. Surely, according to my belief we human beings are fragile as we can do nothing without God's help.

This dissertation comes because of the contribution of many stakeholders and it is not easy to mention all in name. Just for the sake of courtesy I would like to mention only a few of them and this does not mean that I belittle the part contributed by those who remain anonymous.

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ABSTRACT

The effects of climate change in Tanzania affect rain fed agriculture and reduce the productivity in most parts of Tanzania. Indigenous knowledge and different agricultural strategies, on how to diversify to other agricultural activity like beekeeping has been adopted by different communities in Tanzania, especially in semi-arid areas. This paper focuses on assessing potentials of beekeeping as an adaptation strategy against impacts of climate change in Iramba District. The research used different methods in collecting information such as key informants' interviews, focus group discussions and observation methods. Secondary data were collected through documentary review, while the questionnaire was administered to 150 heads of households from four villages namely: Kyalosangi, Galangala, Mdonkolo and Songambele. The results show that over a period of 30 years, about 77% of respondents reported decrease in maize and 78% decrease in sunflower productivity. In interviews, the respondents indicated that they have shifted to beekeeping, which contributes more to household's income than land tilling which is rain-fed. This is supported by 33.1% who were attracted in beekeeping for income purposes. The average honey production per hive ranges from 10 – 15 Lts/hive in top bar hives and frame hives, while traditional hives ranges between 5 – 10 Lts/hive. This study therefore recommends provision of appropriate capacity building and financial support to beekeepers in order to optimize production of bee products in the study area.

Keywords: Climate change, adaptation strategy, agriculture, beekeeping, and rain-fed agriculture

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LIST OF ACRONYMS AND ABBREVIATION

CVs	Cultivars
CSA	Climate Smart Agriculture
DAICO	District Agricultural, Irrigation and Cooperative Officer
DED	District Executive Director
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization
DGTZ	Deutche Gesellschaft fur Technische Zusammenarbeit
LGA	Local Government Authority
LGDA	Local Government District Authorities Act
LGFA	Local Government Finances Act
LGRP	Local Government Reform Programme
MNRT	Ministry of Natural Resources of Tanzania
NAAS	National Agricultural Advisory Service
NEMC	National Environmental Management Council
PMO	Prime Minister's Office
SPSS	Statistical Package for Social Science
WFP	World Food Programme

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Climate change is a global observable fact and one of the biggest challenges before us today. According to Collier and Dercon (2014), climate change refers to the variation in the earth's global climate or in regional climates over a period of time. It describes changes in the state of the atmosphere over time scales ranging from decades to millions of year (Collier and Dercon 2014).

The terms '*global warming'* and '*climate change*' are sometimes used interchangeably, but there is a difference. Global warming is the gradual increase of the earth's average surface temperature due to greenhouse gases in the atmosphere, whereas the 'climate change' is a broader term (Hartmann *et al.,* 2013), which refers to long-term changes in climate, including changes in average temperature and rainfall due to global warming (IPCC 2001). Climate change phenomenon, which is much, more complex is the result of activities that alters the composition of atmosphere, due to undesirable and unwanted over exploitation of our natural resources (Hartmann *et al.,* 2013).

The present changes in the earth's climate cannot be explained alone by the natural processes that explain earth's previous warm periods. There is a broad scientific consensus that most of the warming in the recent decades can be attributed to human activities (IPCC, 2007). If humanity is, in large part, responsible for this change, then whatever choices we make today, will have a significant bearing on the climate of the future (IPCC, 1996). This makes climate change a formidable concern.

Adaptation and mitigation has become a strategic negotiation issue only recently, although UNFCCC (1992) already referred to it in Art. 2 and Art. 4. Adaptation is a useful means of reducing climate-related effects. The benefit-cost ratios of adaptation expenditure are larger than one in all scenarios, and for high and low climate damages and discount rates. Nonetheless, benefit cost ratios, and consequently global welfare, are even larger when adaptation and mitigation are implemented jointly. Even though a clear trade-off between adaptation and mitigation has been quantified, they are strategic complements and both contribute to a better control of climate damages. Mitigation prevails in the short-run and/or if the discount rate is low.

Agriculture employs more than 90% of the population in Iramba District hence significant sector requiring improvement to develop the District community. Farming as experience tells us has the potential to turn unoccupied land into productive land for national economic growth, food self-sufficiency, industrial growth and employment. The District is one of the high potential districts in Singida Region contributing a large share of food grain seeds production in the Region. It is endowed with enough arable land; experienced devoted farmers; fertile sand loamy soils easy to till, black cotton soils and red loam soils suitable to almost every food crops, and relatively good weather with rainfall ranging from 600-800mm per annum. The sound production of food crops in the district depends mainly on rain fed. Food crops grown in the District include: maize, sorghum and Pearl millet.

A good number of studies conducted elsewhere in Tanzania have documented that climate change and vulnerability is happening in Tanzania especially central Tanzania and is coupled with major impacts on various natural resources including agriculture

and water resource, which is the main source of livelihood in rural areas (Majule and Mary 2009). The various climate-related impacts such as floods and droughts frequently have substantial effects on economic performance and livelihood of communities in rural areas that depend on rain-fed agriculture. Ngana (1983) on his study about drought and famine at central Tanzania (Dodoma District), indicated that the presence of dry spells in critical periods for most crops contributed considerably to crop failure and hence food shortage.

Given the over-dependence rainfall in agricultural activities by the majority of people living in rural areas, climate change has been one of the major limiting factors in agriculture production thus resulting in food insecurity and low-income generation. For example, droughts and floods have been reported to cause failure as well as damage to crop and livestock leading to chronic food shortages (Liwenga, *et al.,* 2007. The study conducted by Rosenzweig *et al.,* (2002) revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production.

1.2 Climate Change and Honeybees Production

Agricultural sector is the human activity, mostly directly influenced by the climatic change (FIDA, 2008). However, the impacts of climate change are not just of environmental concern, but will impede efforts to tackle poverty and promote national development. According to Gbetibou (2009), many human development systems will be affected by these changes, particularly agriculture, water resources, industry and human health. Thus, the rural farmers whose livelihoods depend on the use of natural resources are likely to bear the brunt of adverse impacts.

At Iramba district about 75% were engaging in food crop production and 25% were engaging on beekeeping (Iramba district profile 2016) as a means of increasing income at household level. Due to climate change which results to unreliable rainfall hence low productivity and production of food crops lead to food insecure every year. To overcome this situation more than 45% of farmers involved in beekeeping as copping strategies to climate change hence food security and income generating.

Even though honeybees are highly important for indigenous and newly imported crops, they are under great challenge of climate change which resulted the variability of climatic elements mainly rainfall and temperature over extended period of time (decades or more). Due to the effects of climate change, trees are blooming earlier and changed in range and distribution of plants. Responses to climate change has required changing crop species/varieties and modified management of soils and water. New strategies for pest management have been set as species of wild pests, their natural predators and their life cycles in response to climate changes has changed.

The climate change can influence honey bees at different levels. It is known that different race of honey bees has its own rate of development. Any sort of climate change or movement of a race of honey bees from one geographical region to an alien one is therefore bound to have measurable consequences. It can have a direct influence on their behavior and physiology (Reddy, *et al.*, 2012). Also the climate change can also change the quality of the floral environment and may increase or reduce colony harvesting capacity as well as development and can also influence the development cycle (Le Conte and Navajas, 2008). The effect of climate change on bee’s race depends upon their thermal tolerance and plasticity to temperature changes

(Reddy, *et al.*, 2012). The high surface to volume ratio of small bees leads to rapid absorption of heat at high ambient temperatures. All bees with body weight above 35 mg (Apis, Bombus, Xylocopa and Mesachie) are capable of endothermic heating (Rusterholz, and Erhardt, 1998). Behavioral responses of bees to avoid extreme temperatures could significantly impacts pollination services. The time taken for thermoregulation at higher temperatures comes at the cost of foraging. With temperature increase, the effectiveness of pollen removal and deposition normally change and pollinators are at risk of overheating especially in regions where ambient temperatures are high and climatic conditions are stable (Reddy, *et al.*, 2012).

Normally, the honey bees capacity to preserve energy reserves and to handle the colony's development exerts significant adaptive pressure. For example, when the weather becomes milder, the bee queen starts to lay eggs and the colony develops and increases the size of the worker population. During cold season, the cold wave lasting several weeks may occur therefore, the honey bees are unable to move out for foraging. The large size of the honey bee population causes such a rapid depletion of stores that the colony can die of starvation.

1.3 Poisoning of Honeybees Colonies

On the other hand, the human activities like using of different agrochemicals fabricated to kill new pests in crop farming have killed many honey bee colonies every year in the world.

Study conducted by Aynalem, (2017), shows the incidence of poisoning of honeybee colonies by different causes. One of the major honeybees poisoning were pesticides,

herbicides and insecticides applied on crops by farmers as well as on some human health vectors like mosquito and flea in the houses. Thus, due to unwise use of insecticides and other herbicides on agricultural activities (crops and animal husbandry), some beekeepers may lost total honeybee colonies.

Bee keeping's competitive advantage for on-farm integration is ascribed to the low start-up costs, labour requirements, less land, user friendly technology and dependency on traditional knowledge and skills (Ndyomugyenyi *et al.*, 2008). Additionally, it provides complementary services to other on-farm enterprises like crop pollination. Beekeeping is also an efficacious tool in rural development as bees are omnipresent and the required equipment and tools namely: hives, smokers and protective clothing are locally made. Due to all these factors plus its contribution to livelihood outcomes especially the guaranteed year-round financial protection, beekeeping is considered a vital component of poverty eradication in rural areas (Sacco *et al.*, 2014).

Many strategies are applied by small holder farmers elsewhere to enable them to adapt to climate change. However these strategies which were identified earlier in north Africa (Muhammad, *et al.*, 2006), like beekeeping using other species (which implies the diversification of bees species), the change of the sites of the hives, the reduction or increase in the number of hives, the use of a particular type of hive (modern or traditional), the changing of apicultural techniques, the amendment of the periods of operations, the shift from beekeeping to honey hunting activity, praying activities or other strategies of adaptations. The proposed research intends to determine the adaptations strategies developed by beekeepers and honey hunters in central Tanzania

at Singida Region, Iramba District in response to climate change for the conservation of bee diversity.

1.4 Problem Sstatement

In spite of the existing beekeeping potential in Tanzania as a coping strategy to climate change, the opportunity remains unexploited by most of the poor due to insufficient documentation on its profitability, performance and specific contribution to a poor man's needs (Mujuni, *et al.,* 2012). Beekeeping is still marginal with only 10-15% of the households engaged in it (Kidd, *et al.,* 2001). The sub-sector is also fundamentally orthodox and subsistence in nature and the government has done little to improve it.

Additionally, there is still scant information on the monetary value of honey output, which makes it more complex to estimate its contribution. This information is hardly available given poor documentation and record keeping by farmers and statistic institutions plus little research focus on this sector. Focus is rather accorded to other livestock enterprises and major cash crops. Furthermore, the factors underlying adoption of beekeeping in the poorest regions in Tanzania are unknown. Research also shows that during adoption of agricultural technologies, the process tends to be slowed and deterred by a number of challenges (Doss, 2006). These may be environment specific hence the importance to understand these area specific beekeeping constraints.

Moreover, if the unexploited potential of beekeeping is to be met then these constraints must be identified and addressed. Therefore, this necessitates studies to

address these knowledge gaps yet adoption studies have only been done in central Tanzania, Iramba District with no research in other regions. In addition, a systematic and holistic study on livelihood assets of farmers and how these influence adoption and production in the most vulnerable Central Tanzania is still lacking.

This study therefore employed the livelihood framework to predict the effects of various factors driving beekeeping adoption and production in Iramba District along with conditions that would motivate rural farmers to take up beekeeping. The findings from such studies are relevant to future researchers with related topics, policy makers, donor agencies and organizations involved in seeking and designing sustainable poverty reduction strategies in rural areas especially in developing countries. In addition, such findings create awareness and assist extension workers to come up with more practical solutions to address the needs of the farmers.

1.5 Significance of the Study

Honey beekeeping is one of the important roles in contributing to farmers' incomes and household food security in Iramba district. Iramba district has huge potentials for honey and wax production due to availability of ample irrigable farmland and the presence of relatively better market opportunities as compared to other areas in Singida region. In addition to the above, this beekeeping generates employment opportunities for the poor households. The findings from this study will add value to the manipulative of appropriate extension programmes to boost honey bee productivity in the study area and other areas with similar situation like Tabora and Nzega districts.

The climate is changing and mitigation efforts done by honeybee's farmers to reduce the sources or enhance the sinks of greenhouse gases will take time. The adaptation is therefore significant and of concern in study area, where vulnerability is high because skills to adapt is very low. The findings of this study will help inform the farmers on the best adaptation strategies to ensure that they achieve their food, income and livelihood security objectives. This study will help in bringing attention of the policy makers on the challenges experienced by honeybee farmers in their efforts to adapt to climatic change. Also the findings will further help in informing the agricultural extension officers on the need for their services by the farmers in this area. Finally the results of the study will to the existing body of knowledge and form the basis for future research by those who will be interested in this area of research.

The findings of this study will redound to the benefit of society considering that beekeeping potential in Tanzania as a coping strategy to climate change and plays an important role in food security and income generating today. The greater demand for livelihood background justifies the need for more effective, life changing feeding approaches. Thus, farmers applying the recommended approach delivered from the results of this study will be able to improve their livelihood better. Administrator will be guided on what should be emphasized by extension workers in the farm to improve farmer's performance in production of honey and other crops. For the researcher, the study will help them uncover critical areas in the farming process that many extension workers were not able to explore. Thus, a new theory on beekeeping may be arrived at. Such findings create awareness and assist extension workers to come up with more practical solutions to address the need of the societies.

1.6 Overall Objective

This study is intending to assessment bee keeping production as an alternative to the adaptation strategies to agricultural food crops.

1.6.1 The Specific Objectives

(i) To evaluate the contribution of beekeeping to rural livelihood outcomes in Iramba District.

(ii) To establish factors influencing the adoption of beekeeping among the rural farmers in Iramba District.

(iii) To assess factors influencing honey production among beekeepers at Iramba District.

(iv) To identify the major beekeeping constraints faced by farmers in Iramba District.

1.6.2 Research Questions

(i) What is the contribution of beekeeping to rural livelihood outcomes in Iramba District?

(ii) What are the factors influencing the adoption of beekeeping among the rural farmers in Iramba District?

(iii) What are the factors influencing honey production among beekeepers at Iramba District?

(iv) What are the major beekeeping constraints faced by farmers in Iramba District?

1.7 The Conceptual Framework

This section describes the adoption process an individual follows to accept or reject an innovation in question (Figure 1.1).

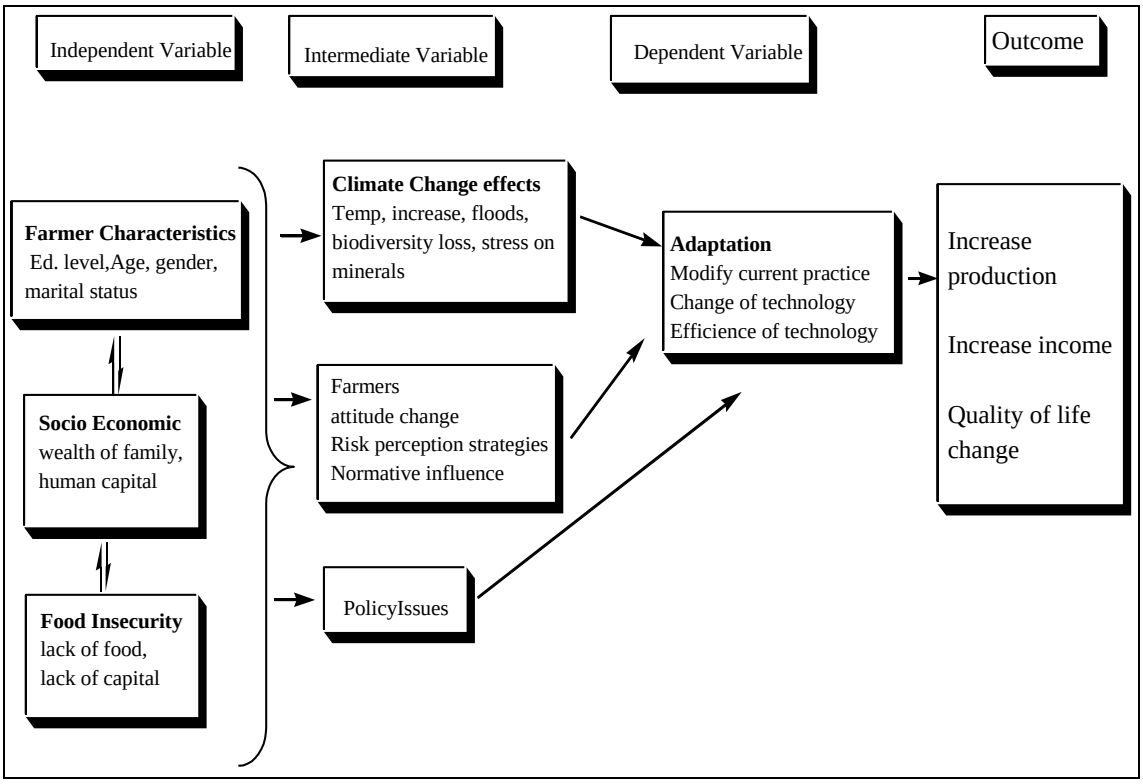

Figure 1.1 Conceptual Framework

The first phase in the framework is the individual farmer characteristics like gender, age, education level and marital status. In many African countries, people living in rural areas and they are governed by rules and traditions which hinder them in decision making. The age is a factor, which can influence participation of an individual in development activities. This is because the influence of age on adoption or participation in development programmes can be a reflection of the characteristics of an individual in relation to ownership and control of resources such as land, cash, hives and labour. The rate of adoption of new technology is likely to be higher among younger members than older ones due to exposure to current changes and education.

Maunder (1973) noted that young people are less conservative than their elders and hence more likely to participate in agricultural development programmes. Nanai (1993) observed that there is an increase in the level of adoption with age to an optimum age group.

Gender is closely related to division of labour in African communities. Women are expected to perform many farm operations in food crop production process but they lack access to production services and resources. The problem stems from the fact that women are not perceived as "real farmers" by development agents especially extension workers. A major constraint to increased food crop production by women is the lack of labour resources especially during the peak of agricultural season (Lombe, *et al,* 1992). According to Nanai (1993), women's workload is one of the major constraints that hinder women participation in development programmes.

Marital status has an influence on adoption in that culturally resource ownership and exposure to training programmes is based on gender. Nanai (1993) and Shayo (1991), have mentioned problems and situations that hinder married women participation in development programmes. Married women are rarely involved in the elaboration of policies or consulted when new technologies are introduced even though these are of direct concern to them. It is further known that, whatever agricultural information that exists in a village is passed on to husbands not to wives who are busy working in fields, household chores and other community obligations. Similarly, Shayo (1991) indicated that husbands and neighbors were observed to be the women's source of information rather than extension agents. Rights to productive resources can be affected by technology transfer, including land, forest, water and other productive

resources like improved hives. Successful introduction of new technology or modification of resource use often depends on recognition of the existing forms of resource rights, or on taking steps to create an optimal resource rights regime (Polenske, 2000).

Education level tends to break the horizons beyond habits and traditions of an individual encouraging participation of an individual in production and development activities. Smallholder farmers are supposed to be put in a position where they can analyze their situations. Nanai (1993) found that the people's level of education has positive relationship with the level of participation in any programme. The average farmer is illiterate, which in part explains his reluctance to reject traditional beliefs, attitude and practice that contribute to his resistance to change (Kauzeni, (1989). Literacy as pointed out by Sylwander (1994) is also linked with utilization of improved technology. According to his study, the low utilization of improved technology on beekeeping by females is a result of being deprived of opportunity to education.

The human capital or household size determines the rate of technology adoption in that it determines the manpower available for farm activities. A farmer with large number of people capable to carry out farm activities will always need to increase area under food crop to maximize the present manpower and will be in position to accomplish farm operations in time. One with few people in his/her household will need extra technology to equate him/her to the former in terms of area under food crop and production some technologies require more people hence create limitation to farmers with small households.

The second phase of the conceptual framework is the effects which can be observed by the farmers due to climate change. According to IPCC (2011), the climate change and its associated uncertainties implies that there is a need regularly of extension services to access new knowledge and extend to farmers timely and adequately. It also entails harnessing the local using the two different knowledge (knowledge of farmers or of extension officers) to improve adaptation practices. Sometimes the low levels of education of some extension officers can affect the quality of extension services (Mmbengwa, 2009).

Fishbein and Ajzen (1975) in their theory of "*Reasoned Action*". it is an expectancy-value with emphasis on attitudes, subjective norms, intentions and behaviours towards a specific focus. This is the farmer understanding the connection between his/her attitudes and their underlying beliefs. The reasoning action has received considerable attention in the field of consumer behaviour and has been found to be a good predictor of intentions and behavior. At this stage an individual is motivated to find out more information about the new idea. An individual wants to know what it is, how it works and what its potential may be.

The third phase is the adaptation phase where smallholder farmers perceive climate change, what are the adaptation strategies they practice, whether new or continue with the modified practices. At this stage, farmers' capacity to choose effective adaptation options is inclined by household demography, as well as positively by farm size, access to markets, honey production income, and access to climate information and extension, that means there is a need to support the indigenous adaptation strategies of the smallholder farmers with a wide range of institutional, technology support; and

policy, some of it targeted on smaller, poorer or female-headed households. Moreover, creating opportunities for non-farm income sources is important as this helps farmers to engage in those activities that are less sensitive to climate change. Furthermore, providing climate change information, extension services, and creating access to markets are

1.8 Limitation of the Study

Iramba district, Singida region being a cosmopolitan district with the majority of nyiramba and Nyaturu tribes, language barrier was experienced due different spoken languages by different tribes as most farmers are aged farmers who did not understand English and Kiswahili well. This was countered by using the field assistants who understood the vernacular language for easy interpretation. The complete negative response by some households to respond to questions was also experienced and this was countered by use of experienced field assistants who are mainly locals and who were familiar with the household behaviors. The problem of time management also came up as many heads of households were working class hence finding them during day time was rather difficulty hence call backs were witnessed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents various theories and literatures from past researchers. It comprises theoretical frameworks regarding agriculture, climate change, effect of climate change and adaptation strategies.

2.2 Concept of Climate Change

Climate change is defined as a result of temperature variability due to emissions of greenhouse gases produced by human activities (Hope, 2009). According to Hope (2009:451) human activities such as 'burning of fossil fuels, industrial production, cutting down of rainforests change the atmosphere's composition by increasing the amount of greenhouse gases, which, in turn, traps heat in the atmosphere and thereby facilitating climatic changes. Mubaya, *et al* (2010), note that the impact of climate change is two-fold, bio-physical and socio-economic. Whereby bio-physical impact includes rising sea waters, more frequent and intense storms, extinction of species, worsening drought, crop failure. As well as changes in cloud cover and precipitation, melting of polar ice caps and glaciers, and reduced snow cover (Mendelsohn and Dinah, 2005; UNDP, 2004; UNFCCC, 2007). There is linkage between bio-physical and socio-economic impacts of climate change.

The Agricultural sector still holds an important role in poverty reduction in most developing countries (*ibid*). The report by World Bank development report (WB, 2008) indicated that agriculture sector offers a great promise for growth, poverty

reduction and environmental service. Nonetheless, the WB (2008) cautions that realizing the above requires the visible hand of the state, an improvement of the investment climate, regulation of natural resources management and securing of desirable social outcomes. Another major challenge facing the agricultural sector and, which could hinder achievement of the poverty reduction is climate change and its variability (*ibid*).

2.2.1 Effect of Climate Change

Climate change and its variability are long and short-term changes in the average statistics of weather (Ernhart and Twena, 2006; Enfors and Gordon, 2007, 2008). These have, as well, significant long and short-term impacts on the livelihoods and living conditions of the poor in developing countries such as Tanzania. They are contemporary global issues, which have the potential to impact everyone, yet these impacts are not equally distributed or felt (IPCC, 2001). This is mainly on the agricultural sector where areas suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas are expected to decrease (Mubaya, *et al*., 2010). Consequently, affects small scale subsistence farmers in terms of productivity, food security and family income.

All over the world natural climatic variability exacerbated by human-induced climate change are putting societies, particularly women, the poor people and vulnerable, at greater risk (IPCC, 2001). The impact of climate change and its variability in Tanzania as elsewhere in the world is therefore increasingly threatening the livelihoods of rural population especially those with low income, food insecurity, inadequate health services, unstable energy supplies, and fragile natural ecosystems.

The relationship between the phenomena and people's livelihoods is seen to have strong linkages to poverty. All over the world natural climatic variability exacerbated by human-induced climate change is disproportionately affecting the rural poor whose livelihood greatly relies on agriculture and the allied sectors (Urassa, *et al.*, 2016).

Consequently, the climate change has direct impacts on pollinators and the results of the impact are revealed in reduced pollination, which then results in yield reduction and arrest the food security. However, the consequences of climate change on pollinators are very little explored. Moreover, to our knowledge, no studies linking honeybees and honey production, and climate change have been conducted in the country.

2.2.2 Climate Change and Food Security in Tanzania

Tanzanian agriculture employs about 80% of the national labor force and most of these are rural dwellers. The country has about 44 million hectares of arable land but less than 24% of the area has been harnessed (FAO, 1996; UNWFP, 2013, Leliveld *et al.*, 2013; Mwandosya, *et al.*, 1998). Similarly, the country has inland rivers, lakes and other water bodies that could supply water for irrigation, however only 2% of the irrigation potential has been exploited.

The main food crops in Tanzania are maize, rice, wheat, sorghum/millet, cassava and beans. Tanzania could be a major food-exporting country, but so far Tanzania's agricultural potential is largely undeveloped. Only 11 % of the total land area suitable for agriculture (about 44 million hectares) is under cultivation, mostly by smallholder farmers (Temu, 2007). The planted area has been stable for several years, indicating

that land expansion has ceased to be a major source of agricultural growth. Unsurprisingly, food crop productivity has been very low. In the past six years (2001/02 – 2006/07) average food crop productivity was 1.7 tons per hectare, whereas good management and optimal fertilizer use should result in yields of 3.5-4.0 tons per hectare (URT, 2007).

According to the report by the Ministry of Agriculture and Food Security and Cooperatives (URT, 2013) about 10% of the cultivation is done using tractor while the 90% is under traditional cultivation. The report further, declares that agriculture is dominated by small holders who cultivate an area averaging from 0.9 hectares to 3.0 hectares using traditional method and entirely dependent of rainfall (Temu, 2007). Thus, despite of having numerous inland drainage and lakes; the country has not succeeded to harness these potentials. To support this fact, the report by Food and Agricultural Organization (1996) showed that only 2% of the arable land is under irrigation agriculture. This implies that about 98% of irrigation potential is not in use.

The current agricultural practices in Tanzania cannot ensure food security under changing climate, partly due to the fact that the conventional practices rely on the increasingly erratic and unreliable rainfall. Furthermore, shifting cultivation exacerbates deforestation, resulting in low yields and environmental degradation. The current approach recommended for coping with climate change has been either to adapt or to mitigate without considering possible synergies. Research geared towards combining mitigation and adaptation strategies against the impacts of climate change, focusing on adopting strategies that build climate resilience, reduce greenhouse gas emissions, and increase food security (Kahimba, *et al.*, 2016).

It is hoped that, effective utilization of irrigation potential could curb the impacts of climate change in the country. Despite of the aforementioned challenges, agriculture has remained significant to peoples' livelihoods (MCGuire *et al.,* 2013) Ahmed et al. (Ahmed *et al.,* 2011) added that agriculture contribute to about half of gross production, and employs about 80% of the labor force.

Much of the sector's recent growth has been due to production diversification at the farm level (horizontal diversification). Traditional food crops (maize, rice, sorghum and millet) now occupy only 50 per cent of total planted areas, while non-traditional export crops such as oilseeds, pulses, vegetables, roots and tubers have increased their shares (URT, 2006. To sustain and expand production diversification at the farm level, yields of food crops need to increase at the same time to meet rising domestic and regional demand. However, food crops are still mainly produced for subsistence and the incentives to produce them for the market are not in place. Tanzania has been facing increased poverty, food insecurity and environmental degradation for many years, like much other country in tropic and sub – tropical African which its economy depends mainly in agriculture sector.

2.2.3 Adaptation Strategies

Environmental management is mainly focused on preventing further damage to the environment. This is a good strategy but there is need to also address the current challenges farmers are facing. According to Mbilinyi, *et al.,* (2013), Interviews with farmers showed that about 49% admitted to have received support from the government for combating climate related disasters while 51% of respondents had not received any help from the government. The type of support received included food

during drought seasons, seeds once in a while, extension services to some places and fertilizer. As such, most of the respondents (89.5%) said this support from the government is still inadequate because even the food assistance they received was only enough for some few days and that some of the seeds did not grow. Apart from food and seeds, farmers also indicated that they do have seminars once in a while on climate change and environmental management with the emphasis on planting trees and noted above (NEMA, 1998).

Apart from the government assistance farmers also indicate different strategies they are using in adaption to climate change. According to Mbilinyi *et al.,* (2013), in order to cope with the effects of climate change at household level, the implication is that people severely affected by climate change and living in a situation demanding urgent solutions can actively apply various adaptation strategies if the strategies are linked to the creation of sustainable income benefits. Some smallholder farmers diversify their economic activities by doing both agriculture and animal keeping. Other coping mechanism include; involvement in petty trade, shifting from one area to another and livestock migration in search of water and pastures.

As a coping strategy people have diversified their economic activities; for instance, they also altered their lifestyle and switched to other income generating activities such as: Young people have established for motorcycles driving business-Bodaboda, selling of oil and petrol, saloon, petty shops and business, small scale poultry keeping, selling food items across the roads and shops as a new income generating activities (Mbilinyi et al, 2013). There have been some changes in population dynamics, in some areas people have been migrating seasonally or permanently from one area to

another especially from rural areas to urban areas, there is a need to conduct a thorough research for this climate change related migration in the country. Such dynamics has resulted in some negative social and economic impacts as noted in the discussion above on the social economic impacts of climate change (*ibid*).

The economic importance of the bees as pollinators in world agriculture is established (Adam, 1985; Kokoye, 1991; DAPS, 1995; Muhammad et al., 2006). In Benin, beekeeping is a secondary activity for most of people involved. However, it is an activity of great importance; but benefits very little attention in the development of agricultural strategies and policies.

In spite of the existing beekeeping potential in Tanzania as a coping strategy to climate change, the opportunity remains unexploited by most of the poor due to insufficient documentation on its profitability, performance and specific contribution to a poor man's needs (Mujuni, *et al.*, 2012). Beekeeping is still marginal with only 10-15% of the households engaged in it (Kidd, *et al.,* 2001). The sub-sector is also fundamentally orthodox and subsistence in nature and the government has done little to improve it.

Additionally, there is still scant information on the monetary value of honey output which makes it more complex to estimate its contribution. This information is hardly available given poor documentation and record keeping by farmers and statistic institutions plus little research focus on this sector. Focus is rather accorded to other livestock enterprises and major cash crops. Furthermore, the factors underlying adoption of beekeeping in the poorest regions in Tanzania are unknown. Research also

shows that during adoption of agricultural technologies, the process tends to be slowed and deterred by a number of challenges (Doss, 2006). These may be environment specific hence the importance to understand these area specific beekeeping constraints. Moreover, if the unexploited potential of beekeeping is to be met then these constraints must be identified and addressed.

Therefore, this necessitates studies to address these knowledge gaps yet adoption studies have only been done in central Tanzania, Iramba disrict with no research in other regions. In addition, a systematic and holistic study on livelihood assets of farmers and how these influence adoption and production in the most vulnerable Central Tanzania is still lacking. This study therefore employed the livelihood framework to predict the effects of various factors driving beekeeping adoption and production in Iramba district along with conditions that would motivate rural farmers to take up beekeeping. The findings from such study are relevant to future researchers with related topics, policy makers, donor agencies and organizations involved in seeking and designing sustainable poverty reduction strategies in rural areas especially in developing countries. In addition, such findings create awareness and assist extension workers to come up with more practical solutions to address the needs of the farmers.

2.2.4 Beekeeping as an Adaptation Strategy

The importance of beekeeping is due to many reasons, one is the nutritional and therapeutic value of the products obtained from the practice of this activity (honey, pollen, propolis, royal jelly and bee venom), the second one the pollination services,

because approximately 80% of the crops are pollinated by bees (Dirina and Bugina, 2012). Because direct and indirect outputs mentioned, beekeeping is a profitable branch of agriculture. Research conducted in Lithuania (Dirina and Bugina, 2012) assumes that beekeeping industry is a profitable branch of the national economy.

Tanzania Mainland has 48.1 million hectares (ha) covered with forests and woodlands representing 55% of total land area. About 93% of the total forest area is woodland and 7% is composed of mangroves, coastal forests, humid montane forests and plantations (Augustino *et al*, 2016). Forests are recognized as an important resource base for social and economic development of Tanzania and also in environmental conservation. They also provide multiple benefits and opportunities to rural and urban communities. The majority of the rural communities depend on forest products for their livelihoods and therefore forests contribute to poverty reduction. The woodlands and dry forests in Tanzania are mainly the miombo forests, dominated by species of the genera *Brachystegia, Julbernardia and Isoberlinia* (URT, 1998).

Beekeeping (or apiculture) is the maintenance of bee colonies, commonly in man-made hives, by humans. Most such bees are honey bees in the genus *Apis*, but other honey-producing bees such as Melipona stingless bees are also kept. A beekeeper (or apiarist) keeps bees in order to collect their honey and other products that the hive produce (including bee wax, propolis, flower pollen, bee pollen, and royal jelly), to pollinate crops, or to produce bees for sale to other beekeepers. A location where bees are kept is called an apiary or "*bee yard*." (Routledge, 1999).

2.2.5 History of Beekeeping

Honey hunters can be found in many countries and are commonly involved in subsistence farming. They hunt for honey in the wild as a way to diversify their food supply as well as to sell honey. However, fire and smoke that are used to rid the bees from their nests can destroy the entire colony, but can also ignite wild fires. This type of practice also affects the surrounding environment as pollination services are no longer available. This puts in jeopardy the honey hunter's livelihood as well as making crops and other plants in the area more vulnerable. Moreover, the honey and wax obtained from such a practice are of low quality. For example, honey can be sold with parts of honey comb in it, ash and brood. Wax from the honey comb is not marketed and is usually either thrown away or used as burning fuel (FAO, 2012).

Alongside honey hunting, traditional forms of beekeeping have also developed over the centuries. In this type of beekeeping the small-scale farmer provides protection for the bee colony in exchange for periodic harvests of honey and wax. This protection may be a simple as providing a hole in a wall, a clay pot or a basket attached to a tree branch so that bees can colonize it. This enables to harvest honey without destroying the colony and risking the important pollination services that bees can provide. The brood taken from wild colonies of bees is sometimes eaten by children as a protein supplement, but is not available on a constant basis, so contributes little to their diets and protein intake (*ibid*).

According to Tylor (2019), the earliest known evidence of hive beekeeping is the stone bas-relief carving shown which dates to 2400 BCE, or nearly 4,500 years ago, when honey and dates was the chief sweetening materials in Egyptian cookery and

beekeeping was an important Egyptian industry. This sculpture is now displayed in the Neues Museum in Berlin, but it was originally part of the pharaoh Nyuserre's temple to the sun god Re at Abū Jirāb.

Seeley, a world authority on honey bees, sheds light on why wild honey bees are still thriving while those living in managed colonies are in crisis. Drawing on the latest science as well as insights from his own pioneering fieldwork, he describes in extraordinary detail how honey bees live in nature and shows how this differs significantly from their lives under the management of beekeepers (Tylor, 2018).

2.2.6 Beekeeping in Tanzania

Tanzania is endowed with favorable environment for production of honey, beeswax and other bee products. The country has about 33.5 million hectares of forests and woodlands that are scattered throughout the country and are ideal for developing beekeeping industry. Almost 20.5million hectares out of this area are unreserved forests and woodlands, while 13 million hectares of forest and woodland have been gazetted as forest reserves. More than 80,000 hectares of the gazetted forest reserves consist of forest plantations that are also suitable for beekeeping. The mangrove forests of mainland Tanzania that covers about 115,500 ha are also valuable as bee fodder. High potential for beekeeping is also found in agricultural land where substantial bee products can be harvested from agricultural crops e.g. sunflower, green beans, coffee, coconut and sisal (Mwakatobe & Mlingwa, 2001).

Beekeeping in Tanzania is carried out using traditional methods that account for 99% of the total production of honey and beeswax in the country. Approximately 95% of

all hives are traditional including log and bark hives. Others are reeds, gourds, pots etc. During the colonial and early independence period the production of bee products was higher than what we have now and was among the important non-wood products from the forests with a higher contribution to the national GDP and international trade (Kihwele, 1991).

In Tanzania traditional beekeeping is credited for almost all production of honey and beeswax (Mwakatobe and Mlingwa, 2001). Her honey fetches high prices on the international market. For example, during 1999/2000 one ton of honey fetched 3,741.13 USD, while the price of beeswax was about 1,075 USD. When compared with the prices of other export crops, export prices of bee products have remained relatively high which indicates high demand and lucrative opportunity for Tanzanian bee products (Kihwele, 1991). This is a unique opportunity that can be utilized to adapt to the impact of climate change and improve livelihood.

2.2.7 Effect of Climate Change on Beekeeping

Climate change has also resulted direct action on the bees' diseases, pests, environment and climate. Honey bees need to adapt to the entire array of pests, predators, parasites and pathogens surrounding them because of climate change (Le Conte, 2008). The effects of climate change are a major threat to the environment and sustainable development of most sub-Saharan African countries. Adaptation is an effective means of reducing climate-related damages.

According to Gbetibou (2009), many human development systems will be affected by these changes, particularly agriculture, water resources, industry and human health.

Thus, the rural farmers whose livelihoods depend on the use of natural resources are likely to bear the brunt of adverse impacts. Climate Change and Climate Variability have negative impacts to the productivity of honeybees; altering plant flowering time, increasing water stress especially in situations of drought, thus reducing pollen and nectar availability, inhibiting movement, affecting bee communications, causing physical damage of hives, colony starvation and retarding bee forage activities.

In response to climate change beekeepers have adapted to reduce impacts by shifting to pollen rich areas, providing food for bees, providing water, changing hive types, changing apiary location, putting hives in tree shadows, use of over-dimensioned wooden hive and changing harvesting methods and time. Nonetheless beekeepers face serious constraints and interventions are needed to strengthen the capacity of beekeepers to adapt through integrating climate services with available indigenous knowledge and local practices (Kates 1985).

Issues of equity and justice are high on international agendas dealing with the impacts of global climate change. But what are the implications of climate change for equity and justice amongst vulnerable groups at local and sub-national levels? We ask this question for three reasons: (a) there is a considerable literature suggesting that the poorest and most vulnerable groups will disproportionately experience the negative effects of 21st century climate change; (b) such changes are likely to impact significantly on developing world countries, where natural-resource dependency is high; and (c) international conventions increasingly recognise the need to centrally engage resource stakeholders in agendas in order to achieve their desired aims, as part

of more holistic approaches to sustainable development. These issues however have implications for distributive and procedural justice, particularly when considered within the efforts of the UNFCCC. (2007).

The issues are examined through an evaluation of key criteria relating to climate change scenarios and vulnerability in the developing world, and second through two southern African case studies that explore the ways in which livelihoods are differentially impacted by (i) inequitable natural-resource use policies, (ii) community-based natural-resource management programmes. Finally, we consider the placement of climate change amongst the package of factors affecting equity in natural-resource use, and whether this placement creates a case for considering climate change as 'special' amongst livelihood disturbing factors in the developing world.

2.3 Legal and Institutional Framework Guide Beekeeping in Tanzania

2.3.1 National Environmental Policy of 1997

National Environmental Policy (NEP) is the umbrella policy where general directives in natural resource management are built. Climate change, as one of the cross cutting issues in natural resources management, is thus embedded in this umbrella policy. Therefore, only one Climate Change Strategy exists in the country to enforce and operationalize climate related issues of concern as directed by this NEP and its 2004 Environmental Management Act (EMA). Other line sectors, which are directly or indirectly interacting with NEP and EMA, have their own policies, acts, guidelines and strategies. A particular emphasis of the NEP is the commitment of the government of Tanzania to address issues that are man-made and that go beyond

country boundaries. All these conventions address issues caused by an increase in the emission of GHGs. It further highlights the need to undertake studies on the climate for potential adoption and mitigation interventions.

2.3.2 Agricultural Environmental Action Plan (2011–2017)

Agricultural Environmental Action Plan (AEAP) was prepared by Ministry of Agriculture, Food and cooperatives (MAFC) as a way of mainstreaming the environmental protection in their development planning and project implementation. This reinforces the Environmental Management Act (2004) and it was further prepared as a requirement by the General Budget Support Performance Framework in 2010. Management of natural resources in the agricultural sector has been the main emphasis for action.

2.3.3 The National Beekeeping Policy, (1998)

The Government of Tanzania developed the National Beekeeping Policy (NBP) in 1998. The overall goal of the National Beekeeping Policy is to enhance the contribution of the beekeeping sector to the sustainable development of Tanzania and the conservation and management of its natural resources for the benefit of present and future generations. NBP encourages active participation of all stakeholders in establishment and sustainable management of bee reserves and apiaries, promoting beekeeping-based industries and products and promoting sustainable management of beekeeping in cross sectoral areas for ecosystem conservation and management. To enable effective implementation of the NBP, two instruments have been put in place: The National Beekeeping Programme (NBKP) and The Beekeeping Act No. 15 of 2002.

2.3.4 The National Beekeeping Programme

The National Beekeeping Programme (NBKP, 2001) is an instrument designed to put into practice the NBP with emphasis on stakeholders' participation in the planning, management, ownership and sustainable utilization of bee resources for poverty eradication, improved biodiversity development and environmental conservation. The programme has three sub programmes including Beekeeping Development Programme, Legal and Regulatory.

2.3.5 The Beekeeping Act No. 15, (2002)

The Beekeeping Act No. 15 of 2002 was enacted by Parliament in April 2002. Its main objectives are: (i) To make provisions for the orderly conduct of beekeeping; (ii) To improve the quality and quantity of bee products; (iii) To prevent and eradicate bee diseases and bee pests, and (iv); To improve revenue collection.

2.3.6 National Forestry Policy, (1998)

The aim of the policy is to enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of natural resources for the benefit of present and future generations. This goal is to be realized through effective management of forest area, conservation of forest biodiversity, water catchments and soil fertility, and enhancing national capacity to manage and develop the forest sector in collaboration with other stakeholders. The policy provides the foundation, together with the Forest Act (2002) for Participatory Forest Management (PFM) and encourages community and private sector involvement in forest management through village land forest reserves, individual, group and community forests.

The National Forestry Policy Provides opportunities for beekeepers to practice beekeeping in forest reserve. Participatory Forest Management (PFM) is a broad, all-encompassing term used to refer to the various types of local involvement in forest management. At one extreme, under the provisions of the Village Land Act (1999), Tanzanian communities can define and demarcate an area of (formerly unreserved) village land as a Village Land Forest Reserve (VLFR). This is one of six forest tenure categories recognized under the Forest Act (2002). Once designated, the community takes full ownership and management responsibility for the area of forest encompassed within the VLFR. The process for establishing a VLFR is detailed.

Tanzania is one of the leading countries in Africa implementing PFM-style practices. Since 1995 more than five hundred VLFRs have been declared by communities out of communal lands. In addition, several thousand households, clans or other community groups in Shinyanga Region have demarcated private forests (called *Ngitili*). Together these developments have brought more than half a million hectares under community protection.

2.3.7 Wildlife Policy of Tanzania, (1998)

Beekeeping activities are encouraged to be carried out in Wildlife Management Areas (WMA) by involving local communities. With special permission from the Director of Wildlife beekeepers are allowed to carry out beekeeping in game reserves and game controlled areas.

2.3.8 Village Land Act, (1999)

The Village Land Act 1999 is one of the most important legislative texts that support community based natural resources management (Wily, 2003). It empowers the

community at local level (village) recognizing it as the appropriate representative structure to implement natural resources management. In view of this, through village land use management system beekeepers can be allocated land for beekeeping development. Our main challenge now is to use this enabling environment created by the Policy, Programme and legal framework to encourage Tanzanians and other investors to take up beekeeping so that they can benefit in terms of income, poverty reduction and conservation of environment.

2.3.9 National Agriculture Policy, (1997)

The National Agricultural Policy realizes beekeeping, biodiversity, germ plasm conservation and wildlife management as the reprehensive natural resources management (NRM) activities that interact directly with many different aspects of agriculture.

2.4 Beekeeping as a Livelihood Strategy and its Contribution at Household Level

Beekeeping as an enterprise fits in very well with small-scale farmers' livelihoods. It is an enterprise that can provide for employment, income and economic security for the farm family and others in rural areas. It requires little start–up investments, does not require complex technologies and techniques to start with and bees usually look after themselves, with little need for tendering. Bees provide for a plethora of products (honey, wax, pollen, royal jelly, propolis, venom, etc.) and are well known in many local markets. This provides a portfolio of products that a small-scale farmer can sell from a single farm enterprise. These products can also, with minimal processing, be

‘transformed’ into value added products, for example wax can be processed into candles, and honey can be made into mead (honey beer) (FAO, 2012).

In many countries beekeeping is a family undertaking. It can be located in and around the farm household; it does not require excessive labour and time to manage, as bees do the majority of the travel far to tender the enterprise and it can be a ready source of cash in times of need, as bee products can be sold to neighbours or in local markets. This enables women to be part of an economic activity, which can provide them with income and an independence that can support them in difficult times. It is also a flexible activity, where there is no need for constant tendering, for example as with livestock and crops, and hence allows women to follow other matters on farm as well (*ibid*).

Furthermore, bee products provide for improved nutrition and consequently better health for farm families and others in local communities. Honey is a useful source of high-carbohydrate food, and commonly contains a rich diversity of minerals, vitamins and others, adding nutritional variety to human diets (FAO, 2009). It has been evidenced as well in Iramba District that people have seen the economic importance of beekeeping and it is currently an emerging business.

2.5 Beekeeping as Adoption for Tanzanian Small-scale Farmers Economic Activity

Beekeeping in Tanzania plays a major role in socio-economic development and environmental conservation. It is a source of food (e.g. honey, pollen and brood), raw materials for various industries (e.g. beeswax candles, lubricants), medicine (honey,

propolis, beeswax bee venom) and source of income for beekeepers. It is estimated that the sector generates about US$ 1.7 million each year from sales of honey and beeswax and employ about 2 million rural people (Mwakatobe & Mlingwa,). It is an important income generating activity with high potential for improving incomes, especially for communities leaving close to forests and woodlands. Beekeeping also plays a major role in improving biodiversity and increasing crop production through pollination. FAO analyzed ten reasons for beekeeping; pollination, honey, beeswax, minimal resources, land ownership not essential, bees convert non valuable resources (nectar and pollen) into valuable resource (honey), cross-sectoral benefits, environmental conservation, can be done by everybody and environmental friendly (Table 2.1).

Table 2.1: Cross-sectoral Benefits of Beekeeping

1	Pollination	Bees normally pollinate flowering plant and cultivated crops hence maintain ecosystem
2	Honey	Has valuable energy, good healthy food and is a big source of income
3	Beeswax and other products	Used as a lubricant and waterproofing agent, casting of metals and glass, for making candles, as a polish for wood and leather and as an ingredient in cosmetics and as an artistic medium in encaustic painting
4	Infrastructure needed	Minimum resources needed to raise bees, No feeding needed
5	Land ownership	Not necessary to beekeepers
6	Nectar and pollen	Not used by livestock hence no competition with crops
7	Trade benefits	Local traders benefits by making hives
8	Ecosystem awareness	Beekeepers advocate seriously environmental conservation
9	Everyone work	No age limit required. Do not need daily caring
10	Environmental friendly	Generate income without destroying habitants. Encourage maintenance of biodiversity

According to Seegeren *et al.,* (1996), in 1984 world honey export total of 270,000 tons of which 60% came from the tropics. Prices varied between US $ 0.7 and 2.5 kg-1. Beeswax, which, among other things, is used in the manufacture of cosmetics, candles, foundation sheets for hives, medicines and polishes, had a good and very stable market. In 1990 world market prices varied between US$ 2 and 3 kg-1. Beeswax production varies from 0.2 to 0.5-kilogram hive^{-1}/year when frames are used and 0.5 to 2 hive^{-1}/years when the honey is pressed and all combs are melted.

According to International Trade Centre (2015), the global demand for honey and beeswax and other products has been increasing over the past 10 years. The global market for honey is projected to exceed 1.9 million tons by the year 2015. This is primarily driven by increasing awareness levels and health consciousness among the consumers, leading to increasing demand for healthy and natural food products. The major consumers and importers are the industrialized countries, led by Germany, Japan, USA and UK. The increased consumption over the last few years can be attributed to the general increase in living standards, and a higher interest in natural and health products. It is difficult to estimate the demand of honey exports within Africa continent or within Eastern and Central Africa.

The actual national demand is not known. It is estimated that 90 % all honey produced (10,000 MT) in Tanzania is consumed within the country as food or input for making local beer known as wanzuki. It is also known that there is more supply in months of June-August, which are main honey harvesting season after the long rains. Usually the prices of honey during these months decline to US $ 4.5 - 5.0 per kilo, but increases to about US $ 8.0 - 9.0 per kilo in months of January and May. This shows that the total

annual demand for honey in the country is much more than 10,000 MT. (Kihwele & Bradbear, 1989; TFAP, 1988; Mlay, 1997), have estimated that the production of bee products could increase by 50%, if its potential could be optimally exploited.

2.6 Factors Influencing Honey Production in Beekeeping

Honey bees access to water sources, favorable climatic conditions and the availability of flowering plants are significant factors influencing honey production (Shenkute, *et al.,* 2012). Nevertheless, the named parameters have been reportedly by both anthropogenic and climatic factors (Deutsche Welle (DW), 2015), which have increasingly become major factors affecting beekeeping activities and honey production for small scale beekeepers in rural areas. In this study, the anthropogenic and climate factors were assessed using parameters such as settlement establishment, charcoal-burning, farming activities, bush fires, fuel, temperature and amount of rainfall on honey production. Generally, unfavorable climatic conditions and anthropogenic activities threaten the availability of water sources, bee fodder sources and pollination services and, in effect, lead to low colonization of bee hives (Nyunza, 2018).

Unpredictable rainfall entails that the low amount of rainfall received in the study area was unable to replenish the water sources available. Similar results were reported by Chokkalingam, (2004), who found that the shortage of rainfall particularly in arid and semi-arid (ASAL) areas have impacts on environmental resources including the drying of water resources. In the study area, the drying of water sources had impact on the socioeconomic activities including beekeeping because honey bees require water to process stores, make brood food and hatch eggs (Garvey, 2013). Indeed, bees

forage for water at almost any source near their colonies (Ellis, 2010). The implication is that proper environmental conservation enables the protection of vital.

2.7 Major Beekeeping Constraints

Mwakatobe and Mlingwa (2001) described the major constraints that hinder beekeeping development in Tanzania as poor technologies, in harvesting, processing, storage and packaging and poor storage of products, increased loss of beekeeping areas, inadequate and ineffective extension service, inadequate statistical information to guide plans and operations, unreliable transport, lack of market information and inadequate entrepreneurship skills among beekeepers. Due to different predators like ants, wax moth, bee lice, beetles, spiders, wasps, lizards, snakes, birds and monks of bee colony, the yield of honey is highly affected because such predators reduce survival powers of bee colonies and sometimes kill them. Moreover, swarming and absconding of bee colonies were commonly observed in Ethiopia (Lijalem, 2017).

He could be either due to delay in harvesting the honey yields; or when they face deficit of water and bee forage especially during dry season; when frequently disturbed while harvesting honey, predator interference or sometimes due to improper inspecting manner by human. Limitations of modern equipment like wax, wax printer, Kenya/Germany hives model form; trained man power and other inputs to transform and scale-up the honey beekeeping into modern production system were the major challenges. Lack of good marketing place, selling of honey at low price in local market by farmers and many of them used traditional honeybee production. To some extent, limitation of bee colony, apiary site, bee forage and water, bee colony agro-chemicals were also major challenges reported. According to Ngaga (2005), there are

opportunities for improving marketing practices and efficiencies exist in Tanzania for both domestic and international markets. Supporting the above findings, Arse *et al.*. (2010), reported on the shortage of honeybee forages, shortage of honey bee colonies, poisoning of agro-chemicals, shortage of modern hives, prevalence of honeybee enemies and market problems.

They also reported on the shortage of improved bee equipment, absconding and swarming problems, prevalence of honeybee diseases, lack of knowledge of the right harvest time and theft problems as the major beekeeping. Chala, *et al.* (2012) also reported that lack of beekeeping knowledge, shortage of trained manpower, shortage of beekeeping equipment, pests and predators, fires, pesticide threat and inadequate research works to support development programs were major constraints that affected apiculture production in area. The prevailing production constraints in the beekeeping development in the country were found to be complex and to a large extent varied between agro-ecological zones and production systems. Variations of production constraints also extended to socio-economic conditions, cultural practices, climate (seasons of the year) and behaviors of the bees (Kerealem *et al.,* 2009).

Edessa (2002) reported the major constraints in the beekeeping sub-sector as unpleasant behaviours of bees (aggressiveness, swarming tendency and absconding behaviors); lack of skilled manpower and training institutions; low level of technology used; high price of improved beekeeping technologies, drought and deforestation of natural vegetation; poor post-harvest management of beehive products and marketing constraints and indiscriminate application of agro-chemicals. Other constraints according to them were honeybee disease, pest and predators; poor extension services;

absence of coordination between research, extension and farmers; absence of policy in apiculture; shortage of records and up to-date information, and inadequate research institutions to address the problems.

Honey bees, Apis mellifera L., are the most important managed pollinators for agriculture, providing direct benefits to crops valued at $5–10 billion annually in the United States (National Research Council., 2007). However, the annual loss of managed colonies has significantly increased in North America and Europe for a variety of reasons, including reduction of available floral resources, increased use of pesticides, and emerging diseases (Steinhauer, 2018). Beekeeping management practices are considered key for the productivity, overall health, and overwintering success of managed honey bee colonies. Control of a number of parasites and pathogens is a priority, because they are among the main causes of summer and winter colony losses. Out of all the pests and diseases that honey bees face, the ectoparasite Varroa destructor (commonly known as the varroa mite) is the most devastating, because it weakens colonies by vectoring several viruses (VanEngelsdorp et al, 2010). Varroa mite control is currently considered one of the most important practices for successful beekeeping (Van Engelsdorp, *et al.*, 2010).

According to Bahta (2018), Edessa (2002) and Ayalew (2001), the major constraints in the beekeeping sub sector are the unpleasant behaviors of bees (aggressiveness, swarming tendency, and absconding behaviors); lack of skilled manpower and training institutions; low level of technology used; high price of improved beekeeping technologies; drought and deforestation of natural vegetation; poor post-harvest management of beehive products and marketing constraints; indiscriminate

application of agrochemicals; honeybee disease, pest and predators; poor extension services; absence of coordination between research, extension and farmers; absence of policy in apiculture; shortage of records and up-to-date information; and inadequate research institutions to address the problems.

2.8 Research Gap

Most of studies have focused on various communities' adaptive strategies that aim at improving the production of food crops under current climate variability. The majority of the studies employed survey methods to assess communities' vulnerability and strategies used to adapt to the challenges of climate change and variability. However, these strategies have never addressed successfully the issues of climate change in food crop production. Some studies (Shemdoe *et al*., 2009; Swai and Majule, 2009; Gwambene and Majule, 2010) focused on various tillage methods undertaken by farmers in response to climate variability and no researches dedicated to examine the beekeeping as adaptation strategy against climate change to food crop. Then this study intends to assess beekeeping as a adaptation strategy against climate change to food crops

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes methods and approaches used by the researcher Beekeeping production as the adaptation strategies against impacts of climate Change at Iramba District. It describes the methods for data collection, analysis and presentation. The chapter encompasses research approach used, research design, the study area, sampling procedure, data collection techniques, data analysis and presentation techniques.

3.2 Description of the Study Area

Iramba District lies between Latitudes 4º to 4º.3º S and Longitudes 34º to 35° E. Altitude ranges from 1,000 meters to 1,500 meters above the Sea level. Administratively, according to the GN (2014 vol V) the Council is divided into 4 Divisions, 20 Wards, 70 Villages and 392 hamlets (United Republic of Tanzania, 2012). The main indigenous ethnic groups are the Nyiramba and Sukuma. Others who form significant minorities are the Taturu and Barbaig.

The Barbaig have advanced from living on herding and collecting honey and are now growers of maize, beans and sweet potatoes. The current population of Iramba district is about 261,370, on which 129,417 are men and 131,953 are women and total households 48,401 as per census of 2012 united republic of Tanzania. Population per square kilometers is 52 people, the population growth rate is 2.3 per annual and average household size is 5.4.

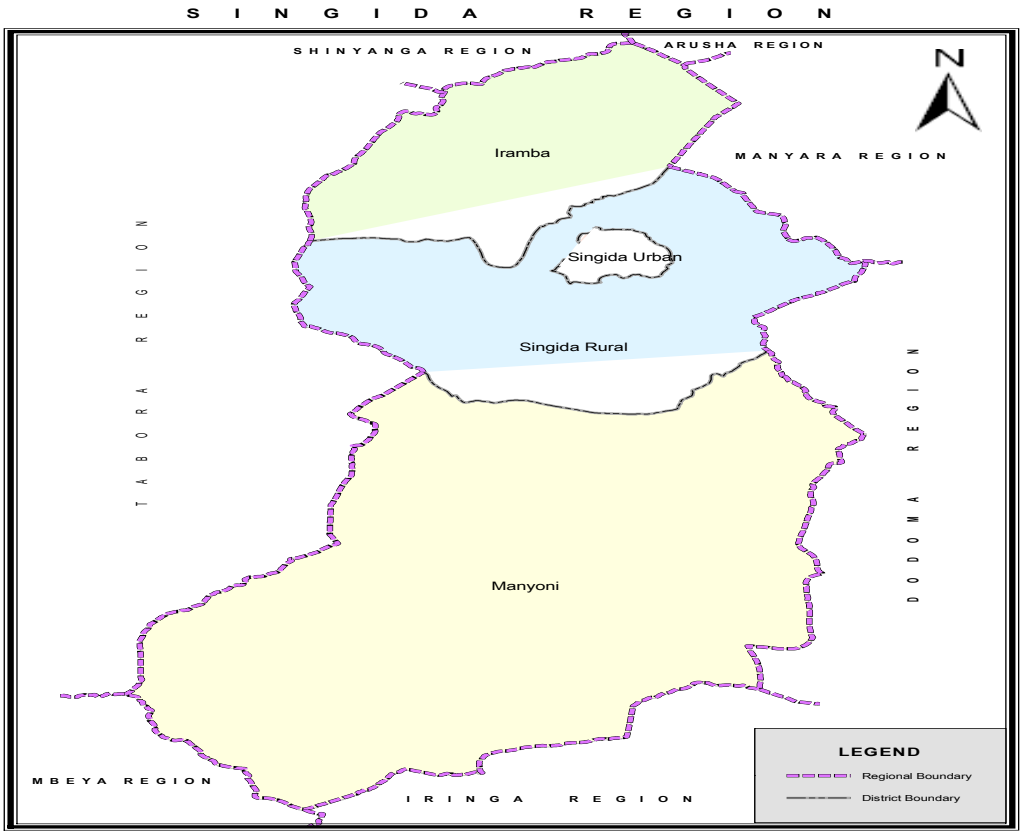

Figure 2.1: Iramba District Map

3.2.1 Geographic Relief, Climate and Economic Activities in the Area of Study

The District forms part of the semi- arid central zone of Singida which experiences monomial rainfall and the rain season interrupted by two notable dry spells in mid-February and mid-March. The total annual rainfall, which is ranges from 500mm to 850mm per annum with geographical, seasonal and annual variation. There are two rather well defined seasons, the short rainy season during the months of December to March or sometimes goes to April and the long dry season from April to November.

The District has an area of 4571.4 square kilometers of which 2025.13 square kilometers (44.3%) are arable land and 1950.62 square kilometers (42.7%) grazing land. Area with forest covers 103.31 square kilometers of land (2.26% of the total

land) while wood and reserve has an area of 322.28 square kilometers (7.05% of the total land). This gives the district high potential for bee keeping.

3.2.2 Topography of Iramba District

Iramba District occupies the northern part of the central plateau of Singida, which has elevations ranging from 1,000m to 1,500m above sea level. A prominent feature of the land escarpment in Iramba is the massive outcrops or rocky peaks (tors) of granite and metamorphic rocks. These outcrops, alternatively known as inselbergs, are remnants of ancient land surfaces, which in the adjacent areas have been eroded to form an extensive gently undulating peneplain.

The only permanent rivers in the region are Sibiti and Ndurumo. Iramba District is rich by having varieties of natural vegetation, which are found in it. This include Miombo woodlands, Acacia woodland and grasslands. Bush or thickets found in uplands are the types of vegetation found in the District. There is also wetland vegetation, which includes wooded grassland. Bushland vegetation is the most common vegetation in Iramba District.

In Iramba District, there are two major superficial geological deposits. These are the alluvium, comprising sandy soil and clay scattered throughout the region and often covers very extensive areas of the Wembere steppe. They occur along water courses and in small and large drainage depressions. The central parts of these alluvial deposits commonly have a surface layer of black soil or *"mbuga".* This clay is of high plasticity, having marked shrink/swell characteristics in response to changes in

moisture content. Bordering the "*mbuga*" are sandy *colluvial* or slope wash materials formed from the surrounding basement rocks.

3.3 Research Design and Data Collection

This study adopted a non-experimental research design by which questionnaire was used to collect primary data. However, the researcher used mixed approach. Mixed approach is a procedure for collecting, analyzing and "mixing" both qualitative and quantitative methods of research (Creswell, 2003). A mixed approach is one in which the researcher tends to base knowledge and claims on pragmatic grounds for example consequence oriented, problem centered and pluralistic. It employs strategic inquiry that involve collecting data either simultaneously or sequencing to best understand research problem (Creswell, 2003). Mixed approach was used in this study because it allows the analysis descriptive data and statistical data at the same time. While mixed approach allows the respondents to give in-depth expression of the matter under study, it allows statistical verification of variables under study to help drawing the inferences.

3.3.1 Sampling Procedure

This study used a multistage sampling technique where three stages were involved (Kothari, 2004). In the first stage Iramba district was selected purposefully from the list of seven districts that constitute the beekeeping in Singida region. In the second stage, two wards (2) Ndago and Kinampanda out of 20 wards were purposefully selected. The same approach was used to select the four (4) villages two from each ward. Ndago ward: Mdonkolo and Songambele while Kinampanda ward: Kyalosangi and Galangala.

3.3.2 Data Collection and Sampling Design

Field surveys, informative interviews, physical observations, group discussions and literature reviews were the main approach of data collection in the study area, where purposive sampling was employed to sample beekeepers among the semi-arid districts of Tanzania mainly based on the frequency of food shortage and other physical aspects (FAO/UNESCO, 1988). Two types of data were collected which included primary and secondary data.

Primary data were collected from beekeepers household heads or their respective representatives. Secondary data were collected from Ward Executive Office (WEO), Village Executive Office (VEOs), the District Beekeeping office (DBO), Extension Officers (EO), District Forest Office (DFO), and IRDP library.

The sampling unit was households, and the sample size was 150 respondents (beekeepers) from four villages, they were obtained using a formula developed by Yamane (1967), that;

$$n = N/ [1+N (e)^2]$$

Where by: n = sample size, N = sampling frame, e = prediction error 0.1 (10%). The sample size of the household survey consisted of 10% of the total number of heads of households in each study ward. According to URT (2007), total number of households beekeepers in Iramba district is 62,528. This gives; $n = 62,528/ [1 + 62,528(0.1)^2]$, where, n = 99.86. Therefore n = 100 respondents. Adding 15% we have 115 respondents (Yamane, 1967). Table 3.1 shows calculation for the distribution of respondents per village.

Table 3.1: Calculation of Distribution of Respondents Per Village

Ward	Village Name	Total HH	Estimation	Respondents
Ndago	Mdonkolo	477	115/2279× 477	24
	Songambele	615	115/2279 ×615	31
Kinampanda	Kyalosangi	651	115/2279 ×651	33
	Galangala	536	115/2279 ×536	27
Total		**2,279**		**115**

Source: Iramba Beekeeping Officer

Table 3.2 shows the profile of respondents. Primary data sources includes focus group discussions (n = 6 for each ward), interviews with key informants (n = 8) consisting of village elders and agricultural extension officers. Household survey (n = 150) and direct field observation through transect walks were other sources of primary data. Field observation was deemed necessary in order to confirm some of the issues raised during focus group discussions and the household survey.

Table 3.2: Respondents Profile

Category	Number
Household Head (Beekeepers)	115
Villages executive officer (VEO)	4
Ward executive officer (WEO)	2
Village Community Development Offices	4
District Beekeeping Officer (DBO)	1
District Forest Officers (DFO)	1
Agriculture Extension Officers	8
Beekeeping NGO working in study area	5
Village leaders	10
Total	**150**

Formation of FGD involved a purposive selection of ten (10) members who represented households, where five (5) represented beekeepers households and village elders, while three (3) represented agricultural extension offices, two (2) represented extension officers, two (2) beekeeping NGO representative. Secondary data such as publication materials such as books, journal papers, original scientific work, government reports and academic dissertation were consulted during review to identify and bridge up the gap basing on the study's objective.

3.3.3 Data Collection and Analysis

Quantitative data were gathered using structured questionnaires as the main tool. The structured questionnaire covered questions on main trends of crop production in five years, the factors influencing beekeeping practices, the quantity of honey produced, the implication of the financial obtained to food security, and the major constraints in beekeeping. Multiple response questions were analyzed so as to get frequencies and percentages.

After being collected from the field using questionnaire, primary data were edited before punching them into the computer software Statistical Package for Social Sciences (SPSS 11.5). Data were analyzed mainly at univariate level where descriptive statistics and frequencies for study variable were computed. Analyzed data mainly presented in tables and graphs for meaningful interpretation and discussion.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the study and discusses the findings. Findings and results have been arranged in order of objectives. In this chapter, the research findings are presented, analyzed and interpreted. These are mainly based on the set of objectives and are in conformity with the research questions.

4.2 Respondents' Characteristics

Different characteristics have got direct and indirect influence on the adoption of bee keeping among rural farmers. During the study, different parameters such as age, sex, gender of household head, education level and marital status, of respondents were assessed. The results and responses are shown in Table 4.1. Out of the 150 total sample respondents, 70% were male. This agrees with the African traditional idea that underscores beekeeping to be men's job due to physical reasons it claims. This can be attributed to the fact that men are under normal circumstances, the heads of the family and hence bear the responsibility of fending food to their families. The small percentage of women practicing apiculture could be those who were separated, divorced or widowed, and hence were the sole breadwinners for their children.

Actually women are not given equal power in heading the family as that of their male counterparts. Most of the sample farmers (54.7 %) are married while the remaining, are single, divorced and death of wife, respectively. The age of beekeepers ranges between 41-50 year of age.

Table 4.1: Socio Demographic Characteristics of Respondents (n = 150)

Respondents characteristics		Frequency	Percent
Age of respondent (Years)	31-40	18	12.0
	41-50	67	44.7
	51-60	57	38.0
	61 and above	8	5.3
	Total	**150**	**100.0**
Sex of respondent	Male	105	70.0
	Female	45	30.0
	Total	**150**	**100.0**
Marital status	Single	43	28.7
	Married	82	54.7
	Separated	10	6.7
	Divorced	5	3.3
	Widowed	10	6.7
	Total	**150**	**100.0**
Gender of household head	Male	118	78.7
	Female	32	21.3
	Total	**150**	**100.0**
Education level	Non Primary education	22	14.7
	Complete primary	113	75.3
	Above primary education	15	10.0
	Total	**150**	**100.0**

Households with no formal education were about 15% where 75.3% completed primary education and 10% had secondary education attainment. This situation automatically brings positive implication towards future development of the Iramba district. Figure 4.1 shows education level of respondents over total number of respondents interviewed.

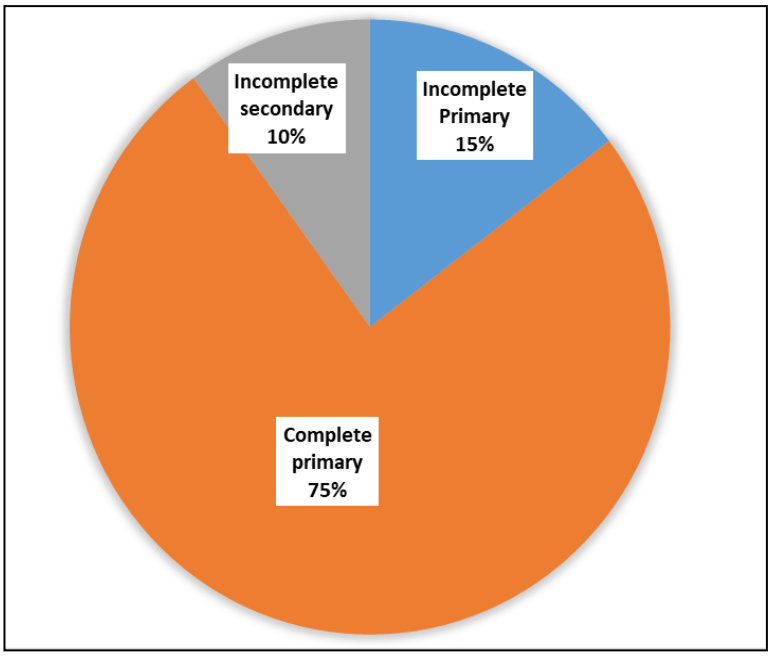

Figure 4.1: Education Level of Respondents

These results contrast with the results reported in Western Uganda that majority had attained formal education with 17.5% being tertiary education graduates (Mujuni *et al*, 2014). The lower the level of education households possess in the area the higher the negative impacts to climate change as far as experiences and skills on adjustment is concerned. Education level may have implication on honey production and it may affect the amount and quality of honey produced. The level of education determines the understanding of climate change and the related issues, decision making, quantity and quality of honey produced (Mujuni *et al*, 2014). The level of education might affect capacity to access to knowledge and skills about beekeeping and environmental management.

In all four villages surveyed, the data show that most of respondents have attained primary education. Only a small portion of respondents has attended secondary school but they did not complete. The results are as shown in the table 4.2.

Table 4.2: Education Level of Respondents by Village

Village	Education level of respondents			Total
	Incomplete Primary	Complete primary	Incomplete secondary	
Kaselya	4	24	2	30
Kinampanda	2	12	1	15
Mbelekese	1	11	3	15
Mdonkolo	8	19	3	30
Ndulungu	2	24	4	30
Urughu	5	23	2	30
Total	**22**	**113**	**15**	**150**

As displayed in Table 4.2, the data shows that in Kaselya village, 24 out of 30 respondents completed primary education, 4 have not completed primary education and 2 went to secondary school but neither of them completed. In Kinampanda village, 12 out of 15 respondents completed primary education, 2 have not completed primary education and 1 went to secondary school but did not completed. In Mbelekese village, 11 out of 15 respondents completed primary education, 1 has not completed primary education and 3 went to secondary school but neither of them completed.

In Ndonkolo village, 19 out of 30 respondents completed primary education, 8 have not completed primary education and 3 went to secondary school but neither of them completed. that in Ndulungu village, 24 out of 30 respondents completed primary education, 2 have not completed primary education and 4 went to secondary school but neither of them completed. In Urughu village, 23 out of 30 respondents completed primary education, 5 have not completed primary education and 2 went to secondary school but neither of them completed.

However, these results imply that most of bee keepers in the district have low education levels. These results contrast with the results reported in Western Uganda that majority had attained formal education with 17.5% being tertiary education graduates (Mujuni *et al*, 2014). Education level may have implication on honey production and it may affect the amount and quality of honey produced. The level of education determines the understanding of climate change and the related issues, decision making, quantity and quality of honey produced. The level of education might affect capacity to access to knowledge and skills about beekeeping and environmental management.

4.3 Status of Crop Production at Iramba District

Agriculture has a significant contribution to economy of beekeepers' households. Interview made to participants from the study show that the most important cash crops in Iramba district were maize, sunflower (*Helianthus annuus*) beans, sunflower, sweet potatoes (*Ipomoea batatas*) and groundnuts. The popularity of sunflower as a cash crop in Singida region spans back to about a decade ago before 1961 when Tanzania got her independence.

Generally, respondents and the Focus Group discussion (FGDs) reported on declining crop productivity due to climate change and its variability. Crop productivity in Iramba has declined. According to Urassa (2016), this is mainly because of climate change, drought, depletion of plant nutrients from the soil and infestation of crop pests and diseases. Table 4.3 summarizes the responses on the trends of crop productivity over the last 30 years.

Table 4.3: Trends of Productivity of Various Agricultural Crops over the Last 30 Years

	Trend	Frequency	Percent
Maize productivity	Increasing	2	1.3
	Decreasing	116	77.3
	Fluctuating	30	20.0
	No change	2	1.3
	Total	**150**	**100.0**
Beans productivity	Increasing	3	52.0
	Decreasing	4	2.7
	Fluctuating	1	0.7
	Do not know	142	44.6
	Total	**150**	**100.0**
Sorghum productivity	Decreasing	10	6.7
	Do not know	140	93.3
	Total	**150**	**100.0**
Sunflower productivity	Increasing	2	1.3
	Decreasing	117	78.0
	Fluctuating	29	19.3
	No change	2	1.3
	Total	**150**	**100.0**
Sweet potato productivity	Decreasing	4	52.7
	Fluctuating	1	0.7
	Do not know	145	46.6
	Total	**150**	**100.0**
Groundnut productivity	Decreasing	17	86.7
	Fluctuating	3	2.0
	Do not know	130	11.3
	Total	**150**	**100.0**

For example, whereas sweet potatoes in which participants indicated the decrease in production by 52.7% were cultivated in the past by women just for household

consumption, currently men cultivate the same as a cash crop leading to competition for land. Sweet potatoes are short duration crops that are relatively drought tolerant therefore, the high importance in food security in semi-arid areas.

4.4 Factors Influencing the Adoption of Beekeeping among the Rural Farmers

Due to climate change impact and to decline of food and cash crops to sustain family, smallholder farmers have adopted new production system as coping strategy to climate change and climate variability. Beekeeping has been one of the best options to Iramba smallholder farmers. Figure 4.2 summarizes the results from respondents what influenced them in keeping bees compared to other crops.

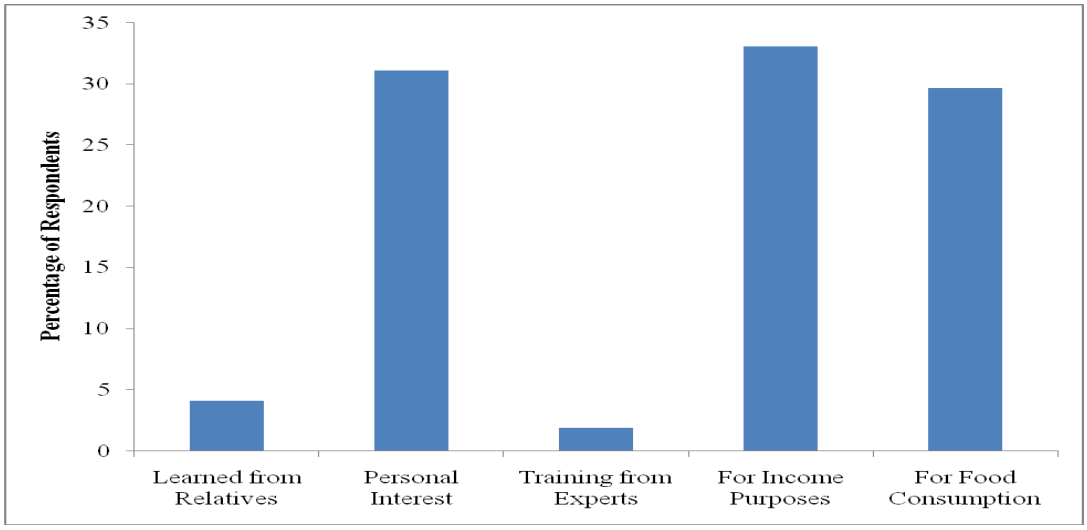

Figure 4.2: Factors Influencing Adoption of Beekeeping (n = 150)

Majority of respondents (33.1%) reported they were attracted in beekeeping for income purposes, this is followed by 31.1% of respondents who reported that they were their own motivation (personal interest) followed by 29.7% of respondents reported that they keep bees just for food consumption. These results agree with the results reported by Paji (2016) where 50% of the respondents were influenced by the

need to increase the income, while only 16% of the respondents got engaged in bee keeping activities due to the fact that honey is medicinal and 6% of the respondents were influenced by the need to obtain food.

According to (Dadant, 1980), honey bees play a critical role in agriculture and beekeeping has many relative advantages and importance that help farmers to improve their livelihoods to ensure food security. Beekeeping conserves the natural resource and contributes to the globe through environmental protection, as beekeeping and agro-forestry are integrated activity. It also provides valuable products like honey, beeswax, propolis, bee venom and royal jelly, which the farmer can get cash income (Keralem, 2005).

Beekeeping is influenced by many factors. Respondents pointed some factors such as markets availability, price of honey, level of education, influence from others and personal interest. The results are as summarized in Table 4.4.

Table 4.4: Factors Influencing Adoption of Beekeeping

Reasons for beekeeping		**Responses**	
		N	**Percent**
	Relative	17	4.1
	Personal interest	128	31.1
	Training	8	1.9
	For income purposes	136	33.1
	Food	122	29.7
Total		**411**	**100.0**

Table 4.4 indicates that 11.5% (n=150) of respondents reported that they were influenced by relatives to adopt beekeeping, 86.5 (n=150) reported that they were their own motivation (personal interest), 5.4% (n=150) reported that they got training that influenced them to adopt beekeeping, 91.9% (n=150) reported they were attracted in beekeeping for income purposes and 82.4% (n=150) reported that they engaged in beekeeping for getting food.

These results agree with the results reported by Paji 2016 that 41(50%) of the respondents were influenced by the need to increase the income, 15(19%) of the respondents got influence from other bee keepers, 13(16%) of the respondents got engaged in bee keeping activities due to the fact that honey is medicinal, 7(9%) of the respondents started beekeeping activities so as to get industrial materials such as wax from beehives as well as honey itself and 5(6%) of the respondents were influenced by the need to obtain food Paji, (2016).

4.5 Quantity of Honey Production

Under good management of beekeeping the production of honey can reach up to 15 kg per hive per harvest. The production ranges of honey in Iramba District are shown in Figure 4.3.

Results in Figure 4.3 indicate that most respondents 42.7% harvest 6 to 8 kg of honey per hive per harvest followed by 22.7% harvest 9 to12 kg per hive, 19.3% harvest less than 5 kg per hive, 13.3% harvest 13 to 15 kg and only 2% of respondents harvest more than 15 kg of honey per hive per harvest. In average, more than 60% of beekeepers at Iramba District harvest less than 9 kg of honey per hive per harvest.

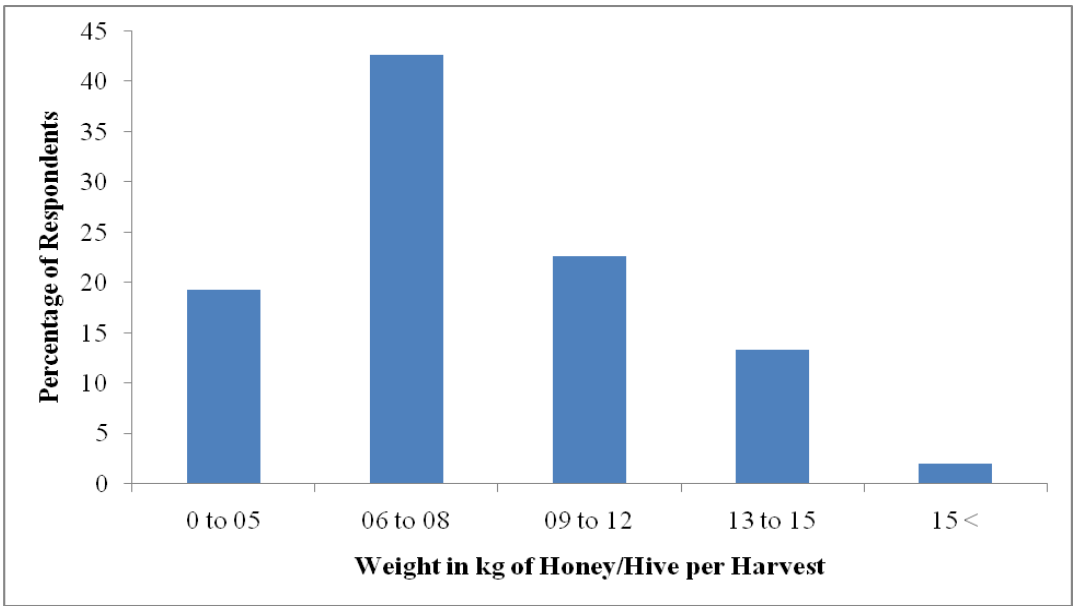

Figure 4.3: Honey Production per Hive per Harvest

These values concur with traditional hive determined earlier by Gidey and Mekonen (2010), which is 8-15 kg/hive and Jacobs, *et al* (2006), which is 5-6 kg /hive. Tessega (2009) in the modern hive produces twice as much to the traditional hives which gave 15.6 kg per hive.

The difference observed in honey yield between traditional (very common at Iramba district) and modern hive might be due to time of honey bees spent for building comb, while in the modern hive the foundation sheet prepared and given by the beekeepers. This might have helped the honey bee colonies in modern beehives to spend their time and energy on collecting nectar for honey than building new combs.

4.6 Factors Influencing Honey Production among Beekeepers at Iramba District

Production of honey is influenced by various factors some of which are environmental, socio-cultural and institutional structure. Some factors influencing honey production as reported by respondents are presented in Table 4.5.

Table 4.5: Factors Influencing Honey Production

Factors influencing honey production		Responses	
		N	Percent
	Education	127	25.1
	Absconding	68	13.5
	Poor extension services	102	20.2
	Forage availability	79	15.6
	Rainfall	129	25.5
Total		**505**	**100.0**

Results in Table 4.5 indicate the responses of beekeepers when asked about factors that influence honey production. Most of respondents reported education and rainfall to have influence on honey production where education was reported by 127 respondents (84.7%, n=150), absconding was reported by 68 respondents (45.3&, n=150), poor extension services was reported by 102 (68%, n=150), forage availability was reported by 79 respondents (52.7%, n=150) and rainfall was reported by 127 respondents (86%n=150).

Low level of education has implication on adoption of technologies, general apiary management and acquisition of information. The results correspond to results of the study done by Nyunza (2018), which asserted that low level of education may affect beekeepers' capacity to manage, keep records of honey production and in searching for local and international markets.

Honey production is sometimes affected by loss of bee colony due to absconding. When the beekeepers lost the bee colony, the suffer the consequences of reduction on

bee population and consequently reduction in honey production. Absconding of bees may be due to unfavorable environment, searching for water source or searching for good forage. Unreliable rainfall and drought affect the growth and flowering of forage that provide bees with nectar, which is a raw material for honey production. For better performance and optimum production there must be a strong extension service to build the skills of beekeepers on management of apiary, honey production and honey handling to maximize the quantity and quality of honey produced.

However, extension services on the beekeeping sector is not readily available and beekeepers mostly use traditional skills of beekeeping. These results coincide with the results reported by Birhan et al, (2019) who reported that, shortage of bee forage leads devastating problem that retards the production and productivity of honey bee colonies especially during the dearth period, the constraint is highly associated with lack of rainfall and insufficient availability of bee forage. Similarly, Guyo and Solomon (2015) reported that beekeeping and honey production is influenced by Poor extension service and lack of appropriate knowledge beekeeping.

4.7 Economic Livelihood to Beekeepers Compared to Land Tilling

According to Mujuni *et al.,* (2012), beekeeping is emerging as a very successful agricultural practice for rural area based people in less developed countries mainly due to its economic benefits from the products of this practice. Figure 4.5, indicated that majority of respondents (63.4%) have benefitted more in solving family issues than cultivating other crops. Only 33.3% shows it is just like production of other crops and only 3.3 indicated it is less than other crops.

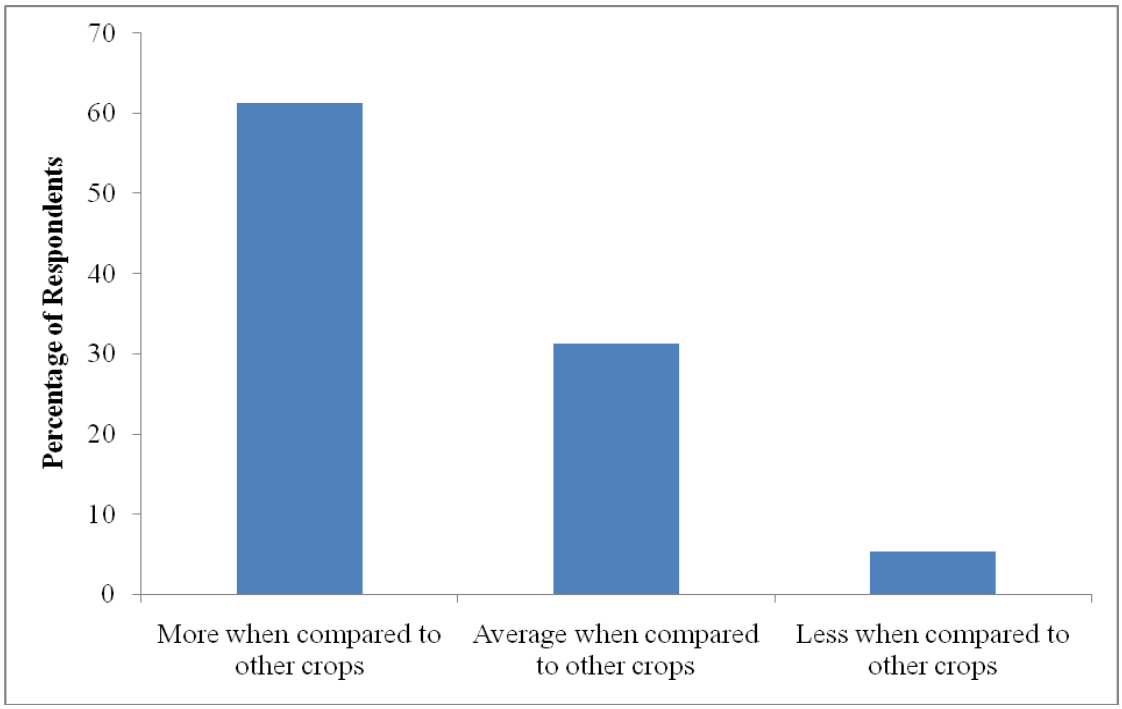

Figure 4.4: Comparisons between Beekeeping and Land Tilling as Income Sources

The implication of the above results is that given the beekeeping, livestock production and crop farming, beekeeping is a better enterprise to the study area community because it generating a higher income for smallholder farmers. These findings agreed with Dalang (2001) who noted that on a comparative basis, apiculture stands out conspicuously as a high revenue-generating venture compared to arable cropping.

During the study, respondents reported various ways in which funds from beekeeping contributes to household social-economic welfares. They reported benefits such as increased household's income, food security, poverty reduction, capital accumulation, source of medicine, payment for education and health expenses. Figure 4.6 summarizes the responses on social economic benefits of beekeeping to household's economy.

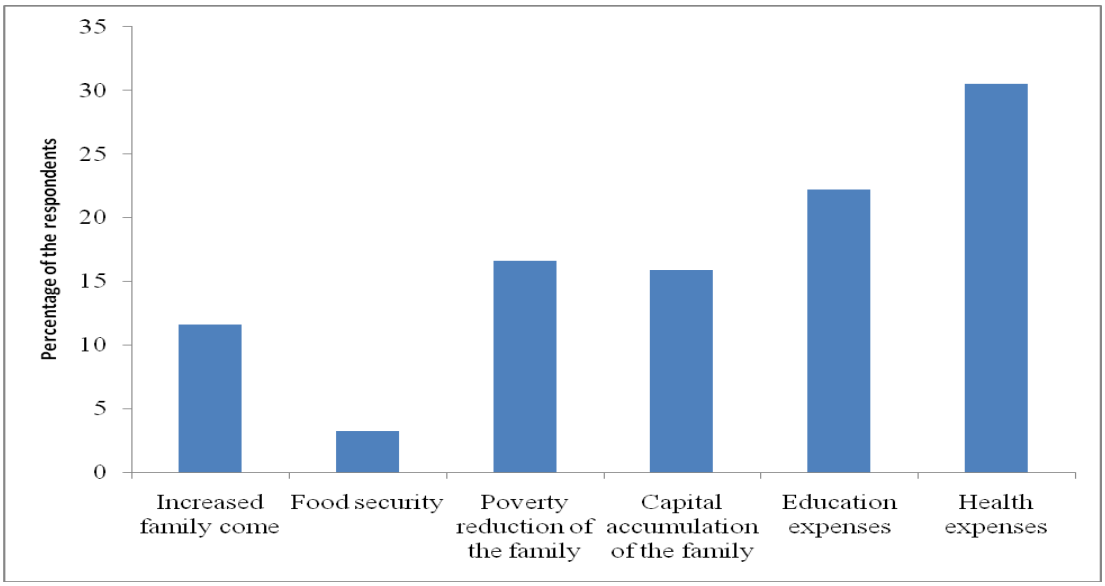

Figure 4.5: Social Economic Benefits of Beekeeping to Household's Economy

Majority of the respondents 30.5% think of covering of medical expenses to the family members. It is the truth with no doubt that family health is the key to growth and performance of household. If family members are in poor health they become weak and they cannot perform any work and that result into loss of work force. In order for the family to stay health they have to seek for medical services wherever possible and money is needed in order to access the service.

Education is an important component of human development. Parents have to pay for tuition fees, meals and accommodation for their children at various levels of education. During in-depth exploration, respondents elaborated that, income from honey helps them pay school fees, buy uniforms, stationeries for their children and any other expenses related to education. About 22% of the respondents indicated that the revenue from beekeeping help to pay for education expenses. These results correspond to those reported in Western Tanzania where beekeepers spent revenue from selling bee products to pay school fees for their children; physical assets

construct houses and buying clothes for the family (Ntalwila *et al*. 2017). Table 4.6 summarizes the responses on social economic benefits of beekeeping to household's economy.

Table 4.6: Socio-economic Benefits of Beekeeping to Household's Economy

Socio-economic benefits of bee keeping	Responses	
	N	**Percent**
Increased income	75	11.6
Food security	21	3.2
Poverty reduction	108	16.6
Capital accumulation	103	15.9
Education expenses	144	22.2
Source of medicine	57	8.8
Health expenses	141	21.7
Total	**649**	**100.0**

Responses, N exceeds the sample size because of multiple responses

Table 4.6 indicate that half of respondents (50%, n=150) reported that beekeeping contributes to increase income of the household through selling of honey where as 14% (n=150) reported that bee keeping contributes to food security by consuming honey itself and through buying food from bee products revenues. Furthermore, 72% (n=150) pointed out that beekeeping contributes to poverty reduction through house construction, pay clothes and payment for various forms of social expenses thereby improving living standards. In terms of financial assets, more respondents (68.7%, n=150) reported that money obtained from beekeeping helps to accumulate capital for family businesses. Majority (96%) of respondents (n=150) indicated that the revenue from beekeeping help to pay for education expenses. Education is an important component of human development, however, it is not given for free. Parents have to

pay for tuition fees, meals and accommodation for their children at various levels of education.

During in-depth exploration, respondents elaborated that, income from honey helps them pay school fees, buy uniforms, stationeries for their children and any other expenses related to education. More respondents (38%, n=150) reported that beekeeping is a source of medicine in that bee honey has got medicinal value to heal various human diseases where as 94% (n=150) of respondents reported to spend funds from beekeeping in payment for health. It is the truth with no doubt that family health is the key to growth and performance of household. If family members are in poor health they become weak and they cannot perform any work and that result into loss of work force.

In order for the family to stay health they have to seek for medical services wherever possible and money is needed in order to access the service. Respondents reported that funds from beekeeping help to pay for health services in terms of family health insurance, payment for health services in cash and transport expenses to health facility. These results correspond to those reported in Western Tanzania where beekeepers spent revenue from selling bee products to pay school fees for their children, physical assets construct houses and buying clothes for the family (Ntalwila *et al*., 2017).

This drives the beekeeping to unique position as an alternative economic activity that is less affected by the issues of climate change and soil fertility depletion. Respondents agreed that currently beekeeping contributes more to household's

economy than other agricultural crops. Table 4.7 shows the response on the extent to which beekeeping has contributed to household economy of the beekeepers.

Table 4.7: Contribution of Beekeeping to Household's Economy

Village	Contribution of beekeeping to household's economy compared to crop production			Total
	Contributes more	Average	Contributes less	
Kaselya	20	7	3	30
Kinampanda	12	3	0	15
Mbelekese	10	4	1	15
Mdonkolo	18	10	2	30
Ndulungu	21	9	0	30
Urughu	11	17	2	30
Total	**92**	**50**	**8**	**150**

Generally, 92 out of 150 respondents interviewed agreed that beekeeping has more contribution to households' economy compared to agricultural crops. Figure 4.7 shows average household's income from various sources.

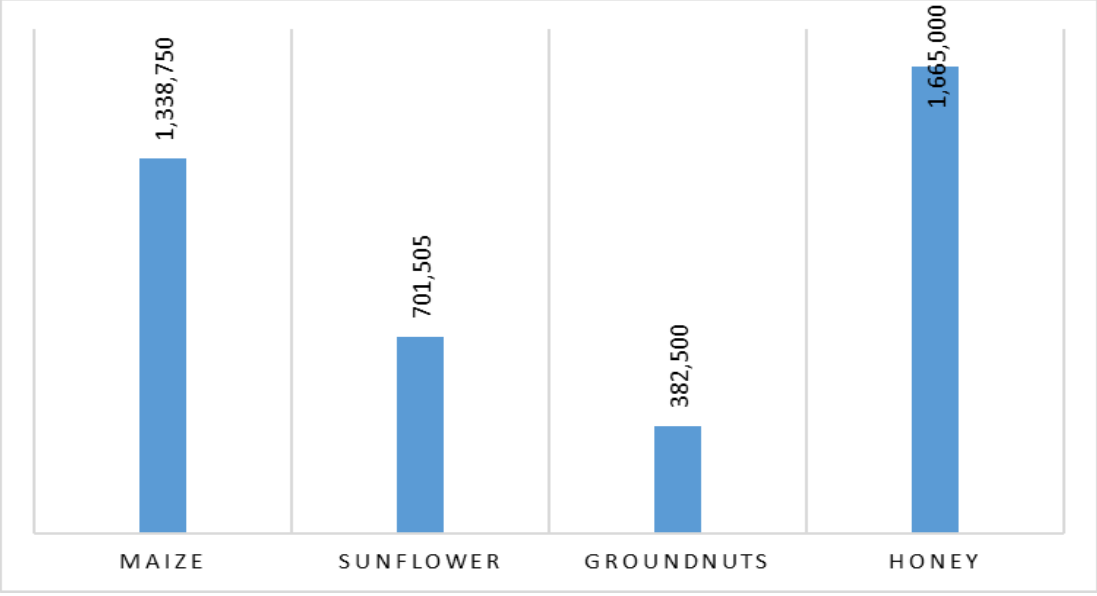

Figure 4.6: Average Household's Income From Various Sources

Figure 4.7 indicates that beekeeping (honey) has the highest contribution to household income. It contributes an average of TZS 1,665,000 annual income followed by maize, which contributes an average of TZS 1,338,750. The third is sunflower, which contributes an average of TZS 701,505, and the last is groundnuts, which contributes an average of TZS 382,500 to household's annual income.

4.8 Major Beekeeping Constraints Faced by Farmers in Iramba District

Based on the result of this study, the major constraint of limited markets, bush fire, theft of hive and products, drought, limited knowledge, pests and diseases, lack of common flowers and poor technologies as summarized in Table 4.8.

Table 4.8: Problems Facing Beekeeping

Problems facing beekeepers	Percentage
Aggressiveness of bees	1.2
Limited space	5.1
Limited market for bee products	14.2
Bush fire	15.4
Theft of hive and products	1.1
Drought	15.2
Limited knowledge	14.3
Pests and diseases	6.2
Lack of common flowers	12.7
Poor technology	14.7

When asked about the problems (constraints) that faces beekeepers, respondents reported several problems. Results in Table 4.6 show that 15.2% of the respondents reported drought is the major problem facing bee keepers at the study area. Due to drought few flowers blooms hence bees cannot access the honey. This ie evident from

number of respondents 12.7% who indicated due to drought common flowers are not available these days. Urassa, *et al.* (2016), indicated that at Iramba district, agricultural production is poorly performing, mainly due to low and erratic rainfall, which ranges between 500 and 800 mm per annum. As it is in Singida region as a whole, famine is a common phenomenon in the district due to lack of rainfall and droughts. Drought has caused many problems one of it is bush fire in which it was indicated by 15.4% of the respondents. Kumar *et al.* (2012) indicated in his study the use of fires may increase the risk of accidental wild fires especially during dry months.

Markets for honey and other bee products in Tanzania are not fully established thus make market unreliable. Beekeepers in Iramba Districts are mainly smallholders and they depend on local markets to sell the honey produced. The market is unstructured and unreliable due to inadequate customers, difficult transportation, lack of realization of the honey value and inadequate ability of beekeepers to search for markets. Namwata, *et al*, (2013) reported that bee keeping industry face a series of drawbacks namely technology, market, equipment, climate, transportation, credit accessibility, lack of training/skills and cultural practices. It also corresponds to the findings by Tutuba and Vanhaverbeke, (2018) who established that commercialization beekeeping in Tanzania is constrained by low market prices and poor, marketing systems and limited market information.

These results also coincide with Arse, *et al.,* (2010), who reported on the shortage of honeybee forages, shortage of honey bee colonies, poisoning of agro-chemicals, shortage of modern hives, prevalence of honeybee enemies and market problems,

shortage of improved bee equipment, absconding and swarming problems, prevalence of honeybee diseases, lack of knowledge of the right harvest time and theft problems as the major beekeeping. This is in line with the work of (Kerealem, *et al.,* 2005) which stipulates that drought is the main constraint of bee keeping. These constraints have a direct and indirect effect on the reproduction and productivity of honeybees.

Price is another important factor that influences beekeeping in the study area. If the price is promising, more beekeepers will be attracted. The results indicate that in Iramba District honey is priced between TZS 8,000 and 10,000 per kg of honey with the average price of 9,000. In most cases the it is sold at 8,000 per kg as indicated in table 4.9.

Table 4.9: Price (TZS) per Kg of Honey

Name of village	Price (Tsh) per Kg of honey			Total
	8000	9000	10000	
Kaselya	17	6	7	30
Kinampanda	10	0	5	15
Mbelekese	8	5	2	15
Mdonkolo	11	3	16	30
Ndulungu	18	6	6	30
Urughu	15	3	12	30
Total	**79**	**23**	**48**	**150**

As the table indicates, 79 out of 150 respondents reported to sell honey at TZS 8,000 while 23 respondents reported to sell at 9,000 and 48 respondents sold the honey at 10,000

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Introduction

The purpose of this chapter is to provide the conclusions and recommendations drawn from the findings. The aim of the study was assessment of beekeeping production as the adaptation strategies against impacts of climate change in agricultural food crops at Iramba District. This chapter have been categorized into two major sections which are conclusion from the findings and recommendations as presented and discussed in the chapter four.

5.2 Conclusion

This research was intended to assessment of beekeeping production as the adaptation strategies against impacts of climate change in agricultural food crops at Iramba District. The researcher employed purposive sampling procedure to sample the target study participants. The study was guided by four research questions stated as;

(i) What is the contribution of beekeeping to rural livelihood outcomes in Iramba District.

(ii) What are the factors influencing the adoption of beekeeping among the rural farmers in Iramba District.

(iii) What are the factors influencing honey production among beekeepers at Iramba District.

(iv) What are the major beekeeping constraints faced by farmers in Iramba District

Several empirical studies on Climate change in Tanzania were considered being one of the most serious threats to sustainable development, with adverse impacts expected on the environment, human health, food security, economic activity, natural resources and physical infrastructure. It is predicted climate change have important social implications in poverty, equity and human-rights. Results from this study shows that poor people especially women have the least capacity to adapt to rapidly changing conditions due to a wide range of social factors including: Livelihood security, poor access to and control over natural resources, food security and health conditions of both human and animals. That is why beekeeping is predominantly a male activity engaged in by the poor that live far away from markets and are largely dependent on crop production for their survival. Beekeeping is also an efficacious tool in rural development as bees are omnipresent and the required equipment and tools namely: hives, smokers and protective clothing are locally made. Due to all these factors plus its contribution to livelihood outcomes especially the guaranteed year-round financial protection, beekeeping is considered a vital component of poverty eradication in rural areas. Even though honeybees are highly important for indigenous and newly imported crops, they are under great challenge of climate change which resulted the variability of climatic elements mainly rainfall and temperature over extended period of time (decades or more). Due to the effects of climate change, trees are blooming earlier and changed in range and distribution of plants.

Additionally, there is still scant information on the monetary value of honey output which makes it more complex to estimate its contribution. This information is hardly available given poor documentation and record keeping by farmers and statistic

institutions plus little research focus on this sector. Focus is rather accorded to other livestock enterprises and major cash crops. Research also shows that during adoption of agricultural technologies, the process tends to be slowed and deterred by a number of challenges. These may be environment specific hence the importance to understand these area specific beekeeping constraints. Moreover, if the unexploited potential of beekeeping is to be met then these constraints must be identified and addressed.

Basis on the result obtained in this study, the researcher has revealed that different characteristics have got direct and indirect influence on the adoption of beekeeping among rural farmers. These parameters are age, sex, gender of household head; education level and marital status, of respondents were assessed. The climate change impact and to decline of food and cash crops to sustain family, smallholder farmers have adopted new production system as coping strategy to climate change and climate variability. That's why beekeeping has been one of the best options to Iramba smallholder farmers.

Beekeeping is emerging as a very successful agricultural practice for rural area based people in less developed countries mainly due to its economic benefits from the products of this practice.

The major constraint of beekeepers at the study area is availability of market for bee products bush fire, theft of hive and products, drought, limited knowledge, pests and diseases, lack of common flowers and poor technologies. Markets for honey and other bee products in Tanzania are not fully established thus make market unreliable. Beekeepers in Iramba Districts are mainly smallholders and they depend on local markets to sell the honey produced. The market is unstructured and unreliable due to inadequate customers, difficult transportation, lack of realization of the honey value

and inadequate ability of beekeepers to search for markets. Finding indicated that beekeeping industry face a series of drawbacks namely technology, market, equipment, climate, transportation, credit accessibility, lack of training/skills and cultural practices.

Other problems facing beekeepers are shortage of honeybee forages, shortage of honey bee colonies, poisoning due to agro-chemicals, shortage of modern hives, prevalence of honeybee enemies shortage of improved bee equipment, absconding and swarming problems, prevalence of honeybee diseases, lack of knowledge of the right harvest time and theft problems as the major beekeeping. These constraints have a direct and indirect effect on the reproduction and productivity of honeybees.

The study findings have also revealed that Iramba district households have a lower awareness about the risk associated with deforestation. Majority found to focus only on advantage of land clearing as it help to improve the plant growth and increase the productivity and production and while forget that deforestation can cause loss of biodiversity. Only few people found to have negative perception on it the researcher revealed that the education have not offered to the community to the extent that those who are direct involved with environmental destruction.

5.3 Conclusion

This study provided information on the current status of beekeeping at Iramba District as the adaptation strategies against impacts of climate change in the district. The low production of bee products at Iramba district has been attributed to the extensive use and low level of productivity of traditional beehives coupled with other inefficient traditional practices. Thus, increasing productivity that is normally associated with

higher earnings would be an important endeavour for beekeepers in particular and for the national economy at large.

Since food security cannot be achieved without income security, beekeeping could be a useful tool for improving rural economy. However, this can only have achieved provided the education level of smallholder farmers is high. The low levels of education might have forced beekeepers to largely depend on on-farm income since alternative sources of income are always limited for the uneducated people.

Due to over dependency on on-farm income sources the beekeepers are still poorer when compared to land tilling smallholder farmers. Since beekeeping participation is currently dominated by the poor and uneducated farmers, its promotion among educated farmers should be targeted to increase its production. If this target is achieved, then this might also translate into increased beekeeping income to households. This will prevent the activity from getting extinct as education levels of farmers increase in the future generations and also given that people choose their household activities based on their ability to satisfy their economic needs.

5.4 Recommendation

Based on the study findings and conclusion, several recommendations have been given out includes;

(i) There is an urgent need for government to assist farmers in searching a potential market for honey, so that farmers who involved in honey production are not discouraged by poor marketability of the products.

(ii) Government and other stakeholders should strive to support farmers by supplying relevant hives and extension services to farmers. This will encourage farmer improvement and commercialization of honey.

(iii) The local government and other authorizes have to ensure that the forest and natural resources are not fired so as to overcome air pollution and destruction of bee colonies.

(iv) Farmers need to be offered intensive education, with aim of raising their awareness concerning environmental conservation. This will reduce the risk not only to them but also to the livestock keepers.

(v) Initiation of education campaigns among farmers and community at large on the potentiality of beekeeping in terms of nutrition and income generating need to considered. Education on marketing need to be extended since it has a indirect influence on the income farmers could get from various agricultural produce.

(vi) Awareness should be created on the value of honeybees for crop pollination, improving the crop yield and quality to ensure food security. Farmers should also be aware of saving honeybee colonies from misuses of agrochemicals applied on cereals, pulses, legumes and horticultural crops during flowering.

(vii) Designing local or scientific prevention and control methods for emerging honeybee pests, predators and climate change adaptive feed sources is timely.

5.5 Areas for Further Studies

(i) To assess how honeybee colonies are supplemented on critical emergency and death periods caused by direct or indirect effects of climate change. Research

should be done on selecting and multiplying of local honeybee species resilient to changing climate.

(ii) Evaluation on suitable soil conditions that could be suitable for a certain food crop production at the same time beekeeping in order to reduce food insecurity and income at house hold level and National at large.

(iii) There is a need of more studies to enhance knowledge on the basic ecology of crop pollination under the severe climate change conditions

(iv) To identify impacts of climate changes and variability and change on beekeeping in central Tanzania.

(v) To identify climate change related factors, which influence honey bee productivity at semi-arid areas.

REFERENCES

Adam, F. (1985). *Les croisements et l'apiculture de demain*. Paris: SNA.

Ahmed, S., Deffenbaugh, N., Hertel, T,. Lobell, D., Ramankutty, N., Rios, A., and Rowhani, P., (2011). Climate volatility and poverty vulnerability in Tanzania. *Journal of Global Environmental Change, 21(4),* 46-55.

Alison, B., and McCallum, B. (2009). *Keeping Bees and Making Honey*. Charles. Brunel House, Newton Abbot, Devon. Published by KHL printing Co Pte Ltd.

Arse, G., Tesfaye, K., Sebsibe, Z., Tekalign, G., Gurmessa, U., Tesfaye, L., and Feyisa, H. (2010). Participatory rural appraisal investigation on beekeeping in Arsi Negelle and Shashemene districts of West Arsi zone of Oromia, Ethiopia. Livest. *Research Rural Development Journal 22:*120.

Augustino, S., Kashaigili, J. J., and Nzunda, E. F. (2016). Impact of Traditional Beekeeping on Mgori Village Land Forest Reserve in Singida District, Tanzania. Sokoine University of Agriculture, Morogoro, Tanzania.

Ayalewm K. (1983). *Beekeeping extension activities in Ethiopia.* Addis Ababa: Juniper Publishers.

Ayalew K. (2001). Promotion of beekeeping in rural sector of Ethiopia. Proceedings of the third National Annual Conference of Ethiopian Beekeepers Association (EBA), Addis Ababa, Ethiopia, 52-58.

Aynalem, T. (2017), Beekeeping, Climate Change and Food Security: The Case of Eastern Amhara Region, Ethiopia, *Livestock Research for Rural Development* 29(5) 45 – 56.

Below, T. (2010). “Factors Influencing the Decision to Adapt to Climate Change: The Cases of two Wards in Rural Tanzania. Tropentag 2010, Presented in September 14–16, Zurich, Germany.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S. Siebert, R., and Tscherning, K. (2012). “Can Farmers’ Adaptation to Climate Change be Explained by Socio-Economic Household-Level Variables?” *Global Environmental Change* 22(1), 223–235.

Birhan, M., Selomon, S., and Zebene, G, (2015). Assessment of Challenges and Opportunities of Bee Keeping in and Around Gondar. *Academic Journal of Entomology 8*(3): 127-131.

Chala, K., Taye, T., and Kebede, D. (2012). Assessment of Honey Production and Marketing System in Gomma district, South Western Ethiopia. Greener *Journal of Business Management Studies* 3(3): 099-107.

Chokkalingamm U. (2004). Fire, Livelihoods and Environmental Degradation in the Wetlands of Indonesia: A Vicious Cycle: Environmental Services and Sustainable Use of Forests Programme. Fire Brief, No. 3.

Collier, P., and Dercon, S. (2014). African Agriculture in 50 Years: Smallholders in a Rapidly Changing World? *World Development.* **63**:92-101.

Creswell, J. (2003). *Research Design, Qualitative, Quantitative and Mixed Method Approaches*. New York: SAGE Publication, Inc.

DAPS (Direction de l’Analyse, De la Prévision et de la Synthèse), (1995). Définition Dune stratégie De Développement de la Filière Apical au Bénin. MDR, Projetconseil technique, GTZ. 58pp.

Deresa, T. T., R. M. Hassan, C., Ringler, T., Alemu and Yesuf, M. (2009). Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change 19*: 248-255.

Doss C. R. (2006). Analyzing Technology Adoption Using Micro Studies: Limitations, Challenges, and Opportunities for Improvement. *Agricultural Economics* 34(3), 207-219.

Edessa N. (2002). Survey of Honey Production System, in West Shewa zone. In: Proceedings of the 4th Ethiopian Beekeepers Association, held in Addis Ababa, Ethiopia, October 25-26, 2002.

Edessa, N. (2002). Survey on honey production system in West Shewa Zone. (unpublished) dissertation. Holeta Bee Research Center (HBRC), Ethiopia, 15p.

Ekaya, W. N. (2007). *Strategies for Developing Dry land Agriculture: Role of Knowledge.* Nairobi: University of Nairobi.

Ellis, A., Ellis, D. O'Malley, J., Zettel, M. K., and Nalen, C. M. (2010). The Benefits of Pollen to Honey Bees: UF/IFAS Extension. Retrieved on 11th July 2020 from: http://edis.ifas.ufl.edu.

FAO, (1998). Proceedings of Sub-Regional Workshop on Forestry Statistics IGAD region, Nakuru, Kenya, 12-16 October, 1998.

FAO, (2009). Bees and their Role in Forest Livelihoods, by N. Bradbear, Non-wood forest products No. 19, Rome, Italy.

FAO, (2012). Beekeeping and Sustainable Livelihood: Rural Infrastructure and Agro-Industries:Food and Agriculture Organization of the United Nations, Rome, Italy.

Fishbein, M. and Ajzen, I., (1975). *Belief, Attitude, Intention, and Behavior: an Introduction to Theory and Research*. Reading, MA: Addison-Wesley.

Gbetibouo, G. A. (2009). Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability. The Case of the Limpopo Basin, South Africa. Environment and Production Technology Division. IFPRI Discussion paper 00849. International Food Policy Research Institute. Washington, DC., USA.

Gregory, P. J., George, T. S. (2011). Feeding nine billion: the challenge to sustainable crop production. *Journal of Experimental Botany*, 62, 5233–5239.

Gupta, R. K, Reybroeck W, van Veen J. W,, and Gupta A. (2014). *Beekeeping for Poverty Alleviation and Livelihood Security*. New York: Springer;

Guyo, S., and Solomon, L., (2015). Review on Beekeeping Activities, Opportunities, Challenges and Marketing in Ethiopia. *Journal of Harmonized Research in Applied Sciences, 2015, 3(4),* 201-214.

Gwambene, B., and Majule, A. E. (2010). "Contribution of Tillage Practices on Adaptation to Climate Change and Variability on Agricultural Productions in Semiarid Areas of Central Tanzania." 9th European IFSA Symposium, 4–7 July 2010, Vienna, Austria.

Hartmann, D. L., Klein T., Albert M. G., and Rusticucci, M. (2013). Observations, Atmosphere and Surface, IPCC WGI AR5 Report p. 198

Hope, K. R. (2009) Climate Change and Poverty in Africa. *International Journal of Sustainable Development and World Ecology*. 16(6), 451-461

International Trade Centre, (2015). *Honey Sector Synthesis Report & Development* Road Map: Geneva.

IPCC, (1996). Climate Change (1995), Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses - Contribution of Working Group II to the IPCC Second Assessment Report.

IPCC, (2001). Climate Change (2001). Impacts, *Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K .S. White, Eds., Cambridg.: Cambridge Univ. Press.

IPCC, (2007). Climate Change, Impacts, Adaptation and Vulnerability, in M.Parry, O. Canziani, J. Palutikof, P. vander Linden, C. Hanson (eds), Contribution of Working Group II to the Fourth Assessment Report on Climate Change, Cambridge: Cambridge University Press.

Kahimba, F. C., Sife, A. S., Maliondo, S. M. S., Mpeta, E. J., and Olson, J. (2015). Climate Change and Food Security in Tanzania: Analysis of Current Knowledge and Research Gaps: *Tanzania Journal of Agricultural Sciences 14(1)*, 21-33.

Keralem, E. (2005). Honey bee production system, opportunities and challenges in Enebse Sar Midir Wereda (Amhara Region) and Amaro Special Wereda (Southern Nations, Nationalities and Peoples Region), Ethiopia. M.Sc. thesis presented to Alemaya University, Ethiopia.

Kerealem E, Gebey T, and Preston T. R. (2009). Constraints and prospects for apiculture research and development in Amhara region, Ethiopia. *Livest. Research Rural Development* 21: 172 – 186.

Kidd, A. D., Christoplos, I., Farrington, J., and Beckman, M. (2001). Extension, Poverty and Vulnerability in Uganda: Country Study for The Neuchatel Initiative: Overseas Development Institute.

Kihwele, D. V. N. (1991). Paper presented on Annual Seminal of R & D Advisory Committee on natural resources research. 4 July, 1991. Dar es Salaam, MNRT. pp 54:4.

Klein, A. M, Vaissiere, B. E., Cane J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., and Tscharntke, T. (2007) Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B-Biological Sciences, 274,* 303–313.

Kokoye, S. J. (1991). Guide Critique Dimidiation Al'apiculture Tropicale. Service Production Animate du CARDER-Atacora (Bénin). Ministère du Développement Rural. 152pp.

Kritsky, G. (2015). *The Tears of Re: Beekeeping in Ancient Egypt.* New York: Oxford University Press, NYISBN: 978-0-199-36138-0$29.95.

Kuboja, N. M. (2017), Economic Efficiency of Beekeeping and its Implications on Household Income among Beekeepers in Tabora And Katavi Regions, Tanzania Degree Of Doctor Of Philosophy Sokoine Univeristy of Agriculture, Morogoro, Tanzania.

Le Conte, Y., and Navajas, M. (2008) Climate Change: Impact on Honey Bee Populations and Diseases, *Office of International Office of Epizootics, 27(2) 499-*510.

Lema, M. A., and Majule A. E. (2009). Impacts of Climate Change, Variability and Adaptation Strategies on Agriculture in Semi-Arid Areas of Tanzania: The Case of Manyoni District in Singida Region. *African Journal of Environmental Science and Technology* 3(8) 206–218.

Lijalem, T., Zereu, G., Tebeje, M. (2017). Opportunities and Constraints of Beekeeping in Wolaita and Dawro zones, Southern Ethiopia: Agriculture College, Wolaita Sodo University, Ethiopia.

Liwenga, E. T., Kangalawe R. Y. M., Lyimo, J. G., Majule, A. E., and Ngana, J. O. (2007). Research Protocols for Assessing the Impact of CC & V in Rural Tanzania: Water, Food Systems, Vulnerability and Adaptation. START/PACOM, African Global Change Research.

Lobell, D. B., Schlenker, W., and Costa-Roberts, J. (2011). Climate Trends and Global Crop Production Since 1980. *Journal of Science*, 333, 616–620.

Maarec, (2009). Beekeeping Basics. Delaware, Maryland, New Jersey, Pennsylvania, West Virginia,

Majule, A. E., and Mary, A. L. (2009). Impacts of Climate Change, Variability and Adaptation Strategies on Agriculture in Semi Arid areas of Tanzania: The Case of Manyoni District in Singida Region, Tanzania, *Af. J. Env Sc and Tech* **3**(8)206 – 218.

Mbilinyi, A., Saibul, G. O., Kazi, V. (2013). Small Scale Farmers: Voices of Farmers in Village Communities in Tanzania: Economic and Social Research Foundation; Dar es Salaam, Tanzania.

McGuire, J., Morton, L., and Cast, A., (2013). Reconstructing the good farmer identity: shifts in farmer identities and farm management practices to improve water quality. *Agric Hum Values* 30: 57–69.

Mmbengwa V. M. (2009). Capacity Building Strategies for Sustainable Farming SMMEs in South Africa, PhD (Agricultural Economics) Dissertation, University of the free state, Bloemfontein

Mongi, H., Majule A. E., and Lyimo, J. G. (2009). "Vulnerability and Adaptation of Rain Fed Agriculture to Climate Change and Variability in Semi-Arid Tanzania." *African Jour of Envir. Science and Technology 4(6)* 371–381

Mubaya, C.P., Nyuki, J., Liwenga, E., Mutsavangwa, E.P., and Mugabe, F.T., (2010) Percerived Impacts of Climate change related Parameters. *Journal of Sustainable Development in Africa.* 12 (5) 170-186.

Muhammad, R. J., Abdurrahman, S., and Yusuf, E. L. S. (2006). A comparative analysis of beekeeping and crop production in Adamawa State, Nigeria. *Apiacta* 41:44-53

Mujuni, A., Natukunda, K., and Kugonza, D. (2012). Factors Affecting the Adoption of Beekeeping and Associated Technologies in Bushenyi District, Western Uganda. Livestock Research for Rural Development, 24:08.

Mujuni, A., Natukunda, K., and Kugonza, D. R. (2014). *Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda*. Makerere University, Uganda

Müller, C., Cramer, W., Hare, W.L., and Lotze-Campen, H. (2011). "Climate Change Risks for African Agriculture." *Proceedings of the National Academy of Sciences of the United States of America (PNAS) 11: 4313*–4315.

Mwakatobe, A. and Mlingwa, C. (2001). Tanzania-The status of Tanzanian honey Trade- Domestic and International Markets. Tanzania Wildlife Research Institute, Arusha. Tanzania.

Namwata B. M. L., Mdundo K. J., and Malila M. N. (2013). Potentials and Challenges of Beekeeping Industry in Balang'dalalu Ward, Hanang' District in Manyara, Tanzania. *Kivukoni Journal*, *1*(2), 75 -93.

National Research Council, (2007). Status of Pollinators in North America. Washington, DC: The National Academies Press: USA; ISBN 978-0-309-102896

Ndyomugyenyi, E., Odel, I., and Okeng, B. (2008), Assessing Honey Production Value Chain in Lira Sub-county, Lira district, Northern Uganda. *Livestock Research for Rural Development.* **20**(5), 7-90.

Ngana J. O. (1983). Rainfall and Agriculture, Droughts and Famine in Dodoma District. Inst. of Resour. Assessment, University of Dar es Salaam, Dares Salaam, Tanzania. Res. Report No. 60, New Series.

Ntalwila J., Mwakatobe A. Kipemba N., Mrisha C., and Kohi E. (2017). Contribution of beekeeping to livelihood and biodiversity conservation in–Inyonga Division (Mlele district) Western Tanzania. *International Journal of Entomology Research*, *2*(6), 33 – 38.

Nyunza, G. (2018). Anthropogenic and Climatic factors Affecting Honey Production: The Case of Selected Villages in Manyoni District. University of Dar es salaam, Tanzania (Unpublished) Dissertation, UDSM, Tanzania.

Paji, K. (2016). Contribution of Beekeeping towards Rural Household Livelihood in Tanzania: The Case of Two Selected Wards Mlali and Chamkoroma in Kongwa District, Dodoma; Master's Thesis.

Porter, J. R., and Semenov M. A. (2005) Crop Responses to Climatic Variation. Philosophical Transactions of the Royal Society B: *Biol Scie*, 360, 2021–2035.

Reddy, P. V., Verghese, A., and Rajan, V. V. (2012). Potential Impact of Climate Change on Honeybees (Apis spp.) and their Pollination Services, *Pest Management in Horticultural Ecosystems*, 18(2), 121-127.

Rusterholz, H. P., and Erhardt, A. (1998) Effects of elevated CO_2 on Flowering Phenology and Nectar Production of Nectar Plants Important for Butterflies of Calcareous Grasslands. *Oecologia*, **113**: 341-349.

Sacco S. J, Jones A. M., and Sacco R. L. (2014), Incorporating Global Sustainability in the Business Language Curriculum. *Global Business Languages. 19(1):* 3

Sammataro D. (1978). Appropriate Technologies for rural development, Lesson plans for beekeeping in the Philippines, Cavite, Philippines. http://www.beekeeping.com/articles/us/philippines/.

Seegeren, P., Mulder, V., Beetsma, J., and Sommeijer, R. (1996). *Beekeeping in the Tropics. Agrodok Series No. **32** Agromisa Sixth edition.* London: Wageningen Publisher.

Shemdoe, R. S., Van Damme, P., and Kikula, S. (2009). "Increasing Crop Yield in Water Scarce Environments Using Locally Available Materials: An Experience From Semi-Arid Areas in Mpwapwa District, Central Tanzania." *Agricultural Water Management* 96(6), 963–96.

Shemsanga, C., Omambia, A. N., and Gu, Y. (2010). "The Cost of Climate Change in Tanzania: Impacts and Adaptations." *Journal of American Science*, 6(3), 182–196.

Shenkute, A. G., Getachew, Y, Assefa, D, Adgaba, N, Ganga, G, Abebe, W. (2012). Honey production systems (Apis melliferaL.) in Kaffa, Sheka and Bench-Maji zones of Ethiopia. *J. Agric. Ext. Rural Dev.* 4(19), 528-541.

Steinhauer, N., Rennich, K., Caron, D., Ellis, J. D., Koenig, P., Kulhanek, K., Klepps, J., Lee, K., Milbrath, M., Rangel, J. et al., (2017). Colony Loss 2016–2017: Preliminary Results. Available online: https://beeinformed.org.

Temu, A. (2007). "Agriculture Development for Economic Growth: Are we addressing 'The' Problem?" presentation at Sokoine University of Agriculture, Conference held on 11th – 15th July 2017 in Morogoro, Tanzania.

Tilman, D., Balzer, C., Hill, J., and Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. Proceedings of the National Academy of Sciences, 108, 20260–20264.

Tutuba N., and Vanhaverbeke, W. (2018). Beekeeping in Tanzania: why is beekeeping not commercially viable in Mvomero? *Afrika Focus*, *31*(1), 213-239. 10.21825/af.v31i1.9047.

Tylor, M. (2019). *Insect of the Week: Beekeeping in Ancient Egypt*. Cairo: Princeton University Press.

UNDP (2004) Meeting the Climate Challenge Sustaining Livelihoods: Lessons for the Future. United nations Development Programme and Global Environmental Facility.

UNFCCC, (2007). Investments and Financial Flows to Address Climate Change, Background Paper on Analysis of Existing and Planned Investments and Financial Flows Relevant to the Development of Effective and Appropriate International Response to Climate Change, p. 273.

UNFCCC, (2007). Climate Change: Impacts, Vulnerability and Adaptation in Developing Countries. Climate change Secretariat. UNFCCC. Bonn.

Urassa, J. K., Nombo, C. I., Kabote, S. J., Mamiro, D. P., M. bwambo, J. S., Mattee, A. Z., Matata, L. M., and Synneå**g**, G. (2016). Climate change and its variability on crop production in semiarid areas of Iramba and Meatu Districts, Tanzania. *African Development, Vol. 32, Special Issue*, 2016.

URT, (1998). Tanzania National Forest Policy. Ministry of Natural Resources and Tourism (MNRT) Dar es Salaam. 59pp.

URT, (2006). Agricultural Sector Review 2006: Performance, Issues and Options, Ministry of Agriculture, Food Security and Co-operatives, October, Dar es Salaam.

URT, (2007). Agricultural Sector and Public Expenditure Review for 2007/08, Zero Draft, Ministry of Agriculture, Food Security and Co-operatives, November, Dar es Salaam.

URT, (2013). Review of food and agricultural policies in theUnited Republic of Tanzania. MAFAP Country Report Series, FAO, Rome, Italy.

Wilcove, D. S., Rothstein, D. Dubow, J., Phillips A., and Losos. E. (1998). Quantifying threats to imperiled species in the United States. *BioScience 48:* 607-615.

Williams, I. H. (1996). *Aspects of bee diversity and crop pollination in the European Union. In The conservation of bees. Linnean Society Symposium Series No. 18 (A. Matheson, S.L. Buchmann, C. O'Toole, P. Westrich & I.H. Williams, eds).* London: Academic Press.

APPENDICES

Appendix 1: Questionnaires

Title : **ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE AND THEIR COPPING STRATEGIES IN BEEKEEPING AT IRAMBA DISTRICT**

Questionnaire Number |____|____|____|____|

ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE AND THEIR COPPING STRATEGIES IN BEEKEEPING AT IRAMBA DISTRICT

HOUSEHOLD QUESTIONNAIRE

Household identification and interview summary

District (name):_____ Ward

_____

Village name: _____

D D M M Y Y Y Y

Date of interview |__|___||___|___||___|___|___|___|

Time_____

SECTION A: HOUSEHOLD CHARACTERISTICS

1. Age of respondent_____(Years)

2. Sex 1=Male |_____| 2= Female |_____|

3. Marital status 1= single, |__| 2= married |__| 3= separated |__|4= divorced|__| 5= widower |__|

4. Gender of household head: 1. Male |__| 2. Female |__|

5. What is your education level?

1. Incomplete primary |_____|2. Complete primary |_____| 3. Incomplete secondary |_____| 4. Complete secondary |_____| 5. College/University|_ _|

SECTION B: FARM ASSET OWNERSHIP

6. How much land does your household own (acres) and how did you acquire the land the household owns?

Plots (pieces)	Size of plot in acres	How was acquired *1	Condition of the field*2 1. Good 2. Average 3. Bad 4. Worse
1			
2			
3			
4			
Total			

*1: How was acquired: 1. Inherited 2. Purchased 3. Cleared the bush/ forest 4. Given by Village Council

SECTION C: AGRICULTURAL PRODUCTION AND TRENDS

7. What crops do your household grow (Tick all that apply) and why do you grow such crops?

1. Maize	1. Food	2. Cash	3. Food & Cash	4. Do not grow
2. Beans	1. Food	2. Cash	3. Food & Cash	4. Do not grow
3. Cowpeas	1. Food	2. Cash	3. Food & Cash	4. Do not grow
4. Irish potatoes	1. Food	2. Cash	3. Food & Cash	4. Do not grow
5. Sunflower	1. Food	2. Cash	3. Food & Cash	4. Do not grow
6. Sweet potato	1. Food	2. Cash	3. Food & Cash	4. Do not grow
7. Vegetable	1. Food	2. Cash	3. Food & Cash	4. Do not grow
8. Rice	1. Food	2. Cash	3. Food & Cash	4. Do not grow

9. Other crops (specify)

8. Historical patterns of crop productivity (per acre, during the last 30 years)

1 Maize 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

2 Beans 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

3 Cowpeas 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

4 Irish potatoes 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

5 Sunflower 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

6 Sweet potato 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

7 Vegetable 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

8 Rice 1. Increasing 2. Decreasing 3. Fluctuating 4. Do not know 5. No change

9 Other crops (specify)

9. Estimates of Crop yield change over the past 30 years for selected common crops (in KG unit)

Type	**Yield (per acre) last season (Kg or bags)**	**Yield in past 30 years (Kg or bags)**
1 Maize		
2 Beans		
3 Cowpeas		
4 Green Peas		
5 Irish potatoes		
6 Sweet potato		
7 vegetables		
8 Rice		
9 Other crops (specify)		

SECTION D: COMMUNITY ADAPTATION/COPPYING STRATEGIES TO CLIMATE CHANGE

10. Have you changed your farming practices in order to respond to the change in climate? **1. YES 2. NO**

11. What are the practices you have adopted in order to increase crop production under the changing climate? Please use the key below the table to indicate the effectiveness of the practice in improving productivity

Climate-smart practice adopted	**1. Yes 2. No**	**Effectiveness of the practice***1.
1. Crop rotation		
2. Mixed cropping		
3. Ways of land preparation e.g. minimum tillage		
4. Use of agricultural inputs. E.g inorganic fertilizers,		
5. Pest control by using pesticides		
6. Water harvesting (specify method and what crop)		
7. Micro-irrigation		
8. Cultivation in valley bottoms		
9. Timing of farm operations		
10. Planting drought tolerant varieties		
11. Planting early maturing varieties		
12. Planting high yielding		

Climate-smart practice adopted	**1. Yes 2. No**	**Effectiveness of the practice***1.
varieties (what crops, varieties and hectare)		
13. Reducing area cultivated		
14. Planting high value crops		
15. Agro-forestry		
16. Mulching		
17. Terracing		
18. Tie ridges		
19. Sunken beds (majaruba)		
20. Crop residue incorporation		
21. Use of composite manure		
22. Use of farm-yard manure		
23. Use of green manure		
24. Agricultural mechanization		

*1. Most effective 2. Effective 3. Less effective 4. Not effective at all

12. What are the other climate change coping /adaptation strategies undertaken by your household? ? Please use the key below the table to indicate the effectiveness of the coping/adaptation strategy)

S/N	**Measures/strategies used to adapt to climate change**	**1. Yes 2. No**	**Effectiveness of the strategies*1**
1	Emphasis on livestock keeping instead of crops		
2	Emphasis on small livestock (small animals)		
3	Distributing livestock herds to different places		
4	Seasonal migration of livestock keepers		

S/N	Measures/strategies used to adapt to climate change	1. Yes 2. No	Effectiveness of the strategies*1
	(Nomadism)		
5	Buying food to bridge food shortage gap		
6	Collecting wild foods		
7	Increased exploitation of forests (Encroachment into protected areas)		
8	Increased exploitation of water resource areas		
9	Movement to key resource-endowed areas (Rural-rural migration)		
10	Social networking		
11	Movement to urban centres during food shortages (Rural – Urban migration)		
12	Relying on remittance		
13	Others (specify)		

***1= Effectiveness of the coping/adaptation strategy: 1. Very effective 2. Effective 3. Not effective 4. Do not know**

SECTION E: REASONS FOR ADOPTING BEEKEEPING

13. What attracted you to beekeeping? Tick and add if not on the list

S/N	Attribute	Tick
1	Relative	
2	Personal interest	
3	Training	
4	For Income purpose	
5	NGOs	
6	Others (Please Specify)	

14**.** Which aspects of beekeeping do you know? Please tick and add

S/No	Beekeeping knowledge	Tick
1	Local Hive Construction	
2	Capturing Swarms	
3	Pest And Disease Control	
4	Honey Harvesting And Processing	
5	Bee Forage Calendar	
6	Other Product Processing	
7	Feeding (Water)	
8	Proper Hive Inspection	
9	Colony Multiplication Techniques	
10	Hive Sitting	

15. What problems do you face in beekeeping**? Choose at least 6**

S/No	Challenge	Tick
1	Aggressiveness Of Bees	
2	Limited Space	
3	Limited Market For Our Products	
4	Bush Fires	
5	Theft Of Hives And Product	
6	Drought	
7	Limited Knowledge	
8	Pest And Diseases	
9	Lack of common flowers	
10	Any other (Specify)……	

16. Which Products do you harvest; what is the annual yield; what do you do to them? And what is the price per kg of each of the products?

S/No	**Product**	**Quantity/year**	**Uses**		
			Home use	**Selling**	**Price/kg**
	Honey				
	Bees wax				
	Propolis				
	Pollen				
	Bees				

Thank you for your cooperation

Appendix II: Letter authorizing to collect data in the study area

THE OPEN UNIVERSITY OF TANZANIA

DIRECTORATE OF POSTGRADUATE STUDIES

P.O. Box 23409
Dar es Salaam, Tanzania
http://www.openuniversity.ac.tz

Tel: 255-22-2668992/2668445
ext.2101
Fax: 255-22-2668759
E-mail: dpgs@out.ac.tz

REF: PG201705541

7th February 2020

District Executive Director,
Iramba District,
P. O. Box 155,
SINGIDA.

RE: RESEARCH CLEARANCE

The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007. In line with the Charter, the Open University mission is to generate and apply knowledge through research.

To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you Mr. Ziwa, Elia Yohana, Reg. No: PG201705541 pursuing Master of Environmental Studies (MES). We here by grant this clearance to conduct a research titled "*Assessment of Bee Keeping Production as the Adaptation Strategies against Impacts of Climate Change in Agricultural Food Crops at Iramba District*". He will collect his data in your district between 15th February to 30th March 2020.

In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O. Box 23409, Dar es Salaam. Tel: 022-2-2668820.We lastly, thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours Sincerely,

Prof. Hossea Rwegoshora
For: VICE CHANCELLOR
THE OPEN UNIVERSITY OF TANZANIA

IRAMBA DISTRICT COUNCIL

SINGIDA REGION:
TEL. NO. 026 – 2532253
" " 026 - 2533001
FAX NO. 026 - 2532253
E-mail: ded.irambadc@singida.go.tz

DISTRICT EXECUTIVE DIRECTOR'S OFFICE
S.L.P. 156
KIOMBOI/IRAMBA

Ref. No. DED/IRA/ E.10/30/252 **10th February, 2020**

The Open University,
P.O. BOX 23409,
DA RE SALAAM.

RE: RESEARCH CLEARANCE.

Refer to the letter dated 07th February 2020 with reference No. PG201705541 concerning the above subject.

The Iramba District Council is hereby granting **Mr. Ziwa Elias Yohana** a research permit with respect to his Master of Environmental Studies (MES) research on " ***Assessment of Bee Keeping Production as the Adaptation Strategies against Impacts of Climate Change in Agricultural Food Crops.*** **The Case of Iramba District Council"** from 15th February to 30th March, 2020. He will report to District Executive Director's Office for further instructions.

The Council shall not bear any financial obligation during this research.

Gilbert Mbowe
For: DISTRICT EXECUTIVE DIRECTOR,
IRAMBA.

FOR: DISTRICT EXECUTIVE DIRECTOR
IRAMBA DISTRICT COUNCIL

Copy to: District Executive Director,
KIOMBOI/IRAMBA.

"Ziwa Elias Yohana

"DAICO"

Appendix IV: Published Papers

(Yamane, 1967). Table 1 shows calculation for the distribution of respondents per village.

Table 1: Calculation of Distribution of respondents per village

Ward	Village Name	Total HH	Estimation	Respondents
Ndago	Mdonkolo	477	115/2279× 477	24
	Songambele	615	115/2279 ×615	31
Kinampanda	Kyalosangi	651	115/2279 ×651	33
	Galangala	536	115/2279 ×536	27
TOTAL		**2,279**		**115**

Source: Iramba Beekeeping Officer

Table 2 shows the profile of respondents. Primary data sources includes focus group discussions (n=6 for each ward), interviews with key informants (n = 8) consisting of village elders and agricultural extension officers. Household survey (n=150) and direct field observation through transect walks were other sources of primary data. Field observation was deemed necessary in order to confirm some of the issues raised during focus group discussions and the household survey.

Table 2: Respondents Profile

Category	Number
Household Head (Beekeepers)	115
Villages executive officer (VEO)	4
Ward executive officer (WEO)	2
Village Community Development Offices	4

District Beekeeping Officer (DBO)	1
District Forest Officers (DFO)	1
Agriculture Extension Officers	8
Beekeeping NGO working in study area	5
Village leaders	10
Total	**150**

Formation of FGD involved a purposive selection of ten (10) members who represented households, where five (5) represented beekeepers households and village elders, while three (3) represented agricultural extension offices, two (2) represented extension officers, two (2) beekeeping NGO representative. Secondary data such as publication materials such as books, journal papers, original scientific work, government reports and academic dissertation were consulted during review to identify and bridge up the gap basing on the study's objective.

Quantitative data were gathered using structured questionnaires as the main tool. The structured questionnaire covered questions on main trends of crop production in five years, the factors influencing beekeeping practices, the quantity of honey produced, the implication of the financial obtained to food security, and the major constraints in beekeeping. Multiple response questions were analyzed so as to get frequencies and percentages. After being collected from the field using questionnaire, primary data were edited before punching them into the computer software Statistical Package for Social Sciences (SPSS 11.5). Data were analyzed mainly at univariate level where descriptive statistics and frequencies for study variable were computed. Analyzed data in this paper have been mainly presented in tables and graphs for meaningful interpretation and discussion.

FINDINGS AND DISCUSSION

Respondents' characteristics

Different characteristics have direct and indirect influence on the adoption of bee keeping among rural farmers. During the study, different parameters such as age, sex, gender of household head, education level

and marital status, of respondents were assessed. The results and responses are shown in Table 3. Out of the 150 total respondents, 70% were male. This agreed with what have been observed earlier (Mujuni *et al.,* 2012) in which they indicated that in most of African countries like Uganda, Kenya and Zambia beekeeping has often been considered a male-dominated enterprise. According to study conducted earlier (Qaiser *et al.,* 2013), African women often encounter social and cultural constraints that hinder them from performing apiary cultural practices.

Table 3: Socio Demographic Characteristics of Respondents (n = 150)

Respondents characteristics		**Frequency**	**Percent**
Age of respondent (Years)	31-40	18	12.0
	41-50	67	44.7
	51-60	57	38.0
	61 and above	8	5.3
	Total	**150**	**100.0**
Sex of respondent	Male	105	70.0
	Female	45	30.0
	Total	**150**	**100.0**
Marital status	Single	43	28.7
	Married	82	54.7
	Separated	10	6.7
	Divorced	5	3.3
	Widowed	10	6.7
	Total	**150**	**100.0**
Gender of household head	Male	118	78.7
	Female	32	21.3
	Total	**150**	**100.0**

Education level	Non-Primary education	22	14.7
	Complete primary	113	75.3
	Above primary education	15	10.0
	Total	**150**	**100.0**

These are bee-sting phobia, lack of time due to taking care of family matters, inability to raise and harvest from the traditional bee-hive. The small percentages of women practicing beekeeping could be those who are either separated, divorced or widowed, and hence were the sole breadwinners for their family. Namwata*et al.* (2013) indicate few women participate in beekeeping, their apiaries are located on farms nearby their homes, and beehives are sited on stands or short trees at reasonable height easy for women to manipulate the bee colonies. The majority of respondents (54.7 %) are married while the remaining are either single, divorced or widow. The majority of beekeepers (44.7%) are at the age ranges between 41-50 year. This is followed by 38% with the age range between 51 – 60 years. The lowest are those old people with the age above 60 (5.3%). The age between 40 – 60 years is known to be energetic and they have family responsibility. Therefore, being active in beekeeping makes more sense because traditional beekeeping in the area is a labour intensive activity usually undertaken in the forests which need energetic experienced people who are committed and able to bear life threatening risks.

The majority of respondents (75.3%) completed primary education while 15% have no formal education and 10% have secondary education. These results contrast with the results reported in Western Uganda where the majority had attained formal education with 17.5% being tertiary education graduates (Mujuni *et al.,* 2014). However, this result shows the majority of respondents have been exposed to education. Exposure to education will increase ability of the keepers to obtain, process, and use information relevant to the adoption of improved innovations of beekeeping at their disposal. Namwata *et al.* (2013) indicate that beekeepers with a minimum of basic education are more likely to adopt improved beekeeping innovations and hence increase productivity of bee

products. This is due to the fact that beekeeping is a self-employment opportunity available in the study area.

Status of Crop Production in the Study Area

Agriculture has a significant contribution to economy of beekeepers' households. Field surveys, and physical observations made show that the most important cash and food crops commonly cultivated in Iramba district were maize, sunflower (*Helianthus annuus*) beans, sunflower, sweet potatoes (*Ipomoea batatas*) and groundnuts. Table 4 summarizes the responses on the trends of crop productivity over the last 30 years (1989 to 2019 years). It is discernible that maize (*Zea mays L.*) is the main food crop, at both local and regional levels including countries like Kenya, Uganda, Burundi and Rwanda. In Tanzania, maize accounts for over 70% of the cereal food requirement (URT, 2013). Therefore, its production has a strong link to food security. Majority of respondents (77.3 %) indicated that maize production has declined for the past thirty years. This is followed by 19.3% who shows the production of maize is fluctuating.

Table 4: Trends of productivity of various agricultural crops over the last 30 years (1989 to 2019years)

Trend		**Frequency**	**Percent**
Maize productivity	Increasing	2	1.3
	Decreasing	116	77.3
	Fluctuating	30	20.0
	no change	2	1.3
	Total	**150**	**100.0**
Beans productivity	Increasing	3	52.0
	Decreasing	4	2.7
	Fluctuating	1	0.7
	do not know	142	44.6
	Total	**150**	**100.0**
Sorghum productivity	Decreasing	10	6.7
	do not know	140	93.3
	Total	**150**	**100.0**

Sunflower productivity	Increasing	2	1.3
	Decreasing	117	78.0
	Fluctuating	29	19.3
	no change	2	1.3
	Total	**150**	**100.0**
Sweet potato productivity	Decreasing	4	52.7
	Fluctuating	1	0.7
	do not know	145	46.6
	Total	**150**	**100.0**
Groundnut productivity	Decreasing	17	86.7
	Fluctuating	3	2.0
	do not know	130	11.3
	Total	**150**	**100.0**

Meteorological data trends (Table 5), show that the study area experienced eight dry seasons in a period of 14 years. The mean rainfall seasonal per season in this area is 777.4 mm in the period between 1994 and 2011. This is an insufficient amount for requirements of many crops, given inconsistency rainfall patterns demonstrated by higher standard deviations. For example, maize rainfall requirement ranges from 500 to 2,000 mm, sorghum 250 to 1,200 mm, paddy 1,200 to 1,800 mm and sunflower 600 to 1,000 mm per annum (TARO, 1987a).

Table 5: Measured Rainfall Variability during Growing Seasons in Iramba District from 1994 to 2008 (Kabote *et al.,* 2017)

Period	November	December	January	February	March	April
1994-1998	71.0±68.9	195.6±197.6	140.2±68.1	158.8±49.5	151.8±112.8	120.8±56.1
1999 - 2003	123.6±84.8	139.1±54.0	192.4±97.2	60.1±26.4	202.2±57.1	87.6±45.3
2004-2008	67.3±50.6	112.9±59.3	149.9±65.7	65.7±134.7	135.3±100.4	66.6±69.1

Similar trend was observed to other food crops (Table 4); sunflower 78% of respondents indicated the harvest was decreasing, groundnuts 86.7%. Sorghum is among the dominant crops in the study area (semi-arid) produced under smallholder farming (TARO, 1987b). It is among the most drought resistant crops and therefore its resilience to climate change impacts is a bit high. That's why 93.3% of respondents do not see the difference in production. Similar results were reported by Sawe*et al.*(2018) in the study conducted at Manyoni Singida district, there is a

crop damaging and persistent of low harvest. These results collaborated the results of Malley *et al.* (2009) who observed that productivity of crops in semi-arid areas of central Tanzania was increasingly becoming threatened by increasing drought frequency. According to Urassa (2016), this is probably due to climate change, drought, depletion of plant nutrients from the soil and infestation of crop pests and diseases. Information from both focus group discussion and in-depth interviews revealed that there is tremendous decline in crop production. The response from key informant (male, 67 years old) from Songambele village said:

> *My brother, since I moved to this village about 42 years ago, I have never experienced this life of buying everything. I have never bought maize, sorghum or beans for my family. Previously I could harvest 10 bags of maize in my 2acre farm, but recently I could hardly get a bag or two. The increases in temperature have accelerated the increase in drought in our village. Nowadays agriculture has become unpredictable because even the rainfall amount has decreased to the maximum.*

Farmers' perception on increasing rainfall unpredictability coincides with higher standard deviations in monthly rainfall from the results determined earlier (Kabote*et al.,* 2017). The higher standard deviations implying that rainfall patterns are inconsistent in each month during crop growing seasons, and some months receive much rain while others get considerably low rains. These results coincide with farmers' perceptions, which show extending back of the dry spell from February to January resulting into decreasing crop growing season. The rainfall in December and April also shows a clear decreasing trend for the period between 1994 and 2008 in Iramba district (Table 5). Sweet potatoes are short duration crops that are relatively drought tolerant therefore, the high in importance in food security in semi-arid areas. About 52% of respondents indicated that there is a decrease in production of sweet potatoes (Table 4). In focus group discussion at Ndago ward, one respondent indicated,

> *When we came to this farm about five year ago, we could harvest 10 bags or 8 bags of sweet potatoes. Now, I only harvest 3 or 4 bags. Now, there is less rain, they don't grow very well. I get a very poor harvest (45 years old man).*

Interview with respondents a 55-year-old female from Kyalosangi village indicated,

> *for almost 10 years now we are experiencing different pests who do not respond to any chemical. When I was young my mother used to use ashes to kill pests. These days, the new pests do not respond to any chemical. Probably, they are used to high temperature. They are the one responsible to decline of our harvest…*

The only crop which shows increasing trend is beans. About 52% of respondents indicated increase in yield of beans (Table 4). This is linked with the introduction of new type of seed which are heat tolerant and they are now commonly grown at the study area. In the survey made at different seed companies, four different varieties were found in the market. These were: *Uyole* 94, *Lyamungo* 90, *Jesca,*and *Kablanketi.*In the discussion with extension officers about the variety preferred by farmers they rank in the order of Jesca followed by Lyamungo 90 and the lowest was Kablanket, which was in line with another study conducted earlier (Hillocks*et al.,* 2006).

Different Reasons Motivating Small Holder Beekeepers

Figure 2 identifies difference reasons which motivate smallholder farmers to be beekeepers. The majority of respondents (33.1%) reported they were attracted in beekeeping for purpose of income generation, this is followed by 31.1% of respondents who reported that they adapted out of own motivation (personal interest) followed by 29.7% of respondents reported that they keep bees just for food security.

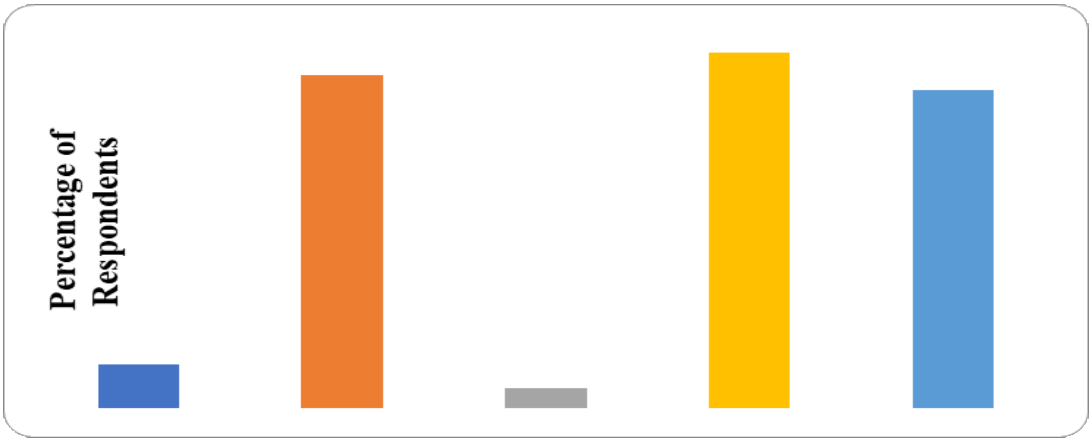

Figure 2: Different reasons motivate smallholder farmers to be bee keepers (n = 150)

These results agree with the report by Paji (2016) where 50% of the respondents were influenced by the need to increase the income, while only 16% of the respondents got engaged in bee keeping activities due to the fact that honey is medicinal and 6% of the respondents were influenced by the need to obtain food. According to Dadant, (1980), honey bees play a critical role in agriculture and beekeeping has many relative advantages and importance that help farmers to improve their livelihoods to ensure food security. Beekeeping conserves the natural resource and contributes to the globe through environmental protection, as beekeeping and agro-forestry are integrated activity. It also provides valuable products like honey, beewax, propolis, bee venom and royal jelly, which farmers use as source of income (Keralem, 2005; Doss, 2006).

Quantity of Honey Production

Under good management of beekeeping, harvested honey can reach up to 15 kg per hive per harvest. However, in Tanzania honey yield per hive is generally low due to several factors. The production ranges of honey per house hold in the study area are shown in Figure 3.

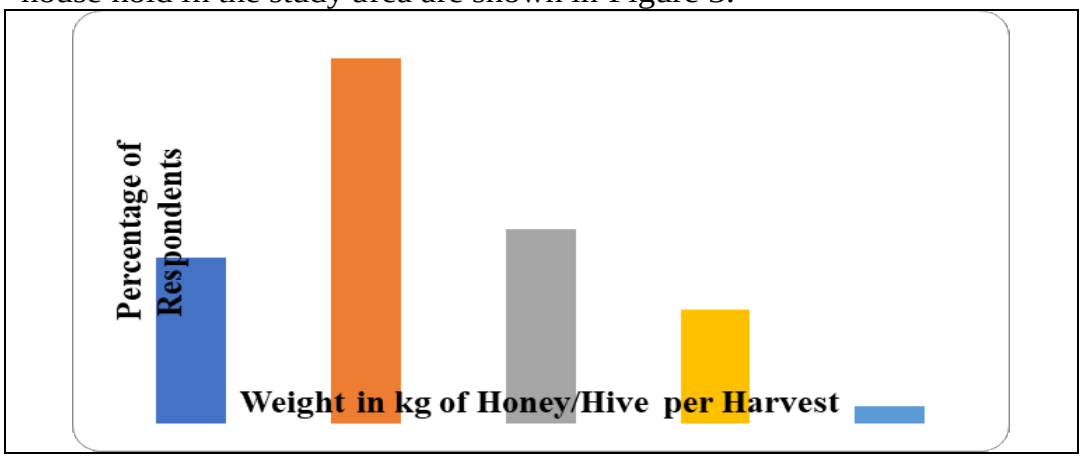

Figure 3: Honey Production per hive per Harvest per Household

Results in Figure 3 indicate that most respondents (42.7%) harvest 6 to 8 kg of honey per hive per harvest followed by 22.7% harvest 9 to12 kg per hive, 19.3% harvest less than 5 kg per hive, 13.3% harvest 13 to 15 kg and only 2% of respondents harvest more than 15 kg of honey per hive per harvest. In average, more than 60% of beekeepers in Iramba District

harvest less than 9 kg of honey per hive per harvest. According to the interview with Iramba District Beekeeping Officer (DBO) the total number of house hold beekeepers is 396 with total number of 1,475 hives, making an average of 3.7 hives per household. The hives are divided into three categories: Top bar hives (146 hives), frame hives (682 hives) and traditional hives (647 hives). The average honey production per hive varies as production in top hives and frame bar ranges from 10 – 15 Lts/hive while traditional hives ranges between 5 – 10 Lts /hive.

These values concur with traditional hive determined earlier by Gidey and Mekonen (2010), which is 8-15 kg/hive and 5-6 kg /hive. Tessega (2009) in the modern hive produces twice as much to the traditional hives which gave 15.6 kg per hive. The difference observed in honey yield between traditional (the common in Iramba district) and modern hive might be due to time of honey bees spent for building comb, while in the modern hive the foundation sheet is prepared and provided by the beekeepers. This might have enabled the honey bee colonies in modern beehives to spend their time and energy on collecting nectar for honey than building new combs.

Preference of Respondents to Beekeeping Compared to Crop Agriculture

According to Mujuni *et al.* (2012), beekeeping is emerging as a very successful agricultural practice for rural communities in less developed countries mainly due to its economic benefits from the products of this practice. Figure 4, indicates that the majority of respondents (63.4%) prefer beekeeping compared to crop agriculture. Only 33.3% said thatit is just like production of other crops and only 3.3% indicated it is less than other crops.

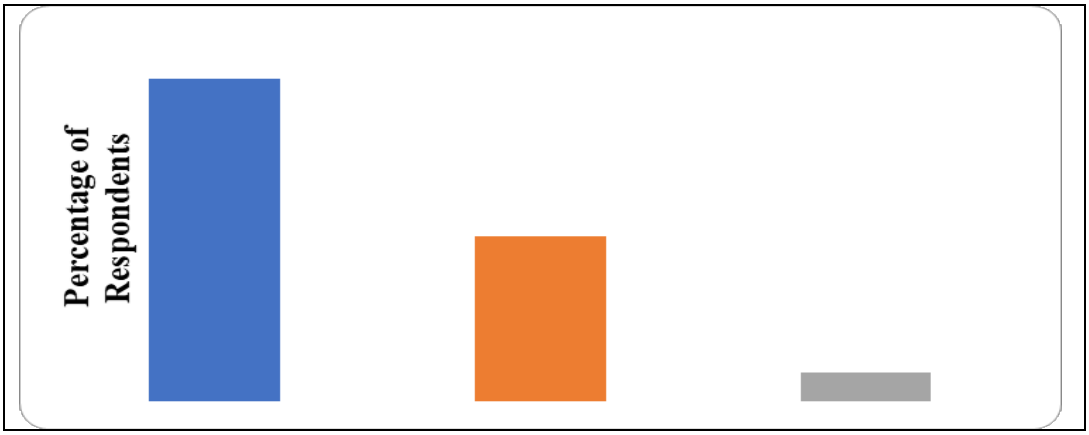

Figure 4: Preference of respondents to beekeeping compared to Agricultural crops

In the FGD the respondent indicated:

> *Beekeeping is the most profitable activity compared to maize and other crops. Also, the price of honey is usually very high compared to the labour it takes. Crops like maize need rainfall, but honey does not*

These findings agreed with Dalang (2001) who noted that on a comparative basis, apiculture stands out conspicuously as a high revenue-generating venture compared to arable cropping. The implication of the above results is that given beekeeping, livestock production and crop farming, beekeeping is a better enterprise to the study area community because it generates a higher income for smallholder farmers. It is estimated that 90% of honey produced in Tanzania is consumed as food in Tanzania. A significant amount of honey is used to make local beer in areas where honey is produced in huge volumes. In an interview with one village elder from Mdonkolo village who is also beekeeper he indicated:

> *"I normally sell my honey to traditional beer brewers, in an average of Tshs 8,0000 – 10,000 per liter. This is because it is easy to get cash to meet my personal requirements. I can get 60 Liter from my hives per harvest; therefore, I am sure of getting about Tshs 600,000" (1 $ = 2230 Tshs).*

This corresponds to another study in Tanzania (ITC, 2015) which indicated, beekeepers own more than 20 hives, they harvest honey twice a year and harvest 5-10litres per hive depending on the season. The price of honey was Tshs. 8,000 per litre. During the study, respondents reported various ways in which funds from beekeeping contributes to household socio-economic welfares. They reported benefits such as increased household's income, food security, poverty reduction, capital accumulation, source of medicine, payment for education and health expenses. Figure5, summarizes the responses on social economic benefits of beekeeping to household's economy. The majority of the respondents (30.5%) use the money they got from selling honey to cover medical expenses for family members (Fig. 5). According to Bright *et al.* (2017), financial barriers are a key limitation to access health services in low- and middle-income countries.

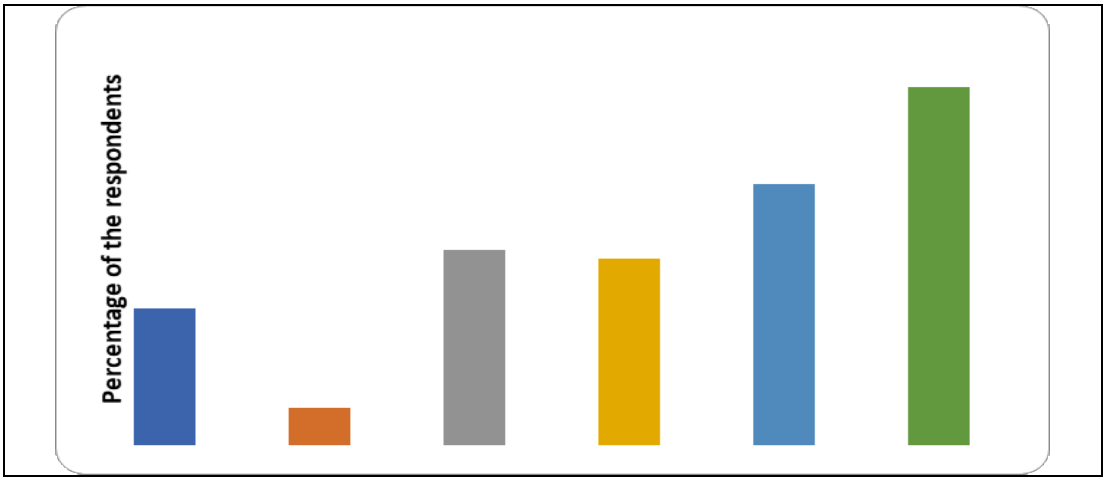

Figure 5: Social Economic Benefits of Beekeeping to Household's Economy

Due to financial barriers in study area, head of family often end up with out-of-pocket patient payments which impact on household budget. Education is an important component of human development. Parents have to pay for tuition fees, meals and accommodation for their children at various levels of education. About 22% of the respondents indicated that the revenue from beekeeping helps to pay for education expenses. These results correspond to those reported in western Tanzania where beekeepers spent revenue from selling bee products to pay school fees for their children, buy assets and clothing, and construct houses. (Ntalwila *et al.,* 2017).

Major Beekeeping Constraints Faced by Farmers in the Study Area

Based on the result of this study, the major constraints faced by beekeepers were: lack of reliable market, bush fire, theft of hive and products, drought, limited knowledge, pests and diseases, lack of common flowers and poor technologies as summarized in Table 6. When asked about the constraints that faces beekeepers, respondents reported several problems. Results in Table 6 show that 15.2% of the respondents reported drought as the major problem facing bee keepers in the study area. Due to drought few flowers bloom hence bees cannot access the honey. This is evident from a number of respondents (12.7%) who said that due to drought common flowers are not available these days.

Table 6: Problems facing Bbeekeeping in the Study Area (Multiple response)

Problems facing beekeepers	Frequency	Percentage
Aggressiveness of bees	11	1.2
Limited space	48	5.1
Limited market for bee products	135	14.2
Bush fire	146	15.4
Theft of hive and products	10	1.1
Drought	144	15.2
Limited knowledge	136	14.3
Pests and diseases	59	6.2
Lack of common flowers	121	12.7
Poor technology	140	14.7

Urassa *et al.* (2016) observed that in Iramba district, agricultural production is poorly performing, mainly due to low and erratic rainfall, which range between 500 and 800 mm per annum. As it is in Singida region as a whole, famine is a common phenomenon in the district due to lack of rainfall and droughts. Drought has caused many problems including bush fire rated by 15.4% of the respondents. Kumar *et al.* (2012) indicates that the use of fires may increase the risk of accidental wild fires especially during dry months. Markets for honey and other bee products in Tanzania are not fully established. Beekeepers in Iramba Districts are mainly smallholders who depend on local markets to sell the honey produced. The market is unstructured and unreliable due to inadequate customers, difficult transportation, lack of realization of the honey value and inadequate ability of beekeepers to search for markets.

Namwata*et al*. (2013) reported that bee keeping industry face a series of drawbacks namely technology, market, equipment, climate, transportation, credit accessibility, lack of training/skills and cultural practices.

This corresponds to findings by Tutuba and Vanhaverbeke, (2018) who established that commercialization of beekeeping in Tanzania is constrained by low market prices and poor, marketing systems and limited market information. These results also compare with Arse *et al.* (2010), who reported on the shortage of honeybee forages, shortage of honey bee colonies, poisoning by agro-chemicals, shortage of modern hives, prevalence of honeybee enemies and market problems, shortage of improved bee equipment, absconding and swarming problems, prevalence of honeybee diseases, lack of knowledge of the right harvest time and theft problems as the major beekeeping constraints. This is in line with the work of Kerealem *et al.* (2005) which stipulates that drought is the main constraint of bee keeping. These constraints have a direct and indirect effect on the reproduction and productivity of honeybees.

CONCLUSION AND RECOMMENDATIONS

This study provided information on the current status of beekeeping in two wards inIramba District as adaptation strategies against impacts of climate change in the district. Climate change is evident due to rainfall patterns inconsistent in each month during crop growing seasons, most of Iramba district receive considerably low rains. This situation has caused frequent food shortages and famine. In order to respond to the impact of climate change in Iramba district, smallholder farmers opt for beekeeping instead to crop production as the source of food and income to meet the family basic needs. The honey production has played a critical role in agriculture and beekeeping has many relative advantages and importance that help farmers to improve their livelihoods, and food security.

Since food security cannot be achieved without income security, beekeeping could be a useful tool for improving rural economy. It is hereby recommended to have the capacity building for beekeepers so that they can get knowledge about the various practices employed in beekeeping through a mixture of practical and theoretical sessions.