INFLUENCE OF INDIGENOUS KNOWLEDGE BASED COPING STRATEGIES ON HOUSEHOLD FOOD SECURITY IN BARINGO COUNTY, KENYA

SHADRACK KEMBOI CHEPLOGOI

A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirement for the Doctor of Philosophy Degree in Agricultural Extension of Egerton University

EGERTON UNIVERSITY

NOVEMBER, 2021

DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in part or as a whole for any academic award in any university.

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

Shadrack K. Cheplogoi

ED12/0408/13

Recommendation

This thesis has been submitted for examination with our approval as University supervisors.

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

Dr. Maurice O. Udoto, Ed.D

Department of Agricultural Education and Extension

Egerton University

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

Dr. Justus M. Ombati, PhD

Department of Agricultural Education and Extension

Egerton University

DEDICATION

I dedicate this work to my wife Millicent, my children Lynnette Jebichii, Emmanuel Kiprotich and Ivy Jerop, My late father Cheplogoi Barkasaw and my late brother Prof Peter Kiplagat.

ACKNOWLEDGEMENTS

I am deeply indebted to God almighty for his abounding grace throughout my research period. My sincere thanks goes to Egerton University for the opportunity accorded to me to study in the institution. Special gratitude to my able supervisors, Dr. Maurice O. Udoto and Dr. Justus M. Ombati for their invaluable contribution in guiding me throughout this study. Many thanks to my great friend Kiprop Chirchir who supported me financially and morally during the data collection stage of this work. Sincere thanks to my colleagues at the Department of Agricultural Education and Extension, Egerton University for their moral support and encouragement. I also thank the staff at the county department of agriculture in Baringo North and Marigat sub counties for their support in responding to the questionnaire. Special appreciation to Kakuko Sikayang, Titus Pariyo, Pastor Daniel Chelimo, Reuben Cherutich, Joel Kosgei and Bishop Lopetes for being instrumental during the Focus Group Discussion process. Much thanks to all the household heads who responded to my research questionnaire. I appreciate the National Commission for Science, Technology and Innovation (NACOSTI) for according me the permission to undertake this study. Thanks to the County Commissioner and the County Director of Education of Baringo for permitting me to undertake data collection in the County. Further, I thank my research assistants who tirelessly worked to ensure that data was collected in time.

ABSTRACT

Food is not only a human right but is essential for good health. Despite its importance, food security is a challenge to many households, especially those in Arid and Semi-Arid Lands (ASALs) like Baringo County, Kenya where climate change variability negatively affects household food security. Being one of the global knowledge base, indigenous knowledge ought to complement scientific knowledge to tackle emerging challenges like climate change and food insecurity. However, indigenous knowledge has not received as much attention as scientific knowledge as far as agricultural and food security programmes are concerned. This study sought to establish the influence of indigenous knowledge based coping strategies on household food security in Baringo County, Kenya. The study adopted the descriptive survey research design. The accessible population of the study was 18,613 household heads, 12 extension staff and 8 key informants. The study involved a sample of 120 household heads, 12 extension staff and 8 key informants, selected using purposive, census, proportionate and simple random sampling techniques. Data was collected using questionnaires, a focus group discussion guide and an observation checklist. The face and content validity of the four instruments were examined by five experts from the Department of Agricultural Education and Extension, Egerton University. The household heads and extension staff questionnaires were piloted and reliability coefficients were 0.78 and 0.81 respectively. Data was analyzed with the aid of the Statistical Package for Social Science. Qualitative data was organized into themes pertinent to the study objectives, then described and summarized using frequencies and percentages of the descriptive statistics. Simple linear regression was used to test the hypotheses at $\alpha = 0.05$ level of significance. It was evident that a positive relationship existed between indigenous knowledge based coping strategies and household food security. Results of hypothesis testing indicated that indigenous knowledge based food preservation and storage strategies had a significant influence on household food security. However, indigenous knowledge based coping strategies on climate change, food production, and pests, parasites and disease control did not significantly influenced household food security. The study concluded that integrating indigenous and scientific agriculture knowledge bases could strengthen agricultural extension content with the potential of improving household food security. This study recommended that the findings be disseminated to farmers and extension practitioners promoted for adoption as a way of enhancing food security. Smallholder farmers who are IK experts be linked with extension practitioners and research institutions to document and integrate IK into extension services.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ASALs	Arid and Semi- Arid Lands
CAADP	Comprehensive African Agriculture Development Programme
CCSI	Climate Change Strategy Index
DFID	Department for International Development
FAO	Food and Agriculture Organization
FSI	Food Security Index
GOK	Government of Kenya
GHI	Global Hunger Index
IFPRI	International Food Policy Research Institute
IK	Indigenous Knowledge
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
MOAIWD	Ministry of Agriculture Irrigation and Water Development
MOALF	Ministry of Agriculture, Livestock and Fisheries
NACOSTI	National Commission for Science Technology and Innovation
NEPAD	New Partnership for African Development
PPDCSI	Pest Parasites and Disease Control Strategy Index
PSSI	Preservation and Storage Strategy Index
SDGs	Sustainable Development Goals
SID	Society for International Development
SPSS	Statistical Package for Social Sciences
USAID	United States of Agency for International Development
WFP	World Food Programme
WVK	World Vision Kenya

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Vulnerability to hunger is common for many households globally despite food being universally recognized as every person's right (International Food Policy Research Institute [IFPRI], 2014). It is estimated that about 690 million people worldwide go to bed hungry each day (Food and Agriculture Organization [FAO], 2020). According to FAO, covid-19 pandemic could further escalate the numbers leading to greater vulnerabilities and inadequacies of global food systems. In Africa, over 250 million people are undernourished representing one third of its population (FAO, 2020; Forest Society of Kenya [FSK], 2010; IFPRI, 2014; Macharia et al., 2010). About 1.3 million people are facing acute food insecurity in Kenya (United States Agency for International Development, [USAID], 2020). In Baringo County Kenya, a sizable proportion of its population depends entirely on food relief (World Vision Kenya [WVK], 2013). In Baringo North and South Sub counties a lone, the global acute malnutrition was reported to be 9.3 percent indicating a poor state of food security (Government of Kenya [GOK], 2019). Baringo County is among the Arid and Semi-Arid Lands (ASALs) and one of the climate change hotspots (FAO, 2000).

Millennium Development Goals (MDG1) which set to halve the number of the poor and the hungry by 2015 (Devereux & Maxwell, 2001) and the Sustainable Development Goals (SDGs) number two on Zero hunger which pledged to end hunger by 2030 (IFPRI, 2016) are among the global policies for addressing food security. In Africa, the Maputo Declaration of 2003 and the subsequent Malabo Declaration of 2014 adopted the Comprehensive African Agriculture Development Programme (CAADP) as a framework for enhancing food security in the continent (African Union [AU], 2016; New Partnership for African Development [NEPAD], 2009; World Food Programme [WFP], 2009). The Kenya Vision 2030 identified agriculture as a priority sector for achieving food security (GOK, 2010). These food policies aimed at enhancing food security at both household and national level.

Agriculture in Kenya is the main driver of economic growth and a key sector for addressing food security as it contributes about 24 percent of the country's Gross Domestic Product (GDP) in addition to employing 80 percent of rural population (GOK, 2010a; Kungu, 2014). The attainment of a food secure nation as a human right has been the primary objective of the Kenyan government through agricultural sector as envisaged in the constitution of Kenya

2010 and the Kenya Vision 2030 (GOK, 2010a). This would be achieved through effective agricultural extension services. Agricultural activities and food security however, are highly vulnerable to climate variability given that Kenya's agriculture is mainly rain–fed (Chinedum et al., 2015; Intergovernmental Panel on Climate Change [IPCC], 2014; Jalloh et al., 2013 Nigerian Environmental Study Action Team [NEST], 2011). In addition, about 80 percent of the Kenyan land is Arid and Semi-Arid Lands which is vulnerable to climate change effects (Chinedumet al., 2015; Muok et al., 2012). This has made food availability, access, safety and stability untenable yet these are the fundamental elements of food security and the foundation for good nutrition and health (FAO, 2013).

Extreme weather variability has resulted in increased incidences of drought, floods, pests and diseases which have undermined the performance of the sector by reducing food supply, availability, access and incomes leading to food insecurity (Economic Survey, 2015; FAO, 2013; GOK, 2015; Kungu, 2014). In addition, Mukiibi (2001) argue that, low agricultural productivity, post-harvest losses and wastages impede the realization of food security defined by FAO (2000) as a situation in which all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Interventions that target food production and those that reduce post- harvest losses as well as those that increases both farm and non-farm incomes are necessary for the achievement of food security (Asogwa et al., 2017; Gustavsson et al., 2011; Kungu, 2014).

Agricultural extension remains the critical means of reaching farming households by providing farmers with information, skills and technologies to improve their agricultural production, incomes and food security (Adejo et al., 2012). Agricultural extension according to Christoplos (2010) are systems designed to build and strengthen the capacity of rural farmers and other stakeholders through provision of access to information and technology as well as enhancing agricultural skills and practices, capacity to innovate and address varied rural development challenges. Enhancing the capacity of farmers and stakeholders to develop skills and innovation to transform agriculture sector through extension services requires knowledge base grounded on both indigenous and scientific knowledge systems. The effectiveness of extension service delivery is however constrained by the low extension staff to farmer ratio partly due to the effects of Structural Adjustment Programme (SAPs) policies of 1980s and the economic hardships facing many countries at the moment (Akuku et al., 2014; GOK, 2012).

Food security is determined by among other factors agricultural production, extension systems, income levels and the inclusion of indigenous knowledge based practices in agriculture and food security intervention strategies (Adejo et al., 2012; Akuku et al., 2014; Gustavsson et al., 2011; Maina, 2015). Indigenous knowledge (IK) is considered among the knowledge base that farmers obtain agricultural information. Incorporating indigenous knowledge in agricultural production systems could improve food security (Maina, 2015). However, the tendency has been the application of the scientific knowledge to supply farmers with information, skills and technologies for use in their farms paying less emphasis on the IK yet scientific technologies can only be successful and sustainable if the interplay of local knowledge systems are taken into consideration (Chege et al., 2018). Most farmers and local communities according to the authors are knowledgeable about their resources and environment and they could use IK to ensure food security in various ecosystems.

There has however been a paradigm shift in the past to adopt a bottom up approach to extension in which the farmer is the center of focus in the Kenyan public extension services. In this dispensation, farmers are encouraged to communicate, share and demand the information they need from the extension service (GOK, 2012). The government has also embraced more participatory approaches that are intended to tap farmer participation and contribution in extension services some of which include the focal area approach, farmer field schools and farmer to farmer extension (GOK, 2015).

Participatory approaches in extension like Agricultural Knowledge Information System (AKIS) provide a means of information exchange which enable rural people to mutually learn, generate, share and utilize agriculture-related technology, knowledge and information (Wasudha et al., 2018). The system according to Worth (2006) and FAO (2000) incorporates aspects of sustainable and people centered development where farmers, agricultural educators, researchers and extension staff are integrated to harness knowledge and information from various sources including indigenous knowledge for better farming and improved livelihoods. This is perhaps because of the realization that farmers' indigenous knowledge is essential for agricultural development and food security. What farmers do, why they do and how they make farming systems profitable and sustainable is at the center of the

AKIS model (Worth, 2006). Agriculture extension practitioners should therefore regard farmers as partners rather than passive recipients of extension including the contribution of their indigenous knowledge to extension programmes.

Indigenous knowledge has gained publicity for instance the constitution of Kenya 2010 recognizes the role of indigenous technologies in the development of the nation and it promotes the intellectual property rights of the people of Kenya (GOK, 2010a). The constitution further recognizes and protects the ownership of indigenous seeds and plant varieties, their genetic and diverse characteristics and their use by the Kenyan community. Similarly, the national policy on the indigenous knowledge provides a legal and institutional framework to support the integration of various aspects of IK in national development planning and decision making process and promote documentation, use and dissemination of indigenous knowledge (GOK, 2009). The policy further seeks to mobilize and harness grass root technological innovations and traditional values and institutions. This is a paradigm shift demonstrating that indigenous knowledge can play a complementary role to the scientific knowledge.

Although indigenous knowledge is predictable and harmless to both people and environment, it has been neglected and marginalized yet it has ensured a wide variety of indigenous foods for sustainable household food security to local communities (Raygorodetsky, 2011). Food insecurity has however remained a challenge to many households despite the continuous application of scientific knowledge practices.

As to whether indigenous knowledge could provide lessons for addressing the food insecurity is a subject of inquiry for this study. As part of global knowledge, indigenous knowledge ought to provide a complimentary role to the scientific knowledge as far as extension services are concerned since rural communities have extensive knowledge about adaptation to food insecurity because they have managed and lived on ASAL ecosystems over centuries (Anaeto et al., 2013; Kimani et al., 2014). The critical gap of utilizing indigenous knowledge lies in the access to relevant and usable indigenous knowledge for diverse stakeholders in the agricultural sector including farmers. As of now IK is not properly documented and packaged in agriculture. Though food security cannot be attributed solely to indigenous knowledge, the neglect of indigenous farming practices that formed the basis for food security for most rural households before the advent of the scientific agricultural methods came into use could perhaps impact negatively on food security. Local experience and practices for enhancing food security have widely been overlooked. Raygorodetsky (2011) asserts that, indigenous knowledge could form crucial foundations for community based adaptation and mitigation actions that could sustain resilience to food insecurity.

Arguably, application of IK would empower local people and increase cultural pride as originators of innovations which enhances ownership and sustainability of food security through use of local solutions to local problems (Tanyanyiwa & Chikwanha, 2011). Local-level knowledge is both cost-effective, environmental friendly and sustainable for food security. Despite this, indigenous knowledge still remains undocumented hence it is likely to face extinction and its benefits may not be realized especially within extension services and food security programmes. In Kenya, Esipisu (2016) gave an account of how indigenous knowledge of rain makers was used to observe behavior of insects, birds and trees in Kakamega to provide accurate and competitive weather information used by farmers to successfully escape disastrous seasons and improve yields. Osman (2013) provided a similar case for Sudan where pastoralists use indigenous knowledge of astronomy in which the appearance of bright stars indicated a condition of rainy season. Sustainable household food security could therefore be enhanced if indigenous knowledge strategies are harnessed.

Appropriate agricultural production practices, proper drought and flood management, effective pests and disease control and proper storage strategies are crucial for enhancing food security (FAO, 2013; Gustavsson et al., 2011). According to Asogwa et al. (2017), recognition, promotion and utilization of indigenous knowledge, skills and practices across the food security value chain has the potential for arresting the huge losses associated with pests, diseases and other post-harvest effects and consequently improve food security. Extension services have for many years transferred scientific farming strategies and technologies neglecting indigenous knowledge yet the situation on food insecurity continues to rise. Indigenous knowledge being one of the knowledge bases and which has been used by local communities since time immemorial ought to be documented, integrated and mainstreamed into extension services to compliment the scientific knowledge in enhancing household food security. Much of the available literature in Baringo County have documented other areas of indigenous knowledge application including health, environment and water conservation but the present study seeks to examine influence of indigenous knowledge based coping strategies on household food security.

1.2 Statement of the Problem

Majority of Households in Baringo County rely on agriculture as source of livelihood. Agriculture is thus the main driver of food security. A significant proportion of these households are however food insecure. This has denied them the right to food and has negatively impacted on their health and social-economic development. Household food security has been associated with many factors among these are knowledge based coping strategies and extension services. Both indigenous and scientific knowledge ought to play a complementary role in generating extension messages for improved production and food security among households in rural areas such as Baringo. IK ought to play pivotal role in food production since it has been used by rural communities for centuries to sustain their livelihoods. However, SK has received more prominence while IK has played a peripheral role. This study set to establish influence of indigenous knowledge based coping strategies on household food security and the extent to which the indigenous knowledge is integrated into extension services in Baringo County, Kenya. This study was deemed necessary because even though studies on household food security has been conducted in Baringo, there is hardly any research linking it with indigenous knowledge based coping strategies.

1.3 Purpose of the Study

The purpose of this study was to enhance food security by examining how it is influenced by indigenous knowledge based coping strategies. The coping strategies were climate change, food production, pests, parasites, disease control and storage and preservation. The purpose was also to strengthen extension services through integration of indigenous knowledge into it.

1.4 Objectives of the Study

The following objectives guided the study:

i. To determine the influence of indigenous knowledge based climate change coping strategies on household food security in Baringo County, Kenya.

ii. To establish the influence of indigenous knowledge based food production strategies on household food security in Baringo County, Kenya.

iii. To establish the influence of indigenous knowledge based pest, parasites and disease control strategies on household food security in Baringo County, Kenya.

iv. To determine the influence of indigenous knowledge based storage and preservation strategies on household food security in Baringo County, Kenya.

v. To establish the extent to which indigenous knowledge based strategies are integrated into agricultural extension services for in Baringo County, Kenya.

1.5 Research Hypotheses

The study tested the following hypotheses:

Ho_1: Indigenous knowledge based climatic change coping strategies do not significantly influence household food security in Baringo County, Kenya.

Ho_2: Indigenous knowledge based food production strategies do not significantly influence household food security in Baringo County, Kenya.

Ho_3: Indigenous knowledge based pests, parasites and disease control coping strategies do not significantly influence household food security in Baringo County, Kenya.

Ho_4: Indigenous knowledge based storage strategies do not significantly influence household food security in Baringo County, Kenya.

1.6 Research Question

The study was guided by the following research question:

i. To what extent are indigenous knowledge based strategies integrated into agricultural extension services in Baringo County, Kenya?

1.7 Significance of the Study

The study outcome will be disseminated through publications and conferences and best IK practices will be utilized by households to enhance their agricultural production and household food security using indigenous knowledge based climate change coping strategies. The findings could also inform on the food production practices, pest and disease control coping strategies and storage strategies that could be applied by households to achieve food security. The extension staff could also come up with strategies of integrating indigenous knowledge based strategies into extension services to address food insecurity. Further, the findings may add to the existing stock of knowledge on indigenous agriculture practices that could be documented and integrated into agriculture extension services to complement the scientific knowledge on agriculture. This could ensure that indigenous knowledge is protected against neglect, marginalization and extinction. Further, the findings could be useful in developing key agricultural policies that integrates indigenous knowledge based strategies into food security programmes.

1.8 Scope of the Study

The study was undertaken in Baringo County, Kenya. The study focused on the influence of indigenous knowledge based coping strategies on household food security in Baringo County. Indigenous knowledge based coping strategies that the study examined were on climate change; food production; pests, parasites and disease control and preservation and storage coping strategies. Food security involved quantity of food crops and livestock products, income levels, diet diversity and food security index.

1.9 Assumption of the Study

This study was based on the assumptions that:

i. Indigenous Knowledge among communities in Baringo County is still valued, retained and shared out among community members.

ii. Household members are able to give an accurate record of how they apply IK in coping with climate change, production, storage/preservation and pest/parasite and disease control coping strategies.

1.10 Limitations of the Study

This study had the following limitation:

i. Language barrier- The respondents comprised of different communities with different dialects. However, the limitation was overcome by using interpreters who understood the local language.

ii. Inaccurate translation by interpreters -This was considered to be a limitation because Pan (2007) observed that interpreters could add or omit information or give inaccurate translation of what is expected thereby affecting quality of data which in turn affect findings. The limitation was however minimized by selecting research assistants from the respective dialects in the study site and training them on contents in the data collection instruments and procedures, how to enter data and other pertinent issues like confidentiality and informed consent. In addition, the research assistants were required to have a minimum of secondary school qualification while monitoring on data collection was also done by the researcher to ensure that consistency in data collection was maintained by the research assistants.

1.11 Definition of Terms

Climate change- FAO (2006) defined climate change as any change in climate over time, whether due to natural variability or human activity. According to this study, climate change referred to erratic rainfall patterns, extreme temperatures, drought and floods

Coping strategies – Farzana et al. (2017) defined coping strategies as the ways used by households to survive when confronted with unanticipated livelihood failure. In this study, coping strategies implied IK's practices on climate change, production, storage and pest and protection strategies in both crops and livestock for food security.

Food security– defined as a state at all times in which all people have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2000). In this study, food security referred to ability of households to have constant supply of food throughout the year measured in terms of quantity, quality and preferences as measured by food security index.

Indigenous knowledge – Referred to indigenous knowledge that include the content or substance of traditional know how, innovations, information, practices, skills and learning of traditional knowledge systems such as traditional agricultural, environmental or medicinal knowledge (Wipo, 2005). In this study IK was Knowledge and practices on production strategies, storage of agricultural products, climate change coping strategies and pest and disease management practices passed on from one generation to the other among the indigenous communities aimed at reducing food insecurity.

Influence- Hall (2007) defined influence as the power one person or agent applies on someone else (the target) to induce changes in behavior, opinion, attitudes, goals, needs and values and the ability to affect the behavior of others in a particular direction. In this study, influence referred to the change in food security status as a result of changes in application of indigenous knowledge climate change, production, pests, parasites and diseases and storage and preservation coping strategies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature related to the study. The chapter is organized to capture an overview of global food security situation, food security status in Kenya and Baringo County, indigenous knowledge and agriculture, indigenous knowledge and food security in Kenya, indigenous knowledge and food security coping strategies in ASALs, indigenous knowledge and food security policies, public extension and indigenous knowledge. Theoretical and conceptual framework concludes the chapter.

2.2 Global Food Security Situation

The world remained way out of the track in achieving the primary assurances made by governments when they approved the Millennium Development Goals (MDGs) to reduce the proportion of people by halve who suffered from hunger by 2015 (Alexander, 2012). This necessitated the establishment of the Sustainable Development Goals (SDGs) as a new commitment to finish hunger and global poverty by 2030 with Goal 2, being a pledge "to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture," (IFPRI, 2016). Vulnerability to hunger remains a daily reality for many households despite the universal recognition of every person's right to food (IFPRI, 2014). Food insecurity is therefore a major challenge facing the world (Chipungahelo, 2015). FAO (2000) defined food security as a situation in which all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The definition identifies four dimensions of food security as food availability, access, utilization and stability which are necessary for achieving food security (Klennert, 2009).

Despite the efforts made for stop hunger in the world, the number of the chronically hungry people worldwide by 2018 was over 820 million with one out of every nine people in the world being undernourished (FAO, IFAD, UNICEF, WFP & WHO, 2019; FAO, 2018). An estimated 300 million rural people in Africa still struggle to feed themselves and their families while one third of the population is chronically undernourished (FSK, 2010; Macharia et al., 2010). Two thirds of the hungry people in the world come from Asia and South of Sahara (IFPRI, 2014). The global, African and sub Saharan African prevalence of undernourished population is estimated at 8.9, 19.1 and 22 percent respectively. (FAO, 2020).

It is also estimated that over two billion people globally do not have regular access to safe, nutritious and sufficient food (FAO, IFAD, UNICEF, WFP & WHO, 2019). In 2017 alone, nearly 151 million under five children or over 22 percent suffered from stunting, wasting continued to affect over 50 million under five children while over 38 million children under five were overweight and the trends were putting the children at increased risk of morbidity and mortality (FAO, 2018). The source further indicates that poor access to food increases risk of low birth weight and stunting of children which are associated with higher risk of overweight and obesity later in life.

Droughts, floods, conflicts which are both internal and interstate, diseases, pests, alongside increasing population growth, land dilapidation, low innovation in agriculture, high poverty and poor infrastructure have all combined to accelerate food insecurity in the region (UNECA, 2010). According to GOK (2019) climate variability, high food prices, conflicts and the effects of pests and diseases are key drivers of hunger which undermine the attainment of all the elements of food security which include food availability, access, utilization and stability. Food availability and accessibility according to Aulakh and Regmi (2013) can be raised by accelerating production, enhancing distribution and lowering losses with reduced in post-harvest losses being a significant element of achieving food security. Food security according to Havas and Salman (2011) relates directly to nutrition and health and is also related to accessibility and availability of food stuffs. The danger to food security according to the Havas and Salman lies with development, income inequality, over population and ecosystems dilapidation.

The 2011 drought in the Horn of Africa caused huge financial losses, undermined food and nutrition security of over 13 million people, mainly pastoralists and farmers as well as causing severe malnutrition to more than 320,000 children (IFPRI, 2012). Climate change effects, manifested through frequency of harshness of droughts, floods and erratic seasons further curtails the attainment of household food security (Kimani et al., 2014). Climate change lead to failure of crop harvest, disease incidences and death of animals, dependency on food relief and loss of livelihoods (Ogega, 2017). According to The United Nations Conference on Trade and Development (2017), changing climate increases extreme weather events such as extreme temperatures, floods, drought and unpredictable changes in weather patterns that affect agriculture.

Agricultural technology, political and economic factors, knowledge systems available and climatic factors are the key determinants of food security (Beyene, 2010; FAO, 2017). Indigenous knowledge is one of the information base from which agricultural technologies and information for enhancing food security can be sourced for use by farmers. Development initiatives for ending food insecurity have not however made appreciable success perhaps because indigenous knowledge has not been taken a center stage in food security (Wole & Ayanbode, 2009). Meles et al. (2016) opined that household food security to a large extent depends on the potential to engage in activities outside productionto improve their livelihoods through diversification strategies. Livelihood diversification strategies is possible with the application of indigenous knowledge.

Agriculture among the developing countries, is dominated by peasant small holder farmers with most agricultural products coming from millions of rural households who are said to be using their indigenous practices (Agidew & Singh, 2018; Tweheyo, 2018). A significant relationship exists between indigenous knowledge of farmers and food security (Epeju, 2003). Indigenous knowledge is now considered one of the cornerstones that is vital to guarantee safety and life of rural communities (Awuor, 2013; FAO, 2014). Like other indigenous people all over the world, Africans have created agricultural systems for generations which if harnessed could improve household food security (Tirivangasi & Tayengwa, 2017). Ngara (2013) while elaborating the importance of indigenous knowledge described it as the systematic body of knowledge acquired by local people through accumulation of experiences, informal experiments and intimate understanding of the environment especially in relationship to land in a given culture.

The growing recognition and interest in indigenous knowledge is a demonstration on the value of integrating it in development programs including agriculture extension services and food security because the success of development projects and initiatives in Africa depends solely upon grass root participation of local people, which is a function of understanding and harnessing their indigenous knowledge (Wole & Ayanbode, 2009). The attainment of SDG 2 may only be achieved if urgent and drastic measures are taken by the individual countries including the participation of local people through employing their indigenous knowledge to address food security. Sigei (2014) explains that Sustainable Development Goals (SDGs) of zero hunger and food security promotion are rooted in enhancing agricultural productivity especially from crops since agriculture is the main driving force of many countries. Ting (2015) describes indigenous knowledge farming as famous for endurance and resilience to environmental hazards. There is need to establish the agricultural extension strategies that have incorporated indigenous knowledge for achieving food security. This study sought to establish whether indigenous knowledge coping strategies influenced households' food security in Baringo County, Kenya.

2.3 Food Security and its determinants in Kenya

It is estimated that 1.3 million people in Kenya are food insecure (USAID, 2020), yet food is one of the basic needs for human survival, in which is a fundamental human right (Kamwendo & Kamwendo, 2014). Ponge (2013) argue that, food security is attained when food is available at all times, that all persons have means to access to it, that it is nutritionally adequate in terms of quantity, quality and variety and that it is acceptable within the given culture. In Kenya, about 80 percent of Kenya's households' budget is on food and there is lack of funds to deal with food security problem (FSK, 2010).

Unfavorable weather conditions, effect of pests and diseases, invasion of locusts and high food prices have led to decline in the performance of agriculture sector in Kenya which have combined to exacerbate vulnerabilities leading to emergency food needs and acute malnutrition (Economic Survey, 2018; USAID, 2020). In Baringo County, whose sizeable proportion is ASALs, drought, high food prices, incidences of resource based conflicts and crop pests and diseases are the main food insecurity drivers in the county (GOK, 2019). As a consequence, households are experiencing food consumption gaps and employing unsustainable coping strategies including dependency on food relief and depleting household savings (Famine Early Warning Systems Network [FEWSNET], 2018). The global acute malnutrition in Baringo North and South was reported to be 9.3 percent which is an indication of poor state of food security (GOK, 2019).

Baringo County food insecurity status as argued by Saina et al. (2012) has in the recent past attracted food relief from food relief organizations like and World Food Programme and World Vision Kenya (WFP). The county was further reported to be under Protracted Recovery and Relief Operation (PRRO) where food was provided through various programmes like Food for Assets (FFA) programmes while schools were under school feeding programmes (BFSR, 2013). Poor consumption patterns like consumption of one meal per day, reduced meal portion sizes, reliance on less preferred foods, purchasing food on credit, skipping meals and reliance on food relief and remittances characterized the county (FEWSNET, 2018).

The most essential human right of every citizen that must be safe guarded especially among the vulnerable is the right to adequate food (Chipungahelo, 2015; FAO, 2010; Manikandan, 2018). Agriculture sector being the key means of livelihoods of most of the rural households is a key element of food security. Abegaz (2017) argues that food security is significantly determined by among others erratic rainfall patterns and lack of income sources for households. Food security is also determined by among other factors agricultural production, extension systems, income levels and the inclusion of indigenous knowledge in agricultural practices (Adejo et al., 2012; Akuku et al., 2014; Gustavsson et al., 2011; Maina, 2015). Berjan et al. (2018) further elaborates that, the fundamentals of food and nutrition security are undermined by food losses and wastage thus hindering the achievement of the all the elements of availability, access, utilization and stability which constitute sustainable food security.

Klennert (2009) identified two crucial determinants for food and nutrition security as one physical food flow which encompasses food availability, accessibility and utilization while the second being temporal determinant of food security which refers to stability. The temporal determinant of food security according to the scholar affects all the three physical essentials of food security which are availability, access and utilization. The scholar further classified stability of food as chronic food insecurity which is the incapacity to meet food needs on an on-going basis and transitory food insecurity which is the failure to meet food needs on a temporary basis.Efforts for improving food security must therefore consider the attainment of the four basic elements of food security. Improving production and reduction food wastage and losses are key in the attainment of food security. Food security efforts must therefore strive to focus on both chronic and transitory aspects of food stability to ensure households have food in their households throughout the year.

Similarly, the other determinants of food security include off-farm and non-farm activities, farming activities, livestock keeping activities and soil conservation practices (Beyene & Muche, 2010). The physical availability of food and the capacity of households to access food through improved incomes determine households’ food security. Agricultural Productivity which is crucial for attaining physical availability of food is affected by both exogenous and endogenous factors emanating from both climate changes and man-made calamities such as civil strife and prolonged war thereby aggregating the chances of plunging households into food insecurity and malnutrition (Abegaz, 2017). Agidew and Singh (2018) cited climate change, shortage of farm land, recurrent drought, and degradation as determining factors for food security adding that off farm income from nonagricultural activities like self-employed income and other petty trading as factors necessary for the achievement of food security.

Diversification of agricultural enterprises, off farm income generation, access to credit, good market, availability of agricultural inputs and effective extension services are other key determinants of household food security (Beyene & Muche, 2010; Kaegi, 2015; Sigei, 2014). Mota et al. (2019) further indicated that household food insecurity was also determined by household-related factors by influencing production and household procuring power of food.

Dlamini and Kaya (2016) further added that, indigenous knowledge systems is critical in determining of household food security and recommended it to be promoted and included in policy development if sustainable food security is to be achieved. Asogwa et al. (2017) in his part argued that exploitation and use of IK of food systems is one way of tackling the challenge of inadequate food. Dlamini and Kaya (2016) consent that, indigenous knowledge is an important knowledge in agriculture and across all the food systems. According to Ngara (2013), indigenous knowledge is acquired through the accumulation of experiences, informal experiment and intimate understanding of the environment the systematic by local people. The advantage of indigenous knowledge technologies lies in the use of locally available skills and materials which are cheap (Tanyanyiwa & Chikwamba, 2011).

Arguably, like othe indigenous communities in the world, Africans have created agricultural knowledge for centuries (Tirivangasi & Tayengwa, 2017). Resilience according to Ponge (2013) is found on indigenous agricultural systems as the diversified indigenous farming systems can adjust to limited resources and unforeseen farm challenges like drought and are still engage in production. The diversified indigenous farming systems increases production levels which further improve food availability and access to households. Ndwandwe (2013) points out that indigenous knowledge is a driver to rural household's food production and is widely used by smallholder farmers to adjust to challenges of food insecurity. Since indigenous knowledge is one of the knowledge base in the community, it is important to note it as an important factor of food security at household level. Most rural households rely on indigenous skills and knowledge survival (Asogwa et al., 2017). Awuor (2013) considers indigenous knowledge in agriculture as one of the foundation stone that can guarantee food and nutrition security. Similarly, Kamwendo and Kamwendo (2014) elaborates that indigenous knowledge is a main pathway transformation of farmers especially in the process of achieving food security.

The importance of indigenous agriculture knowledge practices for enhancing food security cannot therefore be over emphasized. Indigenous knowledge is one of the knowledge base from which agricultural information is obtained by farmers to improve production and food security (Maina, 2015). From the literature, indigenous knowledge has diverse areas for food security intervention ranging from knowledge about pests, diseases, weather forecasting, food preservation, processing and storage of food which are key areas of food security intervention. As Siambombe et al. (2018) asserts, IK is significant in agriculture development for rural households. The motivation of this study was the need to establish the influence of indigenous knowledge on household food security. This study sought to establish the influence of indigenous knowledge coping strategies on household food security.

2.4 Agriculture and Food Security in Kenya

In order to meet the increasing demand for food and attain food security the projected 9 billion world population by 2050, Agriculture has to scale up the production of nutritious food (FAO, 2017). Agriculture in most African nations is the main stay of growth in economy because it is a major source of employment besides generating foreign exchange through export earnings from the sector.The sector contributes to 17.3 percent of the Gross Domestic Product (GDP) of sub-Saharan Africa and more than 40 percent of GDP of several East African countries (FAO, 2017). In Kenya Agriculture sector is the main driver of economic growth and a key sector for addressing food security as it accounts for 24 percent of the GDP in addition to employing 80 percent of rural population (GOK, 2010a; Kungu, 2014). The attainment of a food secure nation as a human right has been the primary objective of the Kenyan government through agricultural sector as envisaged in the constitution of Kenya 2010 and the Kenya Vision 2030 (GOK, 2010a). Agriculture sector has the role of supplying food with variety of diet to feed the county’s population in a more affordable manner. (Ministry of Agriculture, Irrigation and water Development [MOAIWD], 2016).

Production and consumption of diversified foods from all the six groups balanced dietfor improved nutrition is the primary focus of (MOAIWD, 2016). Small holder farmers with an average land ownership of 2.5 acres of land and who account for up to 75 percent of the total agricultural outputs are faced by challenges like lack of capital, markets access, high illiteracy levels and poor information systems (FAO, 2017). Low agricultural productivity has been attributed to lack of information whose source is agricultural extension services and which has the capacity to increase farm production by up to 6 percent (FAO, 2017; GOK, 2012). Agricultural activities and food security is however highly vulnerable to climate variability given that Kenya's agriculture is mainly rain–fed (Chinedum et al., 2015; IPCC, 2014; Jalloh et al., 2013; NEST, 2011). According to Shikavoti et al. (2015), sufficient food and adequate balance diet cannot be achieved owing to erratic rainfall patterns coupled with low irrigation uptake.

Under exploitation of agricultural innovations, poor financing of the sector, lack of good markets and infrastructure coupled with inappropriate agricultural information have let to the stagnating yields (Aker, 2011; Chavula, 2014). Extreme weather variability has resulted in increased incidences of drought, floods, pests and diseases which have undermined the performance of the sector by reducing food supply, availability, access and incomes leading to food insecurity (Economic Survey, 2015; FAO, 2013; GOK, 2015; Kungu, 2014). Tweheyo (2018) however observed that indigenous farmers organize their land use to maintain their farm production to enhance food security using their indigenous strategies like terracing, mixed cropping and ridging. These practices according to the author have been used by rural communities since time immemorial as strategies to sustain their survival at household levels. As Tanyanyiwa and Chikwamba (2011) assert, indigenous agriculture technologies and know how have an advantage over science in that they depend on existing local resources which are cheap than external resources.

Agricultural productivity and food security could thus be improved using indigenous knowledge since resilience is found in indigenous agricultural knowledge systems (Ponge, 2013). Further, the diversified, resilient indigenous farming systems could adjust to limited resources and unforeseen challenges such as drought. This can enable them to maintain subsistence production levels since crop diversity for most resource constrained farming households is a safety net. In addition, a survey on the impact of crop diversification revealed that hunger gap of households reduced from six months to two months thus reducing migration rates and improving a variety of food available (WORD, 2015). MOAIWD (2016) recommended the need for strategies and policies that recognize and promote IK for food security.

The foundation of any food systems diversity for many communities in is the indigenous food resources. (FAO, 2014). The source also reveal that indigenous food crops are environmental friendly, serve cultural needs and also retain cultural heritage of the people. According to Shukla et al. (2017), loss of indigenous foods like millet alongside neglect of indigenous agricultural knowledge are responsible for food insecurity among rural households. Achieving the fundamental food security components of availability, access, utilization and stability requires an increase in agricultural production, improving distribution, improving incomes through diversified means and reducing post-harvest food losses (Aulakh & Regmi, 2013). The aim of agriculture programme is to increase production, prolong shelf life of produce, add value and maintain quality and safety of agricultural products while minimizing losses (MOAIWD, 2016). Agriculture must therefore promote production, enhance diversification both in crop and livestock development. Resilience is found in diversified enterprises both to climate change and price fluctuations while at the same time avail diverse food stuffs for diet variety and a wide variety of income sources (Aulakh & Regmi, 2013; MOAIWD, 2016). These practices have the potential to increase food availability for enhance food security and could be achieved by applying indigenous knowledge related to agricultural production and food security (Chipungahelo, 2015; Gustavasson et al., 2011).

Mugwisi (2016) acknowledged that IK is relevant in present day agriculture and has to receive adequate attention and further recommended that indigenous knowledge be mainstreamed into agriculture. Van den Ban and Hawkins (1996) observed that farmers' knowledge is necessary for achieving justifiable agriculture because the way of farming should be matched with local conditions that the farmer is familiar with. Mugwisi (2016) further established that indigenous knowledge was used extensively in agricultural innovations and appreciated by extension workers and further established that a large number of extension workers and farmers used IK in crop production processes, protection against diseases and pests as well as in post-harvest storage.

Production and income from agriculture has declined substantially as a result of indigenous agriculture being pushed to the back seat leading to shortage of cereals and pulses in the food baskets of the rural communities (WORD, 2015). According to the source, systematic revival of agricultural systems could enhance the food basket of the communities and restore the ecosystems on which to sustain the livelihoods of small and marginal farmers. This calls for the recognition and utilization of IK systems in agricultural sector because integrating indigenous knowledge into agriculture and agricultural extension will among other things help to appreciate the perspectives rural communities, recognize the accomplishment of local farmers and increase the participation of farmers and their organizations in integrating what knowledge and practices already exists (Rajasekaran et al., 1994). Further, application of IK in agriculture would ensure sustainable food and nutrition security through production and diversified income sources. This study sought to establish the influence of indigenous knowledge based coping strategies for household food security in Baringo County, Kenya.

2.5 Agricultural Extension and Food Security

The efficiency of a country's agriculture extension services determines the success of its agriculture sector because through it, information, technology and innovation will be provided to farmers to increase agricultural production and improve household food security. The increasing urge for agricultural production to raise food security has led to an increased attention of the role of agricultural extension (Kaegi, 2015). According to Sigei (2014), farmers acquire crucial information on appropriate farming practices through agriculture extension services which elevate the potential of the farmers to maximize their resources.

Adejo et al (2012) acknowledge the significant function of agricultural extension as a source of agricultural information and innovations to rural farmers in order to improve agricultural production. Danso-Abbeam et al. (2018) further elaborates that, extension programme help maximize farm productivity, revenue while at the same time reduce poverty and minimize food insecurity. A study by Sigei (2014) established that, a strong correlation existed between extension services and food security among families. These benefits accruing from extension services that include improved farm production and income will help attain food availability and access which are the basic elements of food security. Tapping the potential for extension services will go a long way towards the attainment of the household food security which is currently a global concern.

In Kenya, public extension services begun during colonial period and extended beyond post independent error leading to robust growth in agricultural sector (Sigei, 2014). Gradual evolution from conventional extension system that involved top down approaches to participatory ones consisting of bottom up methods have characterized extension systems in Kenya (GOK, 2015). Agriculture extension has however been undergoing various obstacles in most African countries. Poor funding, ineffective research-extension-linkages, inappropriate agricultural technologies for farmers, low extension agents to farmer ratio and lack of clientele participation among the challenges facing agriculture extension (Agbamu, 2005; Rivera et al., 2001).

The freeze on employment, reduced funding for operations and maintenance of public extension has resulted in decline in both staffing and facilitation in extension services leading to decline in food production and negatively affecting household food security (Chimoita, 2014; Sigei, 2014). This has negatively affected the effectiveness and efficiency of extension service delivery as the extension to farmers ration has risen from the FAO recommended ratio of 1:1400 to 1:1500 in Kenya yet the demand for extension services by the numerous and diverse farmers are on the increase (National Agriculture Sector Extension Policy [NASEP], 2012). Extension system is also constrained by declining human and other supportive resources (Chimoita, 2014). Strengthening and supporting agricultural extension would foster an enabling environment for innovation and entrepreneurialism, thus revolutionizing agriculture into modern commercial agriculture from that of subsistence farming ultimately promoting household food security besides empowering local farmers to solve their own problems (Otieno, 2018; Sigei, 2014).

Agriculture extension plays a vital role in sharing knowledge, technologies, agricultural information and linking farmers to other actors in the economy (Sigei, 2014). A study by Mbakaya et al. (2018) on implementation of household approach on extension in Malawi indicated that agricultural extension system adopted the pluralistic, demand driven agriculture extension policy which advocates for community participation in development intervention. Application of indigenous knowledge practices in agriculture would demonstrate a bottom up approach to extension where farmers’ knowledge is given consideration in extension services to complement the scientific knowledge practices.

A paradigm shift of understanding the practicalities for farmers' empowerment, through effective extension service has emerged among stakeholders in agriculture, perhaps because of poor extension delivery approaches sustain agricultural growth (Mudukwe, 2006). In new paradigmfarmers' own knowledge ought to generate new skills and experiences that is support to bring transformation in the farm since framers' knowledge counts more than that of the scientists because farmers are experimenters who have developed most of the technologies that are in use at the moment (Asiabaka, 2010). Therefore extension programmes should be targeted towards promoting farmers' trials which originate from their indigenous knowledge.

Farmers receive agricultural information, technologies and education from both public and private extension organizations to enable them improve their agricultural production and attain food security and incomes at household levels (Muriuki et al., 2016). Bottom up approach to technology transfer where farmers are seen as the focal point should be adopted in extension (Asiabaka, 2010). Indigenous knowledge becomes therefore handy especially in its ability to promote sustainable development including food security (Anaeto et al., 2013). According to Muriuki et al. (2016), farmers can interact in their daily activities and be able to share ideas with fellow farmers thereby disseminating agricultural information.

Meaningful agricultural development could be achieved if IK is recognized and harnessed for use in extension service (Anaeto et al., 2013). Extension workers need to take heed of the relevance of the indigenous knowledge in promoting agriculture and achieving hunger free world by educating farmers on how they can synchronize indigenous knowledge to benefit their farming and attain food security (Siambombe et al., 2018). It is therefore apparent that indigenous knowledge has not been fully utilized in agriculture to benefit farming households in addressing food security. A paradigm shift is therefore necessary that integrates IK system with extension education in order to preserve and sustain the people's local knowledge through their participation in development programmes including extension services. In addition, integrating the IK systems in the Research-Extension- Farmer linkage would improve research and extension by making use of farmers' indigenous ideas that would enhance ownership and sustainability of extension services.

2.6 Indigenous Knowledge, Agricultural Development and Food Security in Kenya

This section examined literature related to indigenous knowledge, agricultural development and food security in Kenya.

2.6.1 The concept of indigenous knowledge

Indigenous knowledge is acquired through the accumulation of experiences, trials and intimate knowing of local environment (Shukla et al., 2017). Indigenous knowledge systems is transmitted orally from generation generation via socialization (Dlamini & Kaya, 2016; Singh & Kumar, 2014). Melchias (2001) also described indigenous knowledge as what indigenous people know, do, and have known and done for generations through trial and error to adjust to change.

In addition, Kamwendo and Kamwendo (2014) defined indigenous knowledge in the domain of food security as knowledge about soil fertility, disease resistant and quick growing crops, soil conservation, weather forecast, pest and disease control, food preservation, processing and storage as well as water management techniques. Moreover, indigenous knowledge according to UNFCCC (2013) local communities act as custodians of the indigenous know-how, skills, innovations or strategies passed to other generations. According to Senanayake (2006) IK is dynamic, experimental and accommodative to new technologies to adopt to new change. Indigenous knowledge therefore is dynamic, innovative and an outcome of interaction with other communities where exchange of ideas occurs via diffusion and adoption of new practices after experimentations of the innovations. Indigenous knowledge detects local conditions, experiment with solutions and readapt previously identified solutions to adjusted environmental, socio-economic and technological circumstances (Brouwers, 1993; Fernandez, 1994).

Mugwisi (2016) characterized indigenous knowledge as experiential rather than theoretical, dynamic rather than rigid, acquired through experiences and transmitted through imitation and demonstration. The aforementioned authors have demonstrated the incredible use of indigenous knowledge in day today life of indigenous communities to sustain their livelihoods and the need to conserve the vital knowledge for the survival of the communities. The development of indigenous knowledge involves experimentation, trial and error activities over time and therefore represent research based knowledge developed as a result of continuous experimentations. In spite of the great value of indigenous knowledge contribution to the society, indigenous knowledge is at risk of being neglected in spite of its usefulness in climate change mitigation (Siambombe et al., 2018). Eyong (2003) argued for the need to conserve biodiversity and its associated indigenous knowledge systems underscoring the fact that IK has been instrumental in the discovery of new drugs from medicinal plants. Yet despite this immense contribution, indigenous knowledge is overlooked especially by the proponents of the western or modern knowledge. Mugwisi (2016) recommended the need to integrate IK into education and training.

The importance of indigenous knowledge in development in Kenya is evidenced by the recognition and appreciation of the importance of indigenous knowledge through the establishment of a national policy on indigenous knowledge systems together with efforts to integrate indigenous knowledge in development processes (Kiplangat & Rotich, 2008). Existing challenges in agriculture include the urgency for attaining food security and reduction of climate change effects which requires innovations, technologies and policy interventions that are knowledge based. One of such is the indigenous knowledge base which can effectively address the challenges (Chinedum et al., 2015).

2.6.2 Indigenous knowledge and agricultural development

Agriculture is the key driver of many of the nations' economy and improvement in the sector can be important intervention to the perennial food insecurity by improving productivity across all the agricultural food systems. In the African context, IK has been marginalized in the agricultural and rural development programmes (Ponge, 2013). Rankoana (2017) established that rural communities practice their farming through their IK farming practices and rainfall prediction. Indigenous agricultural knowledge according to Asogwa et al. (2017) is of immense value in improving food security as indigenous people have adopted strategies and technologies in agriculture for food security.

Indigenous knowledge system of agriculture developed over years of cultural and biological evolution and has provided rural communities with food resources that could be useful in the achievement of the SDG on food security (Rankoana, 2017). According to the author, indigenous knowledge practices which requires a nutritionally adequate and safe food supply at household level. A paradigm change that advocates for the promotion and application of IK and technologies in agricultural development and food security programmes is essential (Chirimuuta & Mapolisa, 2011).

Agriculture sector has been cited as a good example where farmers adopt variety of IK skills and strategies based on experience and experiments to understand their environment. Indigenous knowledge has potential in agricultural and sustainable food security as well as important developmental information (Anyira, 2010). Abioye et al. (2011) argues that local knowledge on farming practices is paramount for small scale farmers since IK and SK must play a complementary role to each other.

Indigenous knowledge encompasses the content on traditional know-how, innovations, information, practices, skills and learning of indigenous knowledge systems such as traditional Agriculture (Abioye et al., 2011). The source further opined that IK is an innovative approach to disaster risk reduction for indigenous communities and an important source of developmental information (Abioye et al., 2011). The use of IK has enabled farmers to monitor seasons and try to minimize risks associated with certain seasons like drought using a variety of strategies (Chege et al., 2018). Esipisu (2016) reports that IK weather forecasting by rainmakers is accurate and scientifically competitive hence should be respected and protected because they have invaluable indigenous knowledge which guide farmers on when and what to plant in their farms. Similarly, Osman (2013) provided a similar case for Sudan where pastoralists use indigenous knowledge of astronomy in which the appearance of bright stars indicated a condition of rainy season.

Indigenous knowledge according to the authors provided useful information to farmers as far as farming is concerned which ultimately influence production level and food security.
Among the Batonga community of Zimbabwe, frogs and fish are used to predict weather message for instance the croaking of frogs in the fall of winter gave a reliable message that it was about to rain hence planting time (Siambombe et al., 2018). This provided useful information for farmers especially with regard to farming activities especially on when to plant. Similar findings were also established by Kaya and Koitsiwe (2016) who found that bird nests found to the top of trees on river banks were indicators of flooding and vice versa. The indigenous weather information enables farmers to plan adequately to ensure that they maximize weather information for increased agricultural production.

One of the strategies for developing the agricultural sector is to harness the potentials of indigenous knowledge which has gained a lot of recognition through many initiatives (Abioye et al., 2011; Asogwa et al., 2017). Indigenous knowledge provides a basis for decision making about fundamental aspects of day today life of rural people (Abioye et al., 2011; Osman, 2013). Tweheyo (2018) indicated that local farmers sustain their food production using their indigenous strategies like terracing and mixed cropping. Integrating Indigenous knowledge into agricultural extension education will among other things help to appreciate farmers' accomplishments and increase their participation in agricultural and food security development (Rajasekaran et al., 1994).

Indigenous knowledge as suggested by Abioye et al. (2011) has much to offer lessons but this is only possible through documentation of it. Kamwendo and Kamwendo (2014) argues that the marginalization of indigenous knowledge systems is one of the causes of food security. As Osman (2013) asserts, the limitations that inhibit optimal utilization of indigenous knowledge to maximize rural communities returns particularly in agriculture include, negative attitude towards its relevance, usefulness and credibility. Lack of documentation also remains major challenge which has led to marginalization of IK, denying it its ability to perform its function (Ngulube, 2017). This study was informed by these gaps and it sought to establish the Indigenous knowledge coping strategies for household food security in of Baringo County, Kenya.

2.6.3 Indigenous Knowledge and Food Security in Kenya

The Constitution of Kenya 2010 recognizes the right to management by communities of their own affairs and further their development (GOK, 2010a). This implies that the application of community's indigenous knowledge to solve their problems including its use in the agricultural field is their right. Ponge (2013) argued that, food security may not be achieved without taking cognizance of the role of indigenous knowledge. Ndwandwe (2013) underscores the importance of IK in enhancing household food security. Chipungahelo (2015) highlights some IK strategies for enhancing food security to include inter planting preserving foods for dry season. The author further argues that in developed and developing countries all over the world, farmers and local communities have indigenous knowledge, expertise, skills and practices related to food security and agricultural production.

Similarly, Chinedum et al. (2015) explains that a wide range of indigenous knowledge, skills and practices are possessed by local communities and have been depended upon for survival and disaster risk reduction since time immemorial. A case example is the scientific research done in Kakamega, Kenya that proved that rainmakers had accurate and scientifically competitive weather information by observing the behaviour of insects, animals, reptiles, trees, migration patterns of bees, croaking sounds of frogs and songs of birds among others to provide accurate weather information for the day, week and a month to evade risks associated with weather change (Esipisu, 2016). In a related study done in Zimbabwe, weather prediction by indigenous communities provides a very reliable signal in the walk of agriculture which when adopted by traditional communal farmers could enable the fight on food insecurity easier.

Additionally, Kamwendo and Kamwendo (2014) indicated that indigenous knowledge is important for transformation in rural areas and potential alternative to scientific knowlede. The authors are in common agreement that indigenous knowledge is of immense value and as FAO (2014) recommends, there is no doubt that indigenous knowledge is vital for rural communities' food and nutrition security. Siambombe et al. (2018) also indicated that indigenous information if utilized well can help the peasants globally to mitigate the levels of change and strive towards achieving sustainable development.

According to Iloka (2016), communities always made use of their indigenous knowledge to solve problems affecting them including risks associated with climate change. As Umar and Musa (2015) elaborates, the fact that local communities have inhabited and survived hardships in the Arid and Semi-Arid Lands (ASALs) for centuries is an indication of preparedness in terms of indigenous mechanisms and strategies to deal with change like food insecurity. This demonstrates the great potential of indigenous knowledge in tackling problems associated with weather and agriculture which have a bearing in determining food security. Such knowledge will be a useful resource to extension agents to tap in order to improve extension services and boost food security using local means. Chipungahelo (2015) pointed out that indigenous knowledge strategies have been used as coping strategies to combat food insecurity and adverse environment for many years. However, indigenous knowledge is undocumented hence becomes difficult to utilize. Besides, most of the IK is held by older generations who might die with the knowledge (Dlamini & Kaya, 2016). This study aimed to bridge this gap.

2.7 Indigenous Knowledge and Food Security Coping Strategies

A large proportion of rural poor communities depend on indigenous knowledge for livelihood and food security (Dlamini & Kaya, 2016). Coping strategies involves strategies of compromising domain adopted to reduce vulnerability (Farzana et al., 2017). Coping strategies involve compromising quality and quantity of food consumption especially to mitigate the adverse effects of food shortage at the household levels (Farzana et al., 2017; Gupta et al., 2015). This implies that communities have wisdom and traditional mechanism of dealing with day to day challenges facing them to reduce the adverse effects of change.

The persistence of rural livelihood system is grounded in the indigenous knowledge about natural resource management and since coping strategies need skills, experience and a positive outlook on the future, application of indigenous knowledge would be paramount in this context (Tanyanyiwa & Chikwanha, 2011). According to Dlamini and Kaya (2016), indigenous knowledge systems refers to bodies of knowledge, skills and beliefs produced locally and traditionally transmitted orally from one generation to the next. Indigenous knowledge is further described as a form of local knowledge that is dynamic and content specific and holistic in its character which is linked explicitly to a culture hence it is intimately related to livelihoods of the people and when combined with scientific knowledge could minimize vulnerability to hunger (Osman, 2013; Ponge, 2013).

Osman (2013) in his study in Sudan provided a wide range of indigenous knowledge coping strategies that include among others use of traditional healers to successfully carry out surgical interventions and treatment of livestock, diversification of both livestock and crops, selling weak animals to minimize losses, selection of suitable varieties of traditional crops, migration in search of pasture and water, effective management and conservation of grazing fields and use of wild plant species as food during periods of scarcity. Water harvesting for growing subsistence crops was also found to be used according to the study. In addition, the traditional systems to predict weather forecast proved to be valid and the technique of range utilization was effective in disease prevention and animal health (Osman, 2013).

Similar study undertaken by Siambombe et al. (2018) in Zimbabwe established that food security strategies employed include alteration of planting dates, mixed farming and crop diversification. Mixed cropping used by indigenous communities also brought about diversity and ensured continuous harvest of food crops round the year to meet the family needs (WORD, 2015). This implies that rural communities have diversified their food sources as coping strategies to food insecurity.

In rural areas of Malawi, a study by Simwaka et al. (2010) on coping strategies to food insecurity revealed that irrigation farming and marketing of agricultural products to earn income was adopted by farmers. The study findings demonstrated the potential for indigenous knowledge in coping with food insecurity through increased production and incomes. While describing the potential for local communities to cope with uncertainties in their environments, (Ponge, 2013) explains that, resilience is found on IK agricultural systems and that diversification can cope with emerging challenges like drought.

Local people according to the author have their own strategies, mechanisms and build on institutions to cope with uncertainties and to achieve food security. Crop diversity for most poor farmers is their safety net as far as food security is concerned (Ponge, 2013). The fast loss of IK sustainable practices have endangered household food security (Ndwandwe, 2013; Ponge, 2013). According to Ndwandwe (2013), it is imperative to reduce dependency on scientific practices and scale up on indigenous knowledge because it is available and cost effective.

Baringo County, like other communities worldwide, have been reported to employ wide range strategies to counter food insecurity. Reliance on in expensive food, reducing meal size and skipping meals are among the coping strategies within the County (WFP, 2013). Charcoal burning was also used as a source of income in the pastoral livelihood zones. Saina et al. (2012) further gives other coping strategies used by households to include hunting and gathering, farming and growing of short season crops. However, Studies on indigenous knowledge practices related to agriculture both in livestock and crops in the county particularly strategies targeting climate change, production, storage, pest and disease management are limited in the county. This study aimed at bridging this gap.

2.8 Indigenous Knowledge Based Coping Strategies and Food Security

This study examined coping strategies related to the five objectives of the study. Indigenous knowledge based climate change coping strategies was related to objective one, indigenous food production strategies addressed objective two, indigenous pests, parasites and disease control coping strategies addressed objective three, indigenous knowledge based storage coping strategies on household food security answered objective four and finally strategies for integrating indigenous knowledge into agricultural extension services in Baringo County, Kenya addressed objective five of the study.

2.8.1 Indigenous knowledge based climate change coping strategies and food security

The effects of climate change have negatively affected agricultural productivity. This is characterized by the rise in temperatures and unpredictable weather patterns, and increased incidences of diseases and pests which have combined to reduce yields especially in Arid and Semi-arid lands (Mutunga et al., 2017). Since climate change is the main determinant of agricultural performance, strategies for increasing food production to enhance household food security need to consider measures that would reduce or cope with the climate change effects (Ihenacho et al., 2019). Drought and floods phenomena affects the livelihoods and the economy of the people which can be countered through application of both indigenous knowledge and conventional knowledge strategies (Nduti, 2014). In Arid and Semi-Arid Lands (ASALs), food crisis has always been attributed to among others climatic and environmental changes, poor storage methods, effects of pests and diseases and inaccessibility to Agricultural services (Asogwa et al., 2017).

The impacts of climate change and variability leads to crop failure, livestock deaths besides dependency on food relief (Ogega, 2017). In addition, changing climate further lead to extreme temperatures, floods and drought which affect agriculture (UNCTAD, 2017). A study by Ogega (2017) on the use of scientific and indigenous knowledge in adapting to climate change and variability at the Kenyan coast revealed the indicators of changing climate include reduced rainfall, a change in rainfall patterns and increased temperatures. The changes according to the author had caused impacts such as crop failure, emergency and re- emergency of pests and diseases.

Reduction in the climate change effects as suggested by Kumar (2014) lies in preservation and expansion of IK and generation of knowledge banks. Ihenacho et al. (2019) recommends the adoption of climate-smart traditional practices as an urgent need for intervention against climate change effects and for attaining sustainable food production. Mafongoya and Ajayi, (2017) argue that valuable local knowledge of relevance to climate change assessment and adaptation is held by rural societies adding that indigenous knowledge is cumulative body of knowledge, practice and belief, evolving by adaptation processes and handed down through generations by cultural transmission.

In Kenya attention has been given scientific knowledge in coping with drought (Nduti, 2014). Drought conditions have however curtailed the achievement of household food security despite the continuous application of the scientific knowledge in agriculture. Kumar (2014) however suggested for the preservation, expansion and application of indigenous knowledge, skills and practices in agriculture to minimize climate change effects. Indigenous knowledge when combined with science and technology can be essential in assisting households to cope with climate change and could ensure food security (Chege et al., 2018; Kumar, 2014; Ogalleh et al., 2012). Communities that have lived under drought situations for many generations develop coping strategies to reduce the impact of drought and have sustained their household food security for generation (Asogwa et al., 2017).

Indigenous knowledge can therefore tackle the effects of climate change and help farmers to be conscious of available solutions (Chege et al., 2018). UNESCO (2018) recommends for adaptation actions that are based on and guided by the best available science and as appropriate knowledge of indigenous people with the intention of incorporating adaptation into environmental policies and actions. Ogalleh et al. (2012) concluded that indigenous knowledge is among the solutions for effective and sustainable adaptation. Indigenous people according to Magni (2016) adopt strategies for climate change based on forecasting weather and adjust agricultural practices to reduce damage to crops from harm. Luseno McPeak et al. (2003) opined that IK weather forecasting can improve value of the scientific knowledge system if integrated together for use especially by pastoralists.

According to Chinedum et al. (2015), indigenous knowledge practices may not be perfect enough but it has over the years sustained farming practices in most communities hence can streghten adaptive capacity to climate change. Farmers are also said to adapt and mitigate climate change using indigenous practices like crop diversification (Lunga & Musurwa, 2016).

According to Gaoshebe (2014), local people over the years build local food security strategies deal with climate change adaptation strategies like knowledge of behavior of animals, position of stars as early warning indicators of changing weather conditions. In a related study, findings by Mafongoya and Ajayi (2017) established that communities in hazard prone areas have through experience and observation understood their environment and prevention and mitigation measures including early warning preparedness.

The study's findings inform of the great potential that indigenous knowledge has as far as climate change mitigation measures are concerned. Umar and Musa (2015) observed that indigenous practices are found to work out well for communities while (Mafongoya & Ajayi 2014) further indicated that rural societies have valuable local knowledge for climate change assessment and adaptation. Resilience is therefore found on indigenous agricultural systems as the diversified indigenous farming systems can adjust to scarce resources situation and unforeseen challenges such as drought and are still able to maintain subsistence production levels (Ponge, 2013).

The outcome of IK coping with climate change is the enhancement of household food security. Ponge (2013) concluded that local people have their own strategies, mechanisms, and build on institutions to cope with uncertainties and to achieve food security. Chipungahelo (2015) further asserts that both developed and developing societies have used IK strategies to combat food insecurity and adverse environment over a number of years. Similarly, UNESCO (2018) observed that indigenous knowledge systems and practices are a major resource for adapting to climate change. According to Singh and Singh (2017), indigenous practices like intercropping, traditional organic composting and integrated crop-animal farming can be a model practices for climate-smart approach in agriculture.

In view of the aforementioned literature, it is evident that the value of indigenous knowledge cannot be overemphasized as it has worked very well among the rural communities in dealing with disasters related to climate change effects and other areas of development. This is perhaps the reason why Singh and Singh (2017) asserts that, IK agricultural strategies has regained the increased recognition worldwide as climate smart practice. As Ihenacho et al. (2019) argues, the tragedy of the disappearance of this knowledge is obvious to the local indigenous communities as the knowledge is undocumented for use in by the next generation. This study sought to determine whether indigenous knowledge coping strategies influenced household food security. Studies determining the extent to which indigenous knowledge coping strategies influence household food security in Baringo County is scanty. The present study intended to bridge this gap in Baringo County, Kenya.

2.8.2 Indigenous knowledge based food production strategies and food security

Agriculture is a key sector in Kenya's economy as reflected by its contribution to income generation, employment creation, food security and raw materials for industrial development in addition to its contribution of 24 percent of the country's GDP (GOK, 2010a). Food production cannot keep pace with the rising food demand while post-harvest losses accounts for a high percentage of food wastage (Waithaka, 2011). Feeding the ever increasing population requires an increase in the local and regional food supply through food production (Mozumdar, 2012).

Small holder farming plays an important role of increasing food production, source of income, employment and export earnings for both rural and urban populations (Sigei, 2014). Household food security according to Beyene (2010) is dependent on food availability through agricultural production, the ability of households to access the available food through diversified income sources from off farm.

Sufficient household food production and adequate economic and physical access to food are important for achieving household food security (Sigei, 2014). Similarly, UNCTAD (2011) argue that smallholder farmers are the main source of food for the food insecure. FAO (2017) posits that, climate change affects the four food components of food security. According to UNCTAD (2011), increasing production of staple and indigenous crops and livestock for market is the main focus of any food security intervention.

The determinants of food security are food production, access to markets and political stability (Maina, 2015). Food security is about quantity of the production, availability, reliability, quality, accessibility and nutritional status. Increasing farm productivity among small holder farmers guarantees food security (Mozumdar, 2012). Danson-Abeam et al. (2018) pointed out that the Sustainable Development Goals (SDGs) of reducing hunger and promoting food security aims at increasing farm productivity especially from crop sector.

Njomo et al. (2019) argue that smallholder farmers have plenty of IK on agricultural practices which could improve productivity and improve food preservation while reducing post-harvest losses. Such knowledge could therefore be instrumental for sustaining household food supply at all seasons. Sustainable agricultural practices such as mulching, intercropping, agroforestry, pest control, integration of livestock into farming systems preventing erosion and water harvesting are the typical characteristics of indigenous knowledge practices and may provide sustainable solutions to household food insecurity. Indigenous knowledge leads to sustainable agriculture. Diversified farm production and income are key elements of attaining sustainable household food security. This study examined the influence of indigenous knowledge coping strategies on household food security in Baringo County, Kenya.

2.8.3 Indigenous knowledge based storage strategies and food security

Post-harvest losses are among the major problems facing most smallholder farmers. In the least developed countries, one third of the food produced is lost before reaching consumers due to spoilage poor storage and transport facilities (UNCTAD, 2017). In Kenya, maize which is considered as the main staple food is affected much by postharvest losses particularly among the smallholder farmers who are the most vulnerable (Muriuki et al., 2016). These losses according to the authors' findings have resulted in perennial food shortages in the country with most of the available modern storage pest control strategies being unavailable to farmers because of their costs.

Post-harvest losses in Kenya accounts for 30-40 percent of the total grain output particularly during post-harvest handing (Rembold et al., 2011). Food by nature begins to spoil the moment it is harvested and therefore processing, preservation and packaging of food is undertaken to prevent spoilage by microorganisms (Aluga & Kabwe, 2016). Food losses cause negative consequences to societies such as emission of greenhouse gases (Aulakh & Regmi, 2013).

Diverse factors such as poor handling, poor storage and destruction by diseases and pests of food are among the causes of post-harvest losses (World Bank, 2011). The need to develop food processing and preservation technologies to reduce food losses and wastage during surplus seasons cannot be over emphasized (Olurankinse, 2014). According to Asogwa et al. (2017), arresting massive losses and improving food security calls for the recognition, promotion and utilization of African indigenous knowledge skills and practices across food security value chains. Increasing production and improving distribution together with the reduction in food losses could improve food availability and accessibility (Aulakh & Regmi, 2013). Increasing food availability, real incomes and household food security can be achieved by reducing post-harvest food losses (Alexandratos & Bruinsma, 2012; World Bank, 2011). Asogwa et al. (2017) argued that, a high post-harvest due topoor food preservation capacity is responsible for food and nutrition insecurity.

Reduction in post-harvest food losses is a critical component of ensuring future global food security as it would increase food availability which is a critical element for household food security (Aulakh & Regmi 2013). Berjan et al. (2018) underscores the importance of food waste reduction by elaborating that food losses and wastage destabilize the basis for food and nutrition security besides affecting all the elements of sustainable food security. The authors concluded by indicating that food waste reduction is crucial for improving the sustainability of achieving food and nutrition security. Though food in most countries is seasonal, they are produced in large amounts during their harvest season (Olurankinse, 2014). The author recommends for better preservation to increase the shelf life and keeping quality of food for future.

Although Kenya has a well-developed agricultural research and extension infrastructure, use of scientific strategies in storage and preservation of agricultural produce is still limited (Waithaka, 2011). The role of IK in food production and preservation has for long been taken for granted and all the credit given to scientific knowledge yet indigenous knowledge is an important asset of the poor and other marginalized social groups because it is used to gain control of their own lives including ensuring their livelihoods (Dlamini & Kaya, 2016). Promotion and utilization of IK food processing, preservation and storage is one way of tackling the challenge of inadequate food (Asogwa et al., 2017).

Africa according to Asogwa et al. (2017) produce various types of food stuffs and also possess diverse indigenous knowledge systems for their preservation and storage hence it is important to incorporate the IK system in food security strategies including preservation and storage strategies. The source further argues that, the use of indigenous knowledge in solving food shortage remains a powerful means of sustaining household food security as it is simple, low cost and the techniques are also the bedrock for small scale food processing enterprises that are crucial to rural development in Africa.

Indigenous Knowledge is not documented but orally exchanged and transmitted from generation to generation. It is therefore in danger of getting extinct as preservation becomes increasingly difficult due to changes in the world (Waithaka, 2011). Tweheyo (2018) while emphasizing its significance in development asserted that indigenous knowledge is a key path way to rural farmers' transformation as it is potentially a reliable alternative to modern especially in the process of achieving food security. Storage is therefore one of the significant determinant of food security. This study examined the indigenous knowledge coping strategies for household food security.

2.8.4 Indigenous pest, parasite and disease control coping strategies and food security

Agricultural sector face the challenge of inadequate pests and diseases management and poor storage facilities (World Bank, 2011). Many farmers continue to rely on indigenous ways of preserving their agricultural products (Njomo et al, 2019). Pests, diseases and climatic conditions are constantly changing. The main agents of post-harvest loss in production are both field and storage insect pests and diseases (Waithaka, 2011). Pests and diseases are the main factors affecting production systems as they cause significant losses (James et al., 2010). Pests and diseases reduces quality and quantity of agricultural produce thus negatively affecting food security. Different communities use various techniques in pests and disease management (Odero, 2011). This study examined the indigenous knowledge coping strategies for food security in Baringo County, Kenya.

2.8.5 Integration of indigenous knowledge based strategies into agricultural extension

Skills and technical innovations which are crucial for agricultural advancement requires an investment in knowledge. Dewes (1993) identified two sets of global knowledge base- indigenous and scientific knowledge systems. According to Naanyu (2013), scientific knowledge systems are made universal through western education including agriculture extension while indigenous knowledge, which is considered as the basic component of any country's knowledge system is often regarded as less progressive hence suppressed, ignored, undervalued or even replaced by the western scientific practices.

The main paradigm for advancing agriculture has therefore been through use scientific knowledge in agricultural extension. Ponge (2013) indicated that the two knowledge bases go hand in hand and complement each other rather than one replacing the other. Mishra and Rai (2013) argues that indigenous knowledge practices correspond well with scientific evaluations despite the many differences between the two knowledge systems. Wasudha et al. (2018) indicated that the concept of agricultural knowledge information systems (AKIS) focused on the links between research, education, extension and farmers.

Similarly, agricultural extension services should be delivered through participatory and pluralistic extension system that should also bring farmers on board (Bourne et al., 2020). In essence, any extension content and service ought to consider incorporating the two knowledge bases without discrimination in which case farmers should be seen as partners in extension rather than being passive recipients of extension as far as their knowledge, skills and innovations are concerned. Although indigenous knowledge has often been neglected by the proponents of the scientific knowledge, Mugwisi (2016) argues that IK ought to receive sufficient prominence in extension work because it is still relevant in modern-day agriculture hence should be documented and integrated into research and extension.

Since agricultural extension involves technology transfer, the forward and backward research-extension-farmer linkage ought to encourage feedback both from top and bottom (Pazvakavambwa & Hakutangwi, 2006). It is therefore justifiable according to Ponge (2013) to integrate both indigenous and scientific knowledge systems in extension messages for effective output and eventual sustainability. One of the benefits of integrating indigenous knowledge in extension service is the fact that indigenous people have lived in perfect harmony with nature and have gained knowledge through many years of experience about the inner functioning of their environment hence their knowledge is adapted to local conditions (Naanyu, 2013; Wasudha et al., 2018).

Similarly, scientific knowledge extension is more or less top down in nature while indigenous knowledge extension reflects bottom up in which cases the two approaches would enhance extension service delivery if they are integrated. Integrating IK and scientific knowledge in agriculture extension promotes interest and ownership of innovations among farmers, harnesses the full potential of farmer's knowledge and improves collaboration among stakeholders thus enhancing the success and sustainability of agricultural innovations. According to the AKIS and Agriflection knowledge triangle for agricultural extension, farmers should always occupy the central position among research, extension and education and with the critical questions for learning being what farmers do, why they do it, and how they can make their farming systems more profitable and sustainable (Worth, 2006). Ideas from farmers could then be tapped and integrated to the extension messages for dissemination to other farmers and to make such knowledge available for future generations.

Farmers according to Owolabi and Okunlola (2015) use both indigenous and scientific knowledge practices in their farms especially in the control of pests and diseases. However, indigenous knowledge practices have not been harnessed and documented so as to be integrated into extension to benefit many users. Njomo et al. (2019) observe that, smallholder farmers have plenty of knowledge on agriculture. This could inform on the basis for the need to integrate indigenous knowledge into the scientific agricultural extension contents for dissemination too the beneficiaries. Generally, the integrated use of the two bodies of knowledge is absent (Guye, 2014).

2.9 Agriculture, Food Security and Indigenous Knowledge Policy Foundations

The Structural Adjustment Programmes (SAPs) are among the most important policy frameworks that greatly influenced both strategies and programmes for agriculture, food and nutrition security in Africa in the 1980s (Heidhues & Obare, 2011). The SAPs according to the authors emphasized policies on private sector and free market development, eliminating subsidies and cutting public support for social services. The scenario impacted negatively on extension services and further led to decline in the sector performance culminating into rising poverty and food insecurity.

The World Developments summit of 1996 and the Millennium Summit Declaration of 2000 set out the Millennium Development Goals (MDGs) which resolved to halve the number of the poor and the hungry by 2015, but the slow progress towards the achievement of the MDGs necessitated the establishment of the Sustainable Development Goals (SDGs) as a renewed hope to end hunger and poverty by 2030 (IFPRI, 2016). Maputo declaration of 2003 on food security and agriculture in Africa and the Malabo declaration of 2014 on accelerated growth and transformation for shared prosperity and improved livelihoods laid the foundation for enhancing food security in the African continent. Malabo declaration of 2014 adopted concrete agriculture goals to be attained by 2025 and further reaffirmed the central commitment of Maputo era of allocating 10 percent of public resources to agriculture and a commitment to increased irrigation and mechanization as well as curtailing the post –harvest losses (AU, 2016). The Kenya vision 2030, singles out agriculture as the critical sector for achieving food security.

Many of the past food policies recognized agriculture-led growth as the main strategy to achieve targets on food and nutrition security (AU, 2014). As GOK (2009) elaborates, no society can achieve its development goals if it ignores its rich cultural heritage embedded in its indigenous knowledge. Abioye et al. (2011) argues that, agriculture sector can better be developed by harnessing the potential of indigenous knowledge. This perhaps explains the growing recognition for IK through various initiatives in Kenya. Dlamini and Kaya (2016) posits that policy makers and other stakeholders have an habit of ignoring IK rural communities have survived on it for years. The Constitution of Kenya (2010) emphasizes the role of IK innovations in the development of the nation and for the promotion of the intellectual property rights of the people of Kenya (GOK, 2010a).

Similarly, the national policy on the traditional knowledge provides a national legal and institutional framework to support the integration of various aspects of IK in national development planning and decision making process and further provide for the recognition, use, preservation, protection and promotion and dissemination of sustainable use of traditional knowledge (GOK, 2009). The policy further recognizes IK as a rich asset for individuals and society and seeks to mobilize and harness grass root technological innovations and traditional values and institutions. In order to arrest the high post-harvest losses and improve food security, Asogwa et al. (2017) recommends a policy on recognition, promotion and utilization of indigenous knowledge, skills and practices on food processing, preservation and storage which according to the author would tackle the challenge of inadequate food for a healthy and active life.

Kamwendo and Kamwendo (2014) while stressing the importance of IK in agriculture and supporting policy shift described indigenous knowledge as important direction to rural farmer’s transformation which is an alternative to scientific innovations especially for achieving food security. There is therefore need for a policy shift to incorporate and integrate indigenous knowledge in agriculture and food security policies. FAO (2014) asserts that, IK is vital for rural communities’ food and nutrition security. Awuor (2013) indicated that IK is considered as a keystone for guaranteeing survival of rural communities in terms of food and nutrition security. Awuor (2013) further argued that for any intervention and policy to bear positive effects must recognize local people’s tradition including valuing their indigenous knowledge regarding agriculture.

2.10 Theoretical Framework

The Cultural Theory of Risks developed by Douglas (1966) and the Traditional Framework Theory (TFT) advanced by Doubleday (1993) guided this study. Cultural Theory of Risk explains the role of culture in dealing with risks such as food insecurity. According to the theory, risks are framed differently in which a perspective is created about the risk followed by the production of the corresponding responses. Accordingly, the risk presented in this study is food insecurity where communities use their culture embedded in their indigenous knowledge to develop coping strategies that respond to change in the environment that would otherwise lower their household food insecurity. The strategies developed mitigate against climate change effects, pests/parasites and diseases in their farms besides improving their agricultural productivity and storage of the farm produce.

The theory according to Bellamy and Hulme (2011) provides an explanation on the ability of indigenous people to recognize certain dangers and adjust their way of life by changing their approach to the risk using their experiences gained in life over time because culture is dynamic and emergent and therefore different communities view and manage risks differently. Indigenous Knowledge in the context of this theory is used to observe, monitor and report changes in the environment for appropriate action by the households. This provides more sustainable actions since it originated from within the community itself based on experience.

In this study CTR provided an understanding of why food security and policies designed to address it requires an insight of people's cultural worldviews that determine the way they see how food security system works as well as the participatory community-based approaches for analyzing, understanding and distinguishing the relationship between culture, food security and coping strategies which would contribute to more a better understanding of the ground of how communities make decisions and policies about coping to the dangers related to food insecurity now and in the future.

Traditional Framework Theory (TFT) on the other hand views indigenous knowledge as a traditional systems thinking in action which is unique to people who formulate it, based on the interaction of their culture with their environment and integral to their worldview. The theorist presents indigenous knowledge as a collective understanding gained over time by the traditional communities and which is both evolutionary and dynamic in perspective. Tanyanyiwa and Chikwanha (2011), while supporting this theory explains that indigenous knowledge facilitates communication in society and the basis for local-level decision making. Indigenous knowledge is therefore a powerful knowledge system in indigenous communities especially in ASAL areas like Baringo who face myriad of challenges emanating from environmental changes key among them being food insecurity. The growing publicity of indigenous knowledge is perhaps because of its capacity to handle difficult circumstances among rural households such as food insecurity.

The two theories provided an understanding of how culture can be a powerful tool for dealing with risks affecting the community which include food insecurity. There is an enormous knowledge in the local community that can be useful in providing solutions to problems in the community because they possess indigenous knowledge that is specific to the locality and to the community affected and if tapped can lead to sustainable solutions to community problems. An understanding of such knowledge systems in terms of how it frames food insecurity and the way in which social organizations and institutional cultures operates to respond to the risk of food insecurity is worth studying. There is limited information on the indigenous knowledge strategies for food security among rural households in Baringo County, Kenya.

2.11 Conceptual Framework

This study was based on the framework that communities possess indigenous knowledge and skills that are employed in agriculture (both crops and livestock) to enhance food security. The indigenous knowledge and skills are considered as coping strategies. The interaction between the studies variables are illustrated in Figure 1.

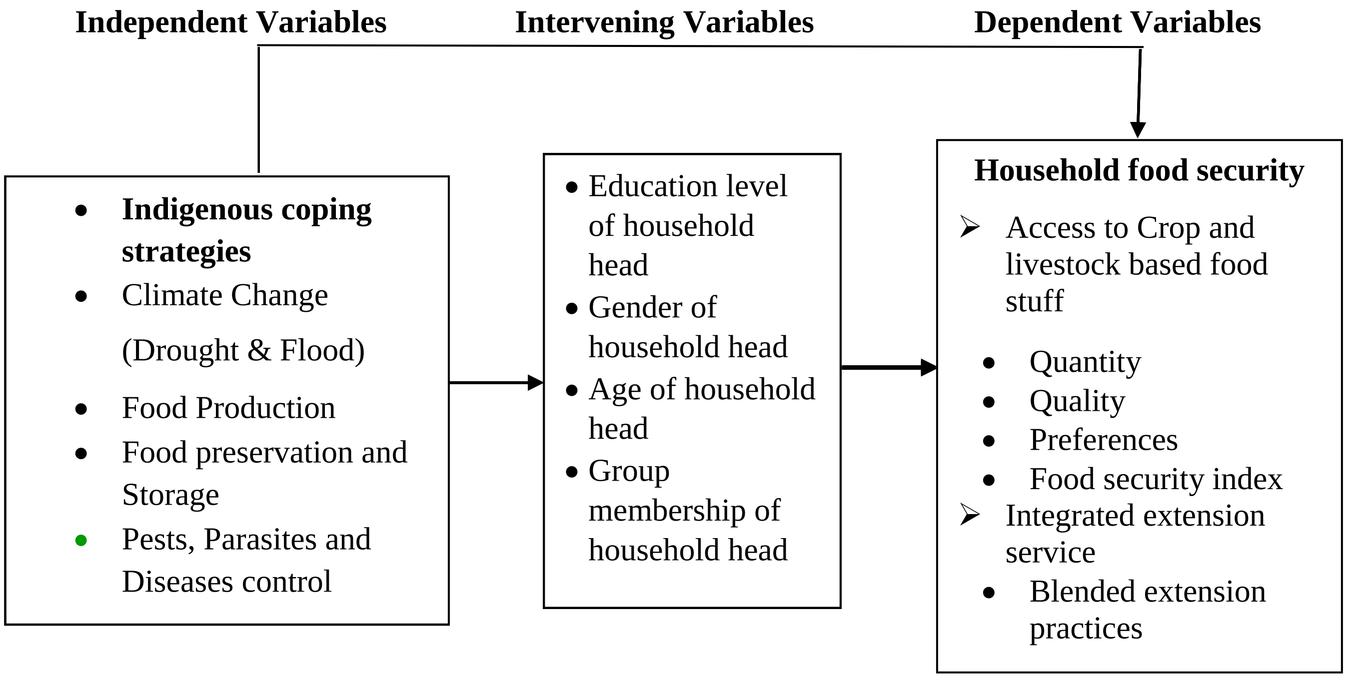

Figure 1. *Conceptual Framework Showing the Interaction of the Independent and Dependent Variables of the Study*

The independent variable was expressed in terms of climate change coping, food production, storage, pest/parasites and disease control strategies. The dependent variable was measured in terms of food quantity, quality and preference and food security index. The diagram indicates that under ideal conditions, food security depends on indigenous strategies. However, under dynamic conditions, there were intervening variables between food security and indigenous strategies. These were; education level, gender, age and group membership. The effects of the intervening variables were minimized through randomization. Best and Khan (2005) recommend this method as an effective means of controlling the effect of intervening variables on an outcome. The effects of the intervening variables were further reduced by drawing samples from a fairly homogenous population (same location and socio-economic set-up).

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology used in this study. It includes: the study design, location of the study, target population, sampling procedure and size, instrumentation, data collection and data analysis, and ethical considerations.

3.2 Research Design

Descriptive survey design was adopted in the study. The design was found appropriate to the study because it examines at phenomena, problems and happenings the way they are (Mugenda & Mugenda, 1999). Survey design further makes precise assessment of the distribution, relationship and influence of an occurrence (Edwards, 2006). The design was therefore, deemed suitable to the study because it enabled data to be obtained at one point in time without manipulation of variables. It also enabled the establishment of the association between variables hence was appropriate for the study.

3.3 Location of the Study

The study was carried out in Baringo County which is one of the 47 counties of Kenya. The county borders Nakuru County to the South, Laikipia and Samburu to the East, Turkana County to the North and Elgeyo Marakwet to the west. Administratively, it is divided into six Sub counties namely Baringo South, Mogotio, Koibatek, Baringo Central, Baringo North and Tiaty Sub Counties with a total of 30 wards (Bartenge, 2013; Kipterer & Ndegwa, 2014). The County covers an area of 11,015 km^2 with an estimated population of 609,910 persons. (KNBS, 2009). Population density in the County is 50 people per square kilometer while the number of households is 110,649. The county poverty levels stands at 58.5 percent (Bartenge, 2013). Temperatures range from a minimum of 10°C to a maximum of 35.0°C in different parts of the county. The rainfall varies from 1000 to 1500 mm in the highlands to 600 mm per annum in the lowlands. A larger part of the County is ASAL characterized by high poverty levels, food insecurity and poor infrastructure. (GOK, 2019; Kipterer & Ndegwa, 2014).

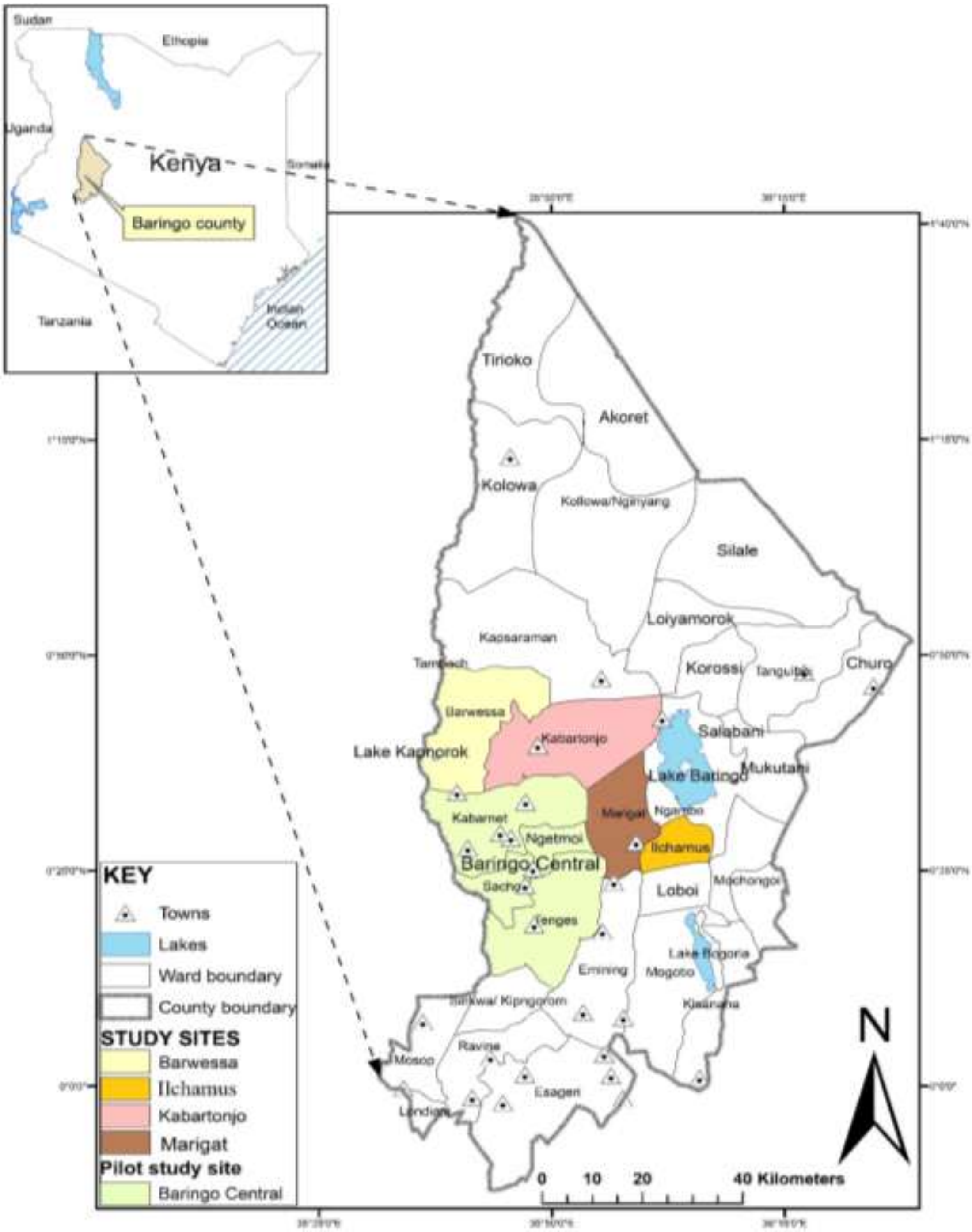

Figure 2. *Map of Baringo County Showing the Study Sites*

3.4 Population of the Study

The target population for this study comprised of 35, 758 smallholder agro pastoral households living in Baringo North and South Sub Counties of Baringo County. The accessible population comprised 9,097 households from Barwessa, Saimo Kipsaraman wards of Baringo North Sub County and 9,516 households from Marigat and Illchamus wards of

Baringo South Sub County. The total accessible population for the study was 18,613 from the four wards of the two sub counties (GOK, 2015; KNBS & SID, 2013). In addition to the households, accessible population also consisted of the 12 agricultural Extension staff working in Barwessa, Saimo Kipsaraman, Marigat and Illchamus Wards. Further, eight (8) key informants comprising community elders who were knowledgeable on indigenous knowledge in weather focusing, food production, preservation, storage, animal keeping, as well as officers from meteorological department and agriculture ministry formed part of the accessible population. Household distribution per Sub County and wards are presented in Table1.

Table 1

Distribution of Study Sample per Wards in the Study Sites

Sub County	Wards	Households	Extension staff	Key informant
Baringo North	Barwessa	4,943	3	1
	Saimo Kipsaraman	4,154	3	3
Baringo South	Marigat	6,615	3	1
	Illchamus	2,901	3	3
Total		**18,613**	**12**	**8**

Source: GOK (2015) and KNBS and SID (2013)

3.5 Sampling Procedure and Sample Size

A multistage (four-stage) sampling technique was used to select the sample. According to Mugenda, (2008), the procedure combines several methods of sampling. The procedures used comprised of purposive, census, proportionate and simple random sampling methods. Purposive sampling was first used to select Baringo North and South Sub Counties because of being the ASAL areas of the county hosting different agro pastoral communities with diverse cultures in addition to being relatively calm security wise. Similarly, purposive sampling was used to select four wards namely Barwessa and Saimo Kipsaraman from Baringo North Sub County and Marigat and Illchamus wards from Baringo South Sub County. The choice of the four wards was based on the reasons of cultural diversity and relative calmness security wise. Proportionate sampling was then used to select the number of household heads that were picked from each of the four selected wards. At the ward level, simple random sampling was fused to select household heads who participated in the study. Census was used to select the extension staff who participated in the study.

The sample size of the household category was determined using Nassiuma (2000) formula.

$$n = NC^2 \div C^2 + (N-1)\, e^2$$

Where;

n is Sample size: N is Population Size: C is Coefficient of Variation: e is Margin of Error. Nassiuma recommends a 30 percent coefficient of variation and 5 percent margin of error for surveys. The household heads sample size was however, computed at 20 percent coefficient of variation and 2 percent margin of error in order to yield a larger sample size that ensured low variability and minimized sampling error. The sample size obtained from the study population was:

$$n= [18{,}613x\ 0.2^2] \div [0.2^2 + (18{,}613 - 1)\ 0.02^2]$$

$$n= 99.47$$

The sample size was rounded to 100 respondents. However, Goodrich and St. Pierre (1979) in Borg and Gall (1989) recommended for an inclusion of 20 percent attrition and non-response as an estimate for a realistic level of planning, hence the actual sample from the household category was120 household heads. The additional 20 respondents took care of attrition and non-response.

In addition to the household heads, all the twelve (12) extension staff and all the eight (8) key informants from the four selected wards were involved in the study. This means that no sampling technique was used to select these two categories of respondents given that all (census) of them were selected. The total sample size for the study from the three categories of respondents was 140 participants. The distribution of the study sample size is summarized in Table 2.

Table 2

Distribution of Study Sample Size per Sub County and Ward

Sub County	Wards	Household's	Extension staff	Key informant
Baringo	Barwessa	32	3	2
North	Saimo	27	3	1
	Kipsaraman			
Baringo	Marigat	43	3	3
South	Illchamus	18	3	2
Total		**120**	**12**	**8**

3.6 Instrumentation

The data collection instruments for the study comprised household heads and extension staff questionnaires, focus group discussion guide, and observation checklist.

i). Questionnaires

Two sets of semi structured questionnaire (Appendix A & C) were administered to both household heads and agricultural extension staffs respectively. Household heads and extension staff questionnaire contained questions on respondent's characteristics, indigenous climate change coping strategies, indigenous food production coping strategies, indigenous pest/parasite and disease coping strategies, indigenous food storage and preservation coping strategies and concluded with food security questions. The questionnaire collected both quantitative and qualitative data. Open ended questions were used in order to obtain in-depth information by exploring on indigenous knowledge practices for food security. The questionnaire was chosen due to its ease in administration, the ability to cover a larger sample and the capacity of to elicit a lot of data with greater depth of response (Mugenda & Mugenda, 1999). Total 120 household heads questionnaires were administered out of which 117 were returned giving a return rate of 97.5%. The agriculture extension staff questionnaire targeted 12 respondents and 11 were returned, giving a return rate of 91.7%.

In order to measure coping strategies adopted by households, a set of 19 closed ended types of items on how frequently they practice the activities were used. A five (5) point rating scale was used in which the responses were assigned scores (Never:1, Rarely:2, Occassionally:3, Often:4, Very often:5), averaged and transformed into indigenous knowledge Coping Strategy Index (CSI) for each of the independent variables. Similarly, Food Security Index (FSI) was obtained by using the same scale using twenty two (22) items.

Hypothesis testing was performed by regressing the CSI of each of the four independent variables with the FSI (dependent variable) which enabled the researcher to test the null hypothesis to determine the influence of each of the independent variable on food security.

ii). Focus group discussion guide

Appendix (B) which was the focus group discussion guide targeted key informants selected purposively on the basis of age and experience on indigenous knowledge as well as position held in the community. The FGD guide contained a set of open ended questions and more information was generated through probing of issues emerging from the discussion. The FGD guide was structured into eight (8) sections. Section A covered the preliminaries location of the discussion and date of the discussion and participant's personal details. Section B captured the introduction where the researcher introduced self and the purpose of the study and the discussion. The section further elaborated on the discussion process and guidelines. Section C collected data on indigenous knowledge strategies and specific areas applied. Section D Collected data on indigenous knowledge climate change coping strategies. Section E focused on indigenous knowledge food production coping strategies. Section F collected data on indigenous knowledge pests/parasites and disease control coping strategies. Section G covered information on indigenous knowledge food storage and preservation coping strategies. The final section H captured data on strategies adopted to enhance food security by households.

iii). Observation checklist

Observation checklist (Appendix D) was used by the researcher to collect information on visible indigenous knowledge based strategies on climate change, production, storage/preservation, and pests, parasites and disease control coping strategies used by the respondents. Based on the data collected, the checklist was structured into six (6) sections. Section A collected data on indigenous knowledge climate change coping strategy. Section B collected data on indigenous food production strategies, section C contained information on indigenous food preservation/storage strategies. Section D collected data on indigenous knowledge pest, parasite and disease control coping strategies. Section E and F collected data on Food security and other observations relevant to the study objectives respectively. A total of 19 observations were made in the study from a target of 20 observations hence a return rate of 95% was achieved.

3.6.1 Validity of the research instruments

Validity refers to the extent to which a measure adequately represents underlying construct that it is supposed to measure and it consists of both face and the content validity (Bhattacherjee, 2012). Household and agricultural extension staff questionnaires, focus group discussion guide, and observation checklist were subjected to five experts from the Department of Agricultural Education and Extension, Egerton University to establish whether instruments measured adequately the objectives of the study. In addition, experts in measurement were used to further validate the research instruments where their suggestions and comments were used to improve the instruments in order to yield valid data that were used to make appropriate, meaningful and useful inferences for the study (Drost, 2011).

3.6.2 Reliability of the research instrument

Reliability is the degree to which the extent of a construct is reliable in determining results (Bhattacherjee, 2012). Reliability of the household and extension staff questionnaires was used as a measure of internal consistency. Reliability of this study instruments was estimated through a pilot study on 24 households and three (3) Agricultural extension of Baringo Central Sub County which was outside the area of study but had almost similar social-cultural, climatic and geographic conditions as the study site. Hill (1998) suggested 10-30 participants for pilot-testing in a survey research while Baker (1994) suggested a sample of 10-20 percent of the sample size for the actual study as reasonable number of participants to consider in enrolling in a pilot study. Taking 20 percent of the actual study sample yielded 24 households for the pilot-testing. The outcome of the pilot testing was useful in revising the items on the questionnaire in order to improve its reliability. Reliability of the questionnaire was estimated using Cronbach alpha coefficient which has the advantage of minimizing the time taken to calculate a reliability coefficient than other methods (Mugenda & Mugenda, 1999). A reliability coefficient of 0.78 and 0.81 was obtained for household and Agricultural Extension staff questionnaire respectively which was above the recommended minimum alpha coefficient of 0.70 thus declaring the instruments reliable.

3.7 Data Collection

Research permit was sought from the NACOSTI through Graduate school of Egerton University. Additionally, clearance from the County Commissioner and County Director of Education of Baringo County were sought. Community leaders and the respondents were conducted to inform of the exercise. Four research assistants were recruited and trained for two days on the data collection procedures prior to data collection to ensure uniformity in the administration and recording of the data from the instruments and to avoid misinterpretation of information. This ensured accurate and valid information was collected during the data collection process. A preliminary visit was made to the study area to work out the data collection procedures including mapping out exercise of the households under study. Local leaders particularly chiefs and their assistants were visited to inform them of the intended study. Focus group discussions were conducted to enable the researcher gain insights into people's shared understanding of IK and the ways households applied it to cope with household food insecurity. Recording of the focus group discussion was done by the researcher to allow room for further probing and recording information the way it was for accuracy purposes.

The return rates from all the instruments for data collection were generally high. The study did not therefore suffer from low return rates which is a common problem in surveys that gather data using a questionnaire especially if the survey is not well executed (Fryrear, 2015). This was as a result of use of local administration (chiefs and their assistants), extensions officers, revisits and replacements to ensure return rates was high. The return rates can therefore be rated as excellent. According to Fryrear (2015), high response rate of 80% or higher is ideal for small random sample.

The household heads responded to appendix A of the research instruments and it involved the household heads. Extension staff responded to the appendix B and it involved staff who worked in the wards that formed the research site. Key informants were invited for a focus group discussion at Kenya Forestry Research Institute (KEFRI) conference Centre Marigat. The focus group discussants comprised of Community elders who were perceived by the community to be experienced in the indigenous knowledge as far as weather forecasting was concerned. The discussants were drawn from the two sub counties of research interest and were selected through snow ball. A total of four indigenous weather focus specialist drawn from pokot, Ilchamus, Tugen and Endorois participated in the discussion. These represented the different communities living in the study area. Other participants of the Focus group discussion were the sub county agricultural officer, county meteorologist, county agriculture sector development support programme (ASDSP) officer and the researcher. The total number of the participants of the focus group discussion were eight and the researcher recorded the discussion points.

3.8 Data Analysis

Data cleaning was done to generate valid and usable data for analysis. A code book was used during data coding followed by keying of data in the data sheet and analyzing it using Statistical Package for Social Sciences (SPSS). Qualitative data was organized into categories by themes and then analyzed to obtain meaning and unique contributions to the study. Original quotations were used after triangulation in order to allow theory to develop from the data. Qualitative data were converted into frequencies and percentages. This enabled comparison, contrasts and insights to be made and demonstrated. Simple linear regression was used to test the hypotheses at 0.05 level of significance. Table 3 summarizes data analysis procedures for the study.

Table 3

Summary of Data Analysis Procedures

Hypotheses/Research question	Independent Variable	Dependent Variable	Statistical Procedure
Ho1: Indigenous knowledge based climate change coping strategies do not significantly influence household food security in Baringo County, Kenya.	Indigenous knowledge climate change coping strategies	Household food security	Frequency Percentages, mean and standard deviations, simple linear regression
Ho2: Indigenous knowledge based food production strategies do not significantly influence household food security in Baringo County, Kenya.	Indigenous knowledge production coping strategies	Household food security	Frequency Percentages, mean and standard deviations, simple linear regression
Ho3: Indigenous knowledge based storage coping strategies do not significantly influence household food security in Baringo County, Kenya.	Indigenous knowledge storage coping strategies	Household food security	Frequency, Percentages, mean and standard deviations, simple linear regression
Ho4: Indigenous knowledge based pest, parasite and disease coping strategies do not significantly influence household food security in Baringo County, Kenya.	Indigenous knowledge pest/parasite and disease control coping strategies	Household food security	Frequency, Percentages, mean and standard deviations, simple linear regression
RQ1. To what extent was IK based strategies integrated into agricultural extension services for household food security?	Indigenous Knowledge based strategies	Agricultural extension service	Frequency, percentages, narratives

3.9 Ethical Considerations

Research permit was first sought from the NACOSTI through Egerton University. Clearance was further obtained from both the County director of education and County commissioner of Baringo County. Consent from the participants was obtained after briefing them on the purpose of the research and the process in which the study was to be conducted. Participants were assured of confidentiality of information including concealing their identity in the data collection tools.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The results and discussions of the study are presented in this chapter which is organized in eight themes. The first theme is an introduction while the second and third themes provides a measure on characteristics of respondents and indigenous knowledge. The fourth and fifth themes examine the influence of indigenous climate change coping and production strategies on household food security. Themes six and seven are on the influence of indigenous pests, parasites and diseases control, and storage and preservation strategies on household food security. Theme eight addresses the extent to which indigenous knowledge based coping strategies are integrated into agricultural extension services.

4.2 Characteristics of Respondents

Demographic characteristics of the household heads, agricultural extension staff and key informants were examined prior to testing the study hypotheses. Kothari (2004) explains that, description of the characteristics of a sample gave a better insights of the respondents and proof that it has characteristics of the population. Schoenbach (2014) further argue that, bio-data is important because they can be used to perform additional analysis around variables.

4.2.1 Characteristics of household heads

Bio-data of the household heads was gathered using questionnaire. The data was described and summarized using frequencies and percentages as shown in Table 4.

Table 4

Characteristics of the Household Heads

Scale	Characteristic	Frequency	Percentage
Gender (n = 115)	Male	73	63.5
	Female	42	36.5
Age (n = 117)	21 – 30 years	15	12.0
	31 – 40	26	22.2
	41 – 50	27	23.1
	51 – 60	24	20.5
	61 years and above	26	22.2
Highest level of education (n = 117)	None	18	15.4
	Primary	49	41.9
	Secondary	32	27.4
	Tertiary	14	12.0
	University	4	3.4
Size of household (n = 116)	5 and below	31	26.7
	6 – 10	61	52.6
	11 – 16	17	14.7
	16 and above	7	6.0

The results indicate that nearly two thirds (63.5 %) of the house hold heads were male while minority (36.5%) were females. Household heads are the major decision makers as far as agriculture and food security are concerned. On the age, majority (65.8%) of household were within 30 – 60 years age bracket which is still energetic to perform agricultural activities that could determine household food security. Similarly, the findings indicated that majority (57.3%) of the household heads had primary or no formal education compared to (42.8%) households who had secondary school education level and above implying a fairly high proportion of households with limited exposure to agricultural knowledge and skills, hence affecting the ability to produce food. In addition, nearly three quarters (73.3%) of respondents had household size of above 6 indicating a high dependency ratio that could ultimately affect food security of the households as it reflects more food consumers who are dependent on the household heads.

4.2.2 Characteristics of the extension staff

Eleven agricultural extension staff were involved in the study. Personal information including gender, age, Ward represented, education level and length of service in the working station were collected using extension staff questionnaire (Appendix C). This was deemed necessary to establish the experience level of the respondents in agriculture extension in the study area. Table 5 shows the results.

Table 5

Characteristics of the Extension Staff

Scale	Characteristic	Frequency	Percentage
Gender	Male	8	72.7
	Female	3	27.3
Age group	Below 25 years	1	9.1
	26 – 40	3	27.3
	40 and above	7	63.6
Ward	Barwesa	2	18.2
	Kabartonjo	4	36.4
	Marigat	4	36.4
	Ilchamus	1	9.1
Education level	Certificate	1	9.1
	Diploma	5	45.5
	Degree	4	36.5
	Post graduate		
	Certificate	1	9.1
Number of years as an staff in the sub county	Below 5 years	1	9.1
	5 – 10	2	18.2
	Above 10 years	8	72.7

(n=11)

Majority of the extension staff (72.7%) were male while (27.3%) were female. The study also revealed that (63.6%) of the respondents being the majority aged 40 years and above while only (9.1%) aged below 25 years. This implied that the work force in the ministry consisted of long serving staff that had gained experience that enabled them to provide quality extension services.

The distribution of the extension staff according to the study also revealed that majority (36.4%) were each from Kabartonjo and Marigat wards followed by Barwessa (18.2%) and the least being Ilchamus (9.1%). The result of the findings indicates that most staff were distributed in the high potential areas while some areas like Ilchamus ward were marginalized with only one extension staff in the ward. This suggests that extension service in the ward lacked personnel which could affect production and food security. With regard to qualification of the extension staff, the study established that the agricultural extension staff were all qualified to perform their extension work as overwhelming majority (91%) had diploma and above qualification. This meant that the extension service delivery was offered by highly qualified personnel that deliver quality services to the farmers in terms of transfer of knowledge, skills and innovations that could have significant effect on food security. The results revealed that majority (72.7%) of the extension staff had work experience of over 10 years. This implied that the workers had enough experience to provide extension services to farmers in the study area. The high levels of academic qualification and experience of means that the extension staff have the ability to transfer vital agricultural knowledge and skills that could boost productivity and household food security.

4.2.3 Characteristics of key informants

The key informants comprised of four elders drawn from each of the sub tribes living in Baringo North and South Sub Counties of Baringo County who were vetted and approved by the community members as knowledgeable, experienced and expertise in indigenous knowledge and weather forecast. They included a representative each from the Tugen, Endorois, Pokot and Ilchamus communities. The elders were all male since the cultural practice of the communities allowed only male gender to predict weather and were also considered as the main custodians of indigenous knowledge to be passed to the next generation. In addition, the key informants also comprised of the county meteorological expert from the ministry of environment, county agriculture extension staff from each of the two sub counties under study and head of the Agriculture Sector Development Support Programme (ASDSP) at the county level. Agriculture extension staff provided additional data that was used to supplement those provided by other category of respondents.

4.3 Indigenous Knowledge in Agriculture

The study examined indigenous knowledge based practices used by household in the production of crops and livestock related foodstuff before focusing on the objectives. This enable the study to ascertain that the household heads were aware of indigenous knowledge given that it was one of the variables. The household heads were asked whether they were aware of indigenous knowledge. Nearly all (97.4%) of the household heads indicated that they were aware of indigenous knowledge. Household heads also indicated that they used both modern and indigenous knowledge to perform agricultural activities in their farms.

The extension officers were also asked to state the types of knowledge that they disseminated to farmers. Majority (81.8%) of the staff imparted only modern agriculture knowledge and technology while less than a fifth (18.2%) offered both modern and indigenous knowledge based practices. The extension staff were further requested to indicate the type of agriculture knowledge that farmers apply in their farms. Table 6 summarizes the results.

Table 6

Agriculture Knowledge that Households Apply on their Farms

Knowledge applied in the farm	**Frequency**	**Percent**
Modern	5	45.5
Indigenous	3	27.3
Both modern and indigenous	3	27.3

(n=11)

The results in Table 6 reveal that most (54.6%) of the farmers used both indigenous and a combination of both indigenous and modern knowledge in carrying out their farming activities as compared to 45.5% who rely on modern knowledge in their farms. It means that more than a half of farmers blend indigenous and modern knowledge in their farming activities perhaps to gain the advantages associated with use of the two knowledge bases. This is consistent with Salami (2020) suggestion on the need to blend both IK and scientific knowledge to yield better output arguing that IK is significant in the quest for sustainable agricultural development.

The household heads were further requested to state areas where they apply indigenous knowledge. The responses are summarized in Table 7.

Table 7

Activities Where Household Heads Apply Indigenous Knowledge

Areas	Frequency	Percentage
Weather forecasting	107	91.5
Crop farming	117	100.0
Water conservation	91	77.8
Keeping livestock	116	99.1
Pests and diseases control	112	95.7
Storage and preservation of produce	104	88.9

(n=117)

Table 7 reveals that all (100.0%) household heads applied indigenous knowledge in crop farming while 99.1% apply it in livestock keeping activities. Other areas of indigenous knowledge usage include; pest and disease control (95.7%), weather forecasting (91.5%), preservation and storage of produce (88.9%) and water conservation (77.8%). The results reveal that IK was utilized in all agriculture related activities from weather forecasting to food storage and preservation. The wide adoption of the IK practices by households could be an indication of yielding positive results in their farming activities. The findings are also consistent with a study by Ndwandwe (2013) on the contribution of indigenous knowledge practices to household food production and security in South Africa who established that farmers used IK in all areas of agriculture from seed selection, land preparation, post-harvest processing, management of pests, diseases, weeds, to soil fertility and storage management. Rankoana (2017) also noted that indigenous knowledge practices were used by farmers to improve soil fertility and structure, seed selection and storage. Siambombe et al. (2018) further amplifies the role of indigenous knowledge by arguing that small holder farmers resort to such knowledge because it is useful in predicting weather and planting seasons.

The extension officers were also requested to state crop production activities where the households apply indigenous knowledge. The results are summarized in Table 8.

Table 8

Crop Production Activities where the Household Heads Apply Indigenous Knowledge

Activity	Frequency	Percent
Planting (broadcasting seeds, use of uncertified seeds, spacing,	2	18.2
Pests/parasite & disease control (ash, magadi, neem leaves)	7	63.6
Land preparation (burning, use of hoes and oxen)	4	36.4
Seed selection (according to size)	2	18.2
Selection of agricultural practices (Crop rotation, shift cultivation, mixed farming)	5	45.6
Weeding (use of hoes, burning)	3	27.3
Weather forecasting (behavior of certain trees, animal behavior, internal organs of livestock)	2	18.2
Produce preservation (drying, soot, ash, herbs)	3	27.3

(n=11)

The results in Table 8 show that crop production areas where the households used IK were; pest, parasite and disease control (63.6%), selection of agricultural practices (45.6%), land preparation (36.4%), produce preservation and storage (27.3%) and weeding (27.3%). Other activities where indigenous knowledge was also applied include planting (18.2%), seed selection (18.2%) and weather forecasting (18.2%). It is evident from the findings that indigenous knowledge is an important knowledge base in farming activities of communities in the study site given that it was applied in all stages of crop production from land preparation to preservation and storage. Similarly, extension staff was also requested to indicate livestock keeping activities where farmers applied indigenous knowledge. Summary of the findings are presented in table 9.

Table 9

Livestock Keeping Activities where the Households Heads Apply Indigenous Knowledge

Area	Frequency	Percentage
Pests/Parasites and diseases control (herbs, hand picking)	6	54.4
Breed selection	4	36.4
Housing (cattle shed, use of log hive)	2	18.2
Weather forecasting (behavior of animals, internal organs)	2	18.2
Feeding (free range, tethering)	5	45.6
Storage/preservation of livestock products (drying, salt)	2	18.2

(n=11)

Table 9 indicate that pests/parasites and disease control (54.4%) feeding (45.6%) and breed selection (36.4%) were the main areas where IK was applied. These activities are the main determinants of livestock productivity as they influence the quantity and quality of livestock products. It means that indigenous knowledge is applied in critical livestock production activities. The application is a reflection of the importance of IK in improving household food availability and access.

Farmers seem to engage in constant experimentation of indigenous knowledge in agriculture to determine its applicability before adoption especially if the practice is successful in improving their farm production. According to the study findings, indigenous knowledge is applied by households across the food systems from production to harvesting and storage perhaps because indigenous knowledge technologies are advantageous over science due to its reliance on locally available skills and materials that makes it cost effective (Tanyanyiwa & Chikwamba, 2011). Besides, indigenous knowledge and practices worked out well for communities (Umar & Musa, 2015). The wide adoption of IK practices in both crop and a livestock production activity is an indication that the practices work well to increase food production which ultimately improve food security at household level.

Mafongoya and Ajayi (2017) further supports the adoption of indigenous knowledge in agriculture arguing that it is grounded on evidences that are well-known or learnt from experience or learnt through observations and practices and are passed down from generation to generation. Similarly, Ponge (2013) further elaborates that, diversified indigenous farming systems can cope with scarce resource situation and unforeseen farm problems such as drought.

Chege et al. (2018) concluded in their study that majority of farmers use IK to guarantee food security in various ecosystems. The utilization of IK by rural communities could therefore provide a solution to the perennial food insecurity experienced in the world today. Kamwendo and Kamwendo (2014) argue that, the neglect of IK systems is one of the bases of food insecurity. Ehukla et al. (2017) further argued that rural communities experience food security challenges mainly due to the loss of traditional foods such as small millets and related crops and associated indigenous agricultural knowledge. Therefore, it is important that indigenous communities conserve their indigenous knowledge practices in agriculture if sustainable food security is to be achieved. The fore going discussions has clearly illustrated the value of IK to farmers and application in farming as a means for boosting household food security.

4.4 Influence of Indigenous Knowledge Based Climate Change Coping Strategies on Household Food Security

Objective one of this study sought to determine the influence of indigenous knowledge based climate change coping strategies on household food security. The data on the IK based coping strategies used by households in the study site were established using both household and extension staff questionnaire and observation guide. In addition, focus group discussants provided the qualitative data on climate change and the IK based coping strategies used by households. Data on the nature and prevalence of climate change was also established. In order to answer the objective and subsequently test the hypothesis on whether indigenous knowledge climate change coping strategies influenced household food security, household heads, agricultural extension staff and key informants were asked series of questions using household heads questionnaire (Appendix A), extension staff questionnaire (Appendix C) and focus group discussion guide (Appendix B). In addition, an observation checklist (Appendix D) was used to observe any visible IK based climate change coping strategies used by households in their farms to cope with climate change phenomenon.

4.4.1 Climate changes, nature and prevalence

Prior to testing the hypotheses, the study sought to establish whether the respondents had observed climate change occurrences. This was deemed necessary as it enabled the researcher to ascertain that the study area has been experiencing changes in climate as envisaged by the study. The household heads and extension staff were asked whether they had observed significant changes in climate for the last five years. Table 10 summarizes their responses.

Table 10

Changes in Climate as Observed by Household Heads and Extension Staff

Response	Household heads (n = 114)		Extension staff(n = 10)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Yes	113	99.1	10	100.0
No	1	0.9	-	-

All the extension staff (100%) and nearly all the households (99.1%) indicated that they had witnessed climate change for the last five years. This implied that climate change effects were real in the community and may have had further implications on household food security. The results were useful for investigating further the type or nature of climate change observed and the coping strategies employed to deal with these climate changes.

The extension staff and household heads were further asked to indicate the climatic changes observed in their farms and their areas of operation. Table 11 provides a summary of the results.

Table 11

Changes in the Climate noted by the Extension Staff and Household Heads

Climate change	Exten. Staff (n = 11)		HH heads (n =117)	
Parameter	**Freq.**	**Percent**	**Freq.**	**Percent**
Floods	9	81.8	37	31.6
Drought	10	90.9	102	87.2
Extreme temperatures	9	81.8	100	85.5
Erratic rains	9	81.8	98	83.8
Unpredictable weather	11	100.0	-	-
Others (soil erosion, landslides, pests, invasive weeds)	4	36.4	-	-

Table 11 indicate that unpredictable weather was the most notable aspect of climate change as observed by 100 percent of the respondents, followed by drought (90.9% and 87.2%), extreme temperatures (81.8% and 85.5%) and erratic rains (81.8% and 83.8%) and floods

(81.8% and 31.6%) characterized climate change phenomena in the study area according to the respondents. Similar results were also found by other scholars who indicated that unpredictable weather patterns (like erratic rainfalls), frequency of floods and droughts and other related phenomena like extreme temperatures and landslides characterized climate change phenomenon (Chinedum et al., 2015; Kimani et al., 2014; Shivakoti et al., 2015). Other indicators of climate change according to the study findings were soil erosion, landslides, pest increase and invasive weeds. The changes seen negatively affect agricultural production. Climate change trends also influence the strategies to be adopted to cope with the changing conditions.

Further, the frequency of the occurrence of these climate change phenomena was sought from the household heads. Table 12 presents the results of the findings.

Table 11

Frequency of Changes in Climate Observed by the Household Heads

Climate change	N	Very often	Often	Occasionally	Rarely	Never
Floods	116	7.8	5.2	19.0	44.8	23.3
Drought	117	12.8	27.4	41.9	12.0	0.6
Extreme (low, high) temperatures	117	6.0	41.0	38.5	14.5	-
Erratic rainfall patterns	115	9.6	36.5	39.1	13.0	1.7

Extreme temperature (85.5%), erratic rainfall patterns (85.2%) and drought (81.1%) according to Table 12 were the frequent climate change phenomena in the study site. Floods was least (31.8%) though it was reported to be part of the climate change phenomenon. The findings in this study are supported by those of Shivakoti et al. (2015) and Chinedum et al. (2015) who established that climate change could exacerbate water scarcity through more erratic rainfall and rise in temperatures. Kimani et al. (2014) in their study on livelihoods in Baringo County further found that climate change was manifested by the frequency and harshness of droughts, floods and erratic seasons. Climate change impacts according to Ogega (2017) stem from extreme events including generally high temperatures and droughts.

Floods was sparingly revealed to be another characteristic with majority of the respondents indicating that it rarely or never occurred. This could be interpreted to imply that the respondents of the opinion were living in the raised areas of the sub counties along the escapements where flooding was rarely or never witnessed while those in the plain land like Ilchamus often witnessed the floods. Flooding though, was a characteristic of climate change in Baringo County according to the findings.

Mutunga et al. (2017) in their study in Kitui County, Kenya indicated that, climate change has influenced productivity of the agricultural sector through reduced crop yields. Similarly, Ogalleh et al. (2012) in their study in Laikipia district, Kenya established households are faced with numerous challenges including climate change which lowers agricultural production. In view of the two studies and other related studies undertaken in the different parts of Kenya, it is evident that climate phenomenon was real in Kenya with the hard hit areas being ASALs including the present study site. Agriculture sector being the mainstay and source of living for most households in Kenya including Baringo is climate sensitive implying that the phenomena that describes climate change in this study could negatively affect household food security by lowering agricultural productivity and farm yields.

It is generally accepted by a number of authors that the impacts of climate change are felt all over the world as it is increasingly acknowledged as a major challenge to agriculture and food production (Mafongoya & Ajayi, 2017; Ogalleh et al., 2012; Shivakoti et al., 2015; Umar & Musa, 2015; UNCTAD, 2011). Mafongoya and Ajayi (2017) warns that, climate change presented a weighty problem to food security in Africa. However, the authors indicated that IK is still applicable in climate change assessment and adaptation. This implied that, indigenous knowledge could offer an alternative mitigation measure for reducing its impacts which was the subject of the present study.

4.4.2 Indigenous knowledge based weather forecasting as a coping strategy for food security

Focus group discussion indicated that indigenous knowledge based weather forecasting was commonly used to cope with climate change by households. In order to establish the details of predictions several questions on why indigenous weather forecasting was preferred, how they applied, means of communicating and actions taken on weather forecasting information were explored in the focus group discussion.

(a) Reasons for the preference of indigenous weather forecasting

One of the reasons why the respondents preferred the use of indigenous weather forecasting according to the FGD was the timeliness nature of indigenous knowledge information to the community where predictions were said to be given early enough which according to the respondents enabled the community to prepare adequately to cope with imminent danger. Therefore, IK based weather forecasting acted as early warning signal to prepare for calamities like drought, floods and other disasters that were about to strike the community. The IK based weather forecasting according to the study findings from the focus group discussion was also cost effective and reliable in its predictions and have gained enough confidence among the community members compared to the modern predictions by the meteorological experts. Indigenous knowledge according to IFAD (2009) was significant to smallholder farmers for observing, monitoring and reporting weather related changes.

The responses according to the FGD indicated that predictions of indigenous weather forecasting were more accurate than modern weather forecasting by meteorologists as they were based on continuous observations by traditional experts who have been vetted and proved beyond reasonable doubt that they gave accurate and precise predictions. A study by Mafongoya and Ajayi (2017) revealed that communities in hardship areas have developed a better knowledge of dealing with disasters such as mastery of early warning signals. Similarly Isipisu (2016) reported that IK provided accurate and competitive weather information used by farmers to successfully escape disastrous seasons and improve yields.

In addition, Siambombe et al. (2018) supported the findings of this study by indicating that indigenous knowledge prediction provided a very reliable signal in the walk of agriculture which when adopted by traditional communal farmers could make the fighting of food insecurity easier. Siambombe et al. (2018) also indicated that, indigenous knowledge systems use match with the climate weather forecast hence putting a greater confidence to farmers and are therefore seen as more accurate with or without the confirmation of a seasonal scientific forecast implying that indigenous knowledge use enables them to stay alert and prepared for any climatic changes and its effects. In addition, indigenous people develop prevention strategies based on forecasting weather and modification of agricultural practices to reduce damage to crops from harm (Magni, 2016). Siambombe et al. (2018) provided an example on the usefulness of indigenous weather forecasting by indicating that trade winds were usually observed in October and November and serve the alarm purposes to alert farmers to prepare for new season.

This study revealed that, indigenous weather forecasting was important for informing the community on the choice of crops to be grown such as early maturing or late maturing; when to plant; when to safeguard what is in store; the looming dangers in the community (floods, drought, extreme heat); onset of rains; crop diversification to reduce risks and uncertainties; planning among individual farmers such as split or pit by pit planting and whether to fatten animals or not in preparation for drought. In addition, IK based weather forecasting helped to inform on the need for migration to safe areas in terms of food, pasture, water and peace if the situation was likely to prolong. The findings are consistent with what Gaoshebe (2014) established that local people over the years developed local food security strategies for climate change adaptations such as knowledge of behavior of living organisms, wind directions, position of stars as early warning indicators of changing weather conditions, selection of appropriate seeds and animal species, mixed cropping and water harvesting technologies and food preservation techniques such as fermentation and sun drying for food security. A study by Chege et al. (2018) share similar views that most farmers and local communities used indigenous knowledge to ensure food security in various ecosystems.

Communities according to this study regard indigenous knowledge as highly valuable since it provides them with a variety of options at their disposal as informed by their indigenous knowledge in averting risks associated with climate change and as Umar and Musa (2015) argues, indigenous practices are found to work out well for communities which would enhance participation and sustainability of projects. The source further cites socio-economic and institutional factors as key in influencing the use of indigenous knowledge coping strategies against climate change and that farmers' socio-economic characteristics were found to be positively related to the use of indigenous coping strategies against climate change. According to the study findings, rural communities have variety of dynamic and innovative options to cope with the effects of climate change which enables them survive even under difficult environments such as in Arid and Semi -Arid lands as is the case with Baringo County.

Predictions on looming dangers like floods and droughts compelled the community to resort to traditional ceremonies to appease God with only those perceived to be 'clean' or blameless being allowed to conduct the ceremonies. In addition, some resort to church for prayer for God's intervention. The finding agrees with what Umar and Musa (2015) reported that farmers in rural areas sometimes are religious and spiritual people who for instance during periods of prolonged dry spell and droughts, all members of the affected community gather for special prayers where they seek God's forgiveness. According to the discussants of the FGD, the 'clean' and blameless elders sacrificed in the sacred hills to seek for God's forgiveness while the women performed traditional ceremony called 'kerebobei' among the Tugen community in which they sing songs for forgiveness and seek for God's intervention in the disaster like drought they were facing.

(b) Observation of trees, flowers and fruits in indigenous weather forecasting

Participants of focus group discussion were also asked what they observed in their weather forecasting. Indigenous weather forecasting according to the present study findings encompassed observation of stars and other heavenly bodies, cloud movement, wind direction, animal behavior and parts such as intestines and liver as well as observation of trees, flowers and fruits as the main predictors of weather. The study indicated that certain trees or plants were used to predict weather for instance flowering of certain trees such as acacia was a sign of good harvest hence rainfall availability. Fruiting of certain trees like Acacia (Sesia) was a symbol of good harvest and also predicted parts of the region where weather would be favorable and harvest would be good.

Similarly, flowering of *Balanites agyptiaca* (Ngoswe) according to the study findings signified drought hence poor or no harvest. Similar findings were found by Siambombe et al. (2018) in their study on indigenous knowledge systems among the Batonga people of Zimbabwe who established that production of many flowers by certain trees indicated forthcoming of heavy rains but lack of flowers meant drought. This indicated that indigenous knowledge on weather forecasting using trees, flowers and fruits was widespread among rural communities and was still in use in many parts of the world.

(c) Observation of stars and heavenly bodies for weather forecasting and food security

Indigenous weather prediction 'experts' according to the focus group discussants had mastered the trends and consequences of the position, arrangement, patterns and movement of stars and other heavenly bodies who then relayed the predictions to the community members for necessary actions especially with regard to the farming activities.

Stars according to the study predicted rainfall amounts and distribution. Prediction indicates either poor or sufficient rainfall. On the other hand, the distribution would mean poor or well distributed across all areas in the community. This would have a significant implication in the farming activities among households. For instance, when prediction suggests high rainfall amounts, the community increases the scale of production in their farming enterprises and vice versa. The prediction also determined the coping strategies to be adopted like planting drought resistant and early maturing crops. Similarly, the distribution of the rainfall serves to guide community members on whether rainfall would be well or sparsely distributed and in which particular region of the community the rainfall is expected to be distributed well. The information will then be used to scale up or down the production levels in the farm by the households.

Further, the position and direction of the stars, milk way, the moon and the sun signified certain phenomena in the community for instance the position of the sun indicated drought or rainfall while the position of bright morning star in relation to the moon determined drought or rainy season. Cloud movement, direction, type, color and intensity signified presence or absence of rainfall. Heavy and dark clouds for instance indicates heavy rainfall which is useful in determining the type and variety of the crops to be planted. This in turn influences production levels which also affect availability of food for households. Wind direction also determined weather changes signifying either warm or cold weather.

The weather changes according to the study also determined the health conditions of their crops and livestock. The outbreaks of diseases like pneumonia in livestock and blight in crops for example is associated with weather changes. The changes according to the study have other implications like preparations by the farmers on crop protection against diseases and livestock health measures like disease and parasites control besides adopting coping strategies against the negative effects. Stars and other heavenly like the sun bodies also predict hunger and drought, floods. For example, the position of the sun signifies drought or rainfall season.

According to the study, the predictions gave early warning signals to the community to prepare to cope with a looming danger. Migration to higher grounds during flood season according to the discussants reduced losses of property including livestock and food stuffs of the households. Similarly, restrictions on grazing fields during drought periods was a strategy to ensure pasture availability throughout the season to reduce livestock losses and enhance household food security through access from income sources from the sale of livestock.

Indigenous knowledge based weather forecasting further predicts the well-being of both people and livestock where it indicates sickness or good health which further affects the production level of both the households members and livestock. Production level of a sick animal is lower while a sick farmer reduces the labor force in the farm there by reducing productivity level. Health status of household was also foretold to help the experts on herbal medicine to prepare in advance to combat the outbreak of diseases. This according to the focus group discussants protected households against loss of lives of both the people and livestock which are crucial for sustaining their food security through labour force and incomes from livestock sources.

Specialization therefore, exists in the community where experts in every field were found such as weather forecasters and herbal medicine experts. Indigenous knowledge based weather forecasting according to discussants benefited the households through early warning signals that prepared households on when and what to plant in their farms, besides guarding households against loss or damage of property including livestock and crops and developing other coping strategies that were crucial in sustaining their household food security.

Among the indigenous Batonga community of Zimbabwe, the moon and the stars are used to predict weather in which the changing direction and angles of the moon varies the interpretation and is used to predetermine the climatic and weather for a particular farming season with the changing direction and angles being observed during the period between October and November when the rain season is expected (Siambombe et al., 2018). The direction of the moon according to the author show the change of season. Like the Tugen community of Baringo, Kenya, the encirclement around the moon was a significant indicator to determine whether there was enough rains or dry spells with a bigger encirclement indicating sufficient rains while a meager figure is believed to be a sign of starvation and little rainfall in a particular season, hence the bigger the encirclement the more the rain to be expected (Siambombe et al., 2018).

The findings from the Batonga community of Zimbabwe are in agreement with the practices by the Tugen community of Baringo County, where the present study was undertaken reflecting commonality on practices of rural communities of any part of the world with regard to indigenous means of weather forecasting which is crucial for farmers as far as planning for farming activities are concerned. The prediction provided a very reliable signal in agriculture which when adopted by traditional communal farmers could fight food insecurity easily (Siambombe et al., 2018).

Magni (2016) observed that indigenous people develop coping strategies based on forecasting weather and modification of agricultural practices to reduce damage to crops from harm. This implies that communities have mastered their environment well to the extent that their long term experience on weather forecasting has proved accurate and useful for their survival. Globally, people have a conception that lightning flashes before rains is a signal of the coming rains which has been appreciated as a reliable source of weather information for farmers as far as fighting hunger and starvation and absorbing the shocks of climate change is concerned (Siambombe et al., 2018).

According to the United Nations Framework Convention on Climate Change (UNFCCC, 2013), best practices and tools should develop and sustain an enabling environment for the fullest expression of indigenous knowledge alongside science for promoting effective adaptation and understanding of the impacts of climate change and as FAO (2014) asserts, there is no doubt that IK is important for rural communities' food and nutrition security.

(d) Observation of animal behavior for agricultural production and food security

Animal behavior according to the study is also used to predict hunger, rainfall drought and other phenomena that was likely to be witnessed in the community. This according to the focus group discussants enabled the community to adequately prepare to cope with it. For instance, the presence of many rats was an indication of looming hunger while giving birth by warthogs was an indication of rain season. Similarly migratory birds moving in cycles towards sky and towards lowlands was an indication of drought. Goats mating was also an indicator of the onset of rainfall. Bees swarming towards highland was an indication of drought while swarming of bees towards lowlands was an indication of rainfall. Migration of Flamingos from Lake Nakuru to Lake Bogoria indicate the start of rain season rainfall. Hare singing at night according to the discussants was a sign of rainfall. Frogs crocking and moving out of rivers was an indication of rainfall. Crocodiles making noises was a sign of rainfall. Crocodiles swallowing stones signified dry spell while crocodiles vomiting the stones was a symbol of rainy season. Crocodiles opening mouths wide was a sign of rainfall. Cows directing their heads in one direction, smelling and making noise was a sign of rainfall. Cows urinating at the back of others or urinating while sleeping was an indication of drought. Observations from the animal parts provided crucial weather information that inform farming community members of the choice of hybrids and varieties of crops to plant during the season and the scale of production to undertake. Similarly, livestock farmers use the information to adjust to the looming situation to come. For instance, livestock farmers could fatten their animals for sale during dry spell. Restriction of grazing fields could also be adopted to avail sufficient pastures during drought period. Redistribution of livestock to relatives through social networks and reduction of stock to avoid loss due to starvation were among the coping strategies that households could undertake according to the discussants. Such practices according to the discussants sustained household food security. The value and potential for indigenous knowledge based weather forecasting in mitigating disasters and enhancing household food security in the community cannot therefore be over emphasized. This also displays a unique and well packaged IK though undocumented in most cases.

The study by Siambombe et al. (2018) indicated that frogs and fish played an important role in providing of weather messages to the Batonga community of Zimbabwe where the croaking of frogs in the fall of winter gave a reliable message that it was about to rain and time for planting had come, a phenomenon which was cemented with the play of fish in the months of October and November in each and every farming season. Among the Botswana community of South Africa, nests found to the top of trees on river banks were indicators of flooding and vice versa (Kaya & Koitsiwe, 2016).

There is therefore greater potential for communal subsistence farmers to abate the danger brought by climatic changes if they resort to use of indigenous knowledge systems and coin it to technological scientific knowledge in the process of farming (Siambombe et al., 2018). It is evident from this study findings and other related studies that indigenous knowledge could provide lasting solutions that could form solid foundations for sustainable household food security. It is also evident from the various study findings that rural communities do not remain helpless victims of climate change phenomenon but rather use their indigenous knowledge base as a resource to abate imminent dangers in their community. This knowledge base must be nurtured as it is cost effective and available when needed. UNFCCC (2013) argue that indigenous knowledge has mostly been used to advance observations of climate change and its effects and for assessment of impacts, susceptibility and adaptation.

The practices and observations by indigenous experts of events in the animal behavior was as a result of patience and routine observation of events in their environments to arrive at the conclusions. A consistency in prediction enhances experience that would result in one being crowned as 'expert' in indigenous knowledge especially if the prediction is deemed reliable among community members. A study by Mafongoya and Ajayi (2017) asserted that, indigenous knowledge was based on known facts or learnt from practice or learnt through observation and practice. Indigenous knowledge weather forecasting is a product of continuous and routine observation of the environmental conditions and relating it with repeated events in the environment.

Luseno et al. (2003) explains that indigenous weather forecasting can offer insight into improving the scientific forecasts for pastoralists it is need driven. According to Chinedum et al. (2015), IK strategies may not be totally correct but it has over the years guided most of the farming practices in most communities. The implication for the present study findings could perhaps be that the communities have tested the trends in the observations over time and related them with the outcome hence made conclusions by relating certain observation with certain trends or phenomena such as in rainfall amounts, droughts, quantity of harvests and certain calamities. This implies that indigenous communities are observant of their environment and have perfected the understanding of their environment for the benefit of protecting their communities against calamities.

(e) Observation of animal parts as a coping strategy in agricultural production and food security

During slaughter of animals like goats, sheep and cows, some internal parts and organs like liver, heart, stomach, intestines and ribs were observed by indigenous weather experts to predict calamities like drought, hunger, floods, good or bad harvest, among others. Prediction enabled the community members to prepare adequately to cope with change. Animal parts according to the discussants predicted phenomena such as flooding of rivers and drowning, sicknesses, cattle rustling, conflict or war and even death cases which addressed the wellbeing of the people. Similarly, observing organs according to the study predicted good or bad harvest or certain dangers like conflict or war or cattle rustling. Observation could also predict livestock survival rates.

The focus group discussants also revealed that certain people had specialization in the observance of animal parts while others in observance of the stars hence there was specialization in weather forecasting. The predictions enabled community members to be warned in advance of likely disasters for adequate preparations to cope with the situation. Similarly, the farmers are provided with information that will be useful in planning of farming activities during the season. For instance, prediction of good harvest season will enable farmers to increase scale of production to improve production levels that led to better harvest to increase food stocks and prolong the periods of food availability.

Prediction of poor harvest on the other hand guided the farmers in downsizing their scale of production, help them select early maturing and drought resistant crops to reduce losses. In addition, prediction of drought led to destocking of livestock through sale of part of livestock to reduce to manageable size and thereby reducing losses associated with deaths from drought and also obtaining income that would be useful in enhancing access to food during periods of drought. Similarly, redistribution of livestock to relatives as part of social network was another mechanism for spreading risks against livestock deaths during drought. This would provide income that was used to purchase food stock for use during drought.

(f) Communicating weather forecast information for food security

Participants of focus group discussion were further asked to state how they communicated IK based weather forecast message to the community. The focus group discussion revealed that community received indigenous weather report through community *barasas*, peace meetings, other formal and informal meetings, church and individual farmers. The findings are consistent with the mode of formal extension methods of passing messages and innovations through both individual and group means. The findings implies that farming households were able to receive and pass weather information to other members in order to apply in planning of their farming activities. For instance, weather information that predicted drought according to the study, enabled the households to adjust in terms of lowering the scale of production, selecting drought resistant and early maturing crops, fattening their livestock, selling livestock in advance before drought and using the proceeds to purchase stock of food and seeking alternative foods through gathering wild foods to supplement farm foods.

Individual households according to the study findings invited indigenous weather forecasters to foretell and the information used to plan for the farming activities. The weather experts became mentors to the interested individuals who then learnt through observation, trials and experience. However, early warning signal was delivered well in advance for the community to prepare adequately to handle or cope with the situation.

Indigenous knowledge according to the study findings was passed to other generation through grandparents and parents to children and grandchildren by word of mouth. In addition, practical sessions were conducted in the field to the trainees for instance showing physically the herbs for treatment of various animal and crop diseases and demonstrating how to prepare and use in terms of dosage. Cultural borrowing of IK based strategies due to exposure to neighboring farmers and communities was also acceptable according to the study findings. This process enabled diffusion of agricultural knowledge and innovations to the community and facilitated cultural borrowing. This ensured that farmer to farmer extension took place both within and outside the community and enabled spread of innovations on IK based farming practices to improve their livelihoods and sustain their food security. The formal extension service encourage and employ the exposure visits to other farmers to learn.

However, the findings of the study cited the lack of documentation of indigenous knowledge based strategies as the messages were passed orally by the ‘experts’ who had over time gained experience as a result of continuous trials. This according to the study is one of the setbacks of indigenous knowledge for use by extension service providers as it lacks documentation and it risks being lost especially if the custodians of such knowledge fade away through natural attritions.

(g) Utilization of indigenous weather forecasting information as a coping strategy in agricultural production and food security

Focus group discussion revealed that, the indigenous weather forecasting information was utilized by the community to plan and implement agricultural production activities based on the weather report. For instance when to plant, the variety and type of crop to plant and the necessary production practices to be applied such as mulch in case of insufficient precipitation. Livestock farmers equally utilized the information to implement practices that would minimize production losses as in the case of droughts where the farmers conserve certain communal grazing fields for use during prolonged droughts. The weather report from indigenous experts further prepared livestock farmers in advance to counter livestock parasites and diseases associated with rainy and cold seasons and vice versa. According to the discussants, rainy and cold seasons are associated with diseases like pneumonia and internal parasites and the households sought indigenous medicine in advance to prevent infections and infestations of parasites on their livestock.

The IK based weather information further provided early warning signals to the community to enable them adjust to the prevailing circumstance by adopting coping strategies that would mitigate them against reduction in their household food levels. The indigenous practices adopted aimed at achieving household food security by employing production practices that are climate smart that would ultimately reduce losses in the farm. Early planting and planting of early maturing and drought resistant crop varieties like millet, sorghum, green grams and cow peace for instance, were practices employed to minimize losses associated with drought and useful during periods of insufficient rain seasons.

Other measures taken to avert imminent drought include: purchase food stocks for households in advance before droughts sets in, preserving and storing livestock feeds during good weather periods, timing market like best months for selling livestock (November/December when prices are high and purchase food when prices are low), planting indigenous drought resistant crops like millet, sweet potatoes, cassavas and enhance social network systems where individuals re-distribute animals to relatives as security measure in case of calamities like drought seasons.

A part from the indigenous weather forecast predictors, the study also established that the community also had specialists in the indigenous medicine for treatment of both human and animal diseases and controlling pests and parasites. These were experts in indigenous herbal medicine. The study established that aloe vera (Tengeretwo) was used in the prevention and treatment of diseases like East coast fever (ECF). Other traditional herbs for treatment of livestock diseases include croton (Otonwo) seeds for ECF; African green art (soke) soaked in water and sprayed to eradicate Fall Army Worm while pepper solution was sprayed on the stores to prevent rats and other rodents from destroying food. Other concoctions included solutions from Mexican marigold (bangi), tobacco, ash mixed with pepper which was said to be commonly used to control pests especially Fall Army Worms and mites and termites.

Focus group discussants further noted that, the concoctions had been proved to be effective in the control of pests, diseases and parasites while it was safe both to human beings and animals. According to the study, an outbreak of new disease and pest prompts the community with the leadership of experts in indigenous medicine to carry out experimentations and trials and observations and come out with an intervention based on successful trial on their farms. The results of continuous trials and experimentations would lead to the adoption of the new herb or action that has been proven to be effective. This finding implies that indigenous people are in constant trials and experimentations to find solutions to the community challenges. In so doing, the experts help in reduction of crop and livestock pests, parasites and diseases in the community which ultimately reduce production losses and improve household food security.

The adoption of the IK based strategies for controlling pests, parasites and diseases was intended to increase agricultural and livestock products which in turn improve food availability for household food security. The community according to the discussants were satisfied with the indigenous knowledge based strategies because they were available, reliable, cheap and easy to apply. Besides, the challenge of decreased extension staff to farmer ratio coupled with the rising costs associated with demand driven extension, the community opted for indigenous practices as alternative measure in their agricultural activities.

In a related study by Ndwandwe (2013) in South Africa, farmers used anything with sharp smell like concoctions made from a variety of solutions like salt, aloe, smoke soot, paraffin, garlic, pepper and even soap to control pests and diseases in their farms. The farmers according to the author believed that the solutions had ability to repel and/or kill pests yet they do not poison the farmers themselves. This study reveal further that farmers across the world have similar actions and are in constant farm experimentations and research in an attempt to cope with any emerging risk as far as farming is concerned. Siambombe et al. (2018) further document that farmers use homemade solutions such as ash, water, urine acacia leaves and chili peppers to control pests and diseases. The source also recommend that extension officers educate farmers on how they can synchronize indigenous knowledge to benefit their farming in order to enhance food security.

Similarly, Kamwendo and Kamwendo (2014) argue that rural people are acquainted with IK systems and do not in any way need specialized training. However, there is need for policy makers to integrate indigenous knowledge practices with scientific knowledge in extension services and food security programme for each of the knowledge base could complement one another. This would benefit farmers more as far as extension services and household food security is concerned. Indigenous knowledge according to this study dynamic, evolving and adaptive to change and is useful to the present dynamic society and environment which is constantly changing and therefore should not be neglected in extension services.

(h) Indigenous knowledge based drought coping strategies for food security

Participants of focus group discussion were further asked to provide the coping strategies employed to mitigate the effects of drought. The study revealed that the community members castrated male goats and bulls to fatten them in preparation for drought season in which case the fattened animals were sold to fetch higher prices in the market and the money used to purchase food or exchange of fattened animals for food. In addition, honey was harvested, preserved and stored for future during periods of drought.

Flight termites were harvested, fried and crushed into paste and mixed with honey then stored in specialized containers which can be stored for long periods for use during drought seasons when food was scarce. The honey in this case acted as a preservative to store the flight termites paste for a long period of time. This demonstrates knowledge of diversification and preservation skills on food stuffs displayed by indigenous communities in the study site to cope with food insecurity resulting from drought. Further the study demonstrated that, the community had mastered what worked well as far as coping with drought and food security was concerned using indigenous knowledge based practices.

Focus group discussants also indicated that households had separate stores for husband and wife as a safety net against food insecurity. Under this arrangement, the husband's store was only used when the wife's store was depleted and the husband's store would be carefully used when only necessary. Like what Tweheyo (2018) established in his study, traditional granaries according to the study findings are built at a raised level to allow free flow of air and smeared with cow dung to protect grains from weevils and pests. This ensured long food storage and thus food security is guaranteed. According to Tweheyo, harvested grains were dried in the sun to lower moisture content prior to putting them in the granary. The IK strategies lowered post-harvest losses and helped to boost household food security by ensuring that food is available and accessible and sustainable throughout the year thus meeting the basic elements of food security.

According to Tweheyo (2018), storage granary performed four functions namely: to reserve food for future consumption in case of food shortage, to preserve seeds for next planting season, to protect food from pests and weevils and finally to reduce losses resulting from destruction by rain water. Similarly, Storage granaries were mainly in warm place (fire place) to avoid weevils because the black soot near fire place prevented weevils and butterfly from accumulating. This would ensure proper preservation of food and seeds for the next season thereby promoting sustainable household food security by improving food availability and by protecting seeds for the next season.

According to James et al. (2010), pests and diseases are major problems in production systems as they cause serious losses. Chippungahelo (2015) further elaborates that farmers and local communities all over the world have expertise, skills, and practices on IK related to food security and agricultural production some of which include collection and processing of traditional plants during growing season and preserving in dry season. Indigenous knowledge therefore presents strategic approach to tackle household food security by devising variety of strategies that are applicable in their local environment and which enhances their survival mechanisms for their household members.

Indigenous knowledge-based storage and preservation practices are undertaken to prevent spoilage of food by micro-organisms since food by nature begins to spoil the moment it is harvested, processed, preserved and packaged with about one third of all the food produced for human consumption estimated to go to waste (Aluga & Kabwe, 2016). Aulaka and Regmi (2015) argued that food availability and accessibility can be enhanced by improving production, distribution and reducing losses and therefore reduction of post-harvest losses is a critical component of ensuring future global food security. According to Berjan et al. (2018), food waste reduction is critical for sustaining food supply and achieving food and nutrition security. Food losses and wastage as argued by the authors, lower the achievement of food and nutrition security.

The aforementioned authors underscore the role of indigenous knowledge in ensuring sustainability of household food security through their rich, varied and effective indigenous agricultural practices embedded in their culture. This was also observed this study where specialization on the various fields such as indigenous weather forecasting and herbal medicine was revealed in the focus group discussion. The fact that there is a commonality among the various coping strategies employed by different communities in different parts of the world imply that communities are innovative, dynamic and the process of diffusion is a continuous phenomenon across the world.

Indigenous rural communities according to this study are intelligent and knowledgeable people who plan for the future using sustainable practices that are environmentally friendly and are ready to face the future with ease. Embracing such indigenous innovations in food security programmes would enhance sustainability of household food security and act as safety nets against food scarcity that results from climate change effects. WORD (2015) documents other practices that farmers use to reduce post-harvest losses to include use of mixture of dried leaves of wild plants to control pests during storage while the seeds are stored in polythene bags. Indigenous knowledge has therefore aided communities to cope with the risks like starvation by farming valleys and flood plains, storing excess food and praying to their gods to bring more rain and control pests (Siambombe et al., 2018).

According to the focus group discussants, migration to other safer areas in terms of water and pasture was common among livestock keeping households as a coping strategy against drought. This enable households who are unable to adjust to the existing situation to move away from hard hit areas to better and safe areas within or outside the community. In some cases, this strategy enables the migrant to escape the adverse effects of climate change and other calamities that could have posed danger to both human and livestock lives, hence it acted as a survival strategy for rural households. This indigenous strategy implied that households had wisdom that enabled them to have a variety of options upon which community members could alternatively apply to safeguard their lives from effects of drought and maintaining their household food security.

Social network was also a common practice considered as a coping strategy against drought and other adverse conditions of food insecurity. According to the study, some animals were distributed to relatives and friends to spread risks such as death of animals due to drought, diseases and other calamities. Social network also helped the weak and poor households to get animal products like milk and meat and in some cases money especially when the animals are milked, slaughtered or sold. The strategy according to the discussants cushions households who do not have productive resources against effects of food scarcity as they were able to benefit from the food products or money to purchase food while at the same time helping to spread the risks of loss of animals by the owner as a result of deaths caused by drought. The practice enhances relationships and unity among community members and reduces the gap between the haves and the have not who could likely suffer the impacts of disasters especially those related to the changes in the environments. This indigenous knowledge based strategy besides minimizing risks and uncertainties also maintains stock levels that has positive implications for household food security.

Gathering wild food, fruits, and boiling and eating wild fruits, honey and milk was used in periods of prolonged drought and famine according to the focus group discussion. As established by the study, the practice was meant to reduce the rate of depletion of stored food and help prolong the periods in which the food would last. In this case, they would skip common meals and replace with wild foods and fruits so that the stored food will last to the next season when food would be available. Use of indigenous knowledge as a local resource had a positive multiplier effect on the local economy by improving food security in the whole community which is essential for household food security. The fact that a variety of wild foods and fruits were known and used displayed an element of diet variety which is crucial for balanced diet hence improving household nutrition thus satisfying the basic element of food security for an active and health life.

The focus group discussion a further revealed that, the charcoal in milk was also an indigenous knowledge based coping strategy meant to prolong the shelf life of milk besides being a value addition for the commodity. In addition, the charcoal reduced acidity and enhanced sweet smell since it was carefully extracted from special type of trees known to contain such properties. The prolonged shelf life of milk enabled the commodity to be available for longer periods of time to ensure sustainable food security. Integrating such forms of knowledge with existing practices increases the effectiveness of adaptation to climate change effects besides ensuring a constant supply of food even during periods of scarcity. The is less costly, environmental friendly and sustainable in nature according to this study since the such trees are within the community and are communally protected and preserved from generation to generation.

4.4.3 Diversification as climate change coping strategy for food security

Focus group discussants revealed that farmers engaged in diversification of enterprises in their farms including crops and livestock as well as other income sources as a climate change coping strategy. Diversification according to the study enabled the community to diversify income sources which was significant for cushioning them against food scarcity. In addition, the practice according to the discussants reduced risks associated with weather changes and enabled them to adequately cope with the changes in the environment. Similarly, diversification according to the study improved food quality or diet because it resulted in variety of food which led to a balanced diet for improved nutrition. The study further indicated that diversification was a strategy for food security at the household level. Mixed cropping, intercropping and mixed farming brought about diversity and ensured continuous supply of food crops and livestock products throughout the year to meet the family food needs. Diversification as an indigenous knowledge based strategy availed and stabilized food to households besides mitigating climate change effects through risk aversion.

Kihila (2017) lists mixed cropping, intercropping and crop diversification as among the indigenous coping strategies against climate change which according to Concern Worldwide (2020) are part of the climate smart agriculture. Crop diversification improves soil fertility, controls pests and diseases, and brings about yield stability, nutrition diversity, and health besides reducing risks associated with single crop failure (Kihila, 2017; Lin, 2011). Livestock diversification according to the study enabled the households to access a variety of livestock products and income sources from the sale of the surplus of such products hence sustaining household food security for longer periods. Indigenous knowledge strategies according to the findings are conscious of food sustainability, access, availability and stability which are the essential elements of household food security.

Lunga and Musarurwa (2016) further argue that, farmers use indigenous practices like crop diversification in order to adapt and mitigate climate change. While underscoring the importance of diversification as indigenous farming practices, Lin (2011) opined that the diversified cropping systems in general tend to be more agronomically stable and resilient. This resilience according to the author is mainly because they are usually associated with reduced weed and insect pressures, reduced need for nitrogen fertilizers especially if the crop mix include leguminous crops, reduced erosion because of cover crops inclusion, increased soil fertility and increased yield per unit area. Besides, MOAIWD (2016) argue that diversified production systems are important to vulnerable producers to enable resilience to climate and price shocks, more diverse food consumption from all the food groups to consume all nutrients, reduction of seasonal food and income fluctuations and greater and more equitable income generation for households. Diversification is also observed in the indigenous knowledge based practices as local communities employ a variety of indigenous practices to sustain their production systems such as knowledge on crops, livestock and weather forecasting which were left to 'experts' in which case the experts were diverse in their activities.

The diversified practices according to this study was meant to improve household food availability and access through the increased income from the diversified activity sources hence achieving household food security. The focus group discussants revealed that the diversification ensured availability, access and stability of household food security. Aulakh and Regmi (2013) consent that food availability and access can be increased by increasing production, improving distribution and diversifying income sources. Diversification would therefore raise the production levels through mixed farming and cropping, thereby improving food availability and income levels through sale of variety of food products. Meles (2016) further argued that the success of household and their members in managing food insecurity is largely dependent on their ability to get access to off-farm job opportunities which could aid as livelihood diversification strategies. Roert et al. (2013) further established that the coefficient of the off-farm income was positive indicating that there is a positive relationship between off-farm activities and food security. In a related study, Ponge (2013) supported the concept of diversification by suggesting that resilience is found on indigenous agriculture systems indicating that, the diversified indigenous farming systems can cope with scarce resource situation and unforeseen farm problems like drought while still being able to maintain subsistence production levels.

Rural communities according to the aforementioned studies are knowledgeable about the importance of diversification as a coping strategy for food security. Diversification also reduces risks and uncertainties associated with climate change effects in addition to improving outputs and incomes associated with different enterprises that cumulatively improve household food security. As Yong et al. (2007) puts, incorporating indigenous knowledge would promote local participation in the development of sustainable, cost effective strategies rich in local content for improving household food security. This provides an opportunity for policy makes in agriculture and food security programme through extension services to integrate useful indigenous knowledge based practices that could improve household food security. Asogwa et al. (2017) concluded that indigenous knowledge methods of food security are time tested and have been used by locals over generations as a survival strategy. The author further described indigenous foods as inexpensive, safe and nutritious foods throughout the year hence boosting overall food security. This study according to the focus group discussants also indicated that indigenous knowledge based practices on diversification stabilized household food security.

4.4.4 Selection of seeds and varieties to cope with climate change and food insecurity

This study established that households carefully selected local quality seeds and varieties for planting during the next season of planting. The seeds and varieties were identifying during harvest season, selected and kept near the fire place where smoke protected them against storage pests and diseases. Properties like size and undamaged seeds. Households according to the respondents continuously experimented and observed the and selected seed varieties that were adaptable and well performing, stored and preserved for them for the subsequent seasons in their farms. Repeated trials and selection of seeds according to the study resulted in varieties that were high yielding, adaptable, quick/early maturing and resistant to both diseases and pests. As a result of seed and variety selection, household yields from the farm would improve which enhances household food security through increased food availability.

This study therefore, argue that households are not passive farmers but rather active researchers and experimenters of agricultural practices and their trials may perhaps be the reasons for the success of indigenous knowledge based practices that has led to the paradigm shift to the use of this knowledge base in during this era. Indigenous varieties are much resistant than the hybrid varieties (WORD, 2015) and according to Tweheyo (2018), people have knowledge of drought and disease resistant seeds hence have drought coping strategies and therefore know which seeds do well in certain types of soils and those that do not in certain conditions based on experience. The author further pointed out that indigenous people have knowledge about seeds that mature fast and those that are good in responding to famine after long dry spell or other natural disasters.

The indigenous knowledge based practices on seed varieties and the adaptations to different conditions could therefore, help improve agriculture production and sustainability of food security. As Kamwendo and Kamwendo (2014) recommended, indigenous knowledge is a key path-way to rural farmer's transformation and it is potentially a reliable alternative to modern technology especially in the process of achieving food security. This is further supported by FAO (2014) that, there is no doubt that indigenous knowledge is vital for rural communities' food security. Equally, Asogwa et al. (2017) points out that the livelihood of rural poor depends almost entirely on indigenous skills and knowledge which are essential for their survival.

Although the indigenous knowledge practices like diversification and preservation of food are time tested and have been used by locals over generations as a survival strategy, there is a tendency among policy makers, environmentalists and other stakeholders to ignore community based knowledge, value systems and experiences of local communities yet these have been used for centuries to interact sustainably with their immediate environments (Dlamini & Kaya, 2016). These authors seem to suggest that sustainable food security among rural communities could be achieved if indigenous knowledge is given the attention it deserves because of its great value. Selection of seeds and varieties is one of the important practices for achieving household food security as it enhances the potential for households to increase production levels in the farms. Indigenous knowledge based practices could compliment scientific practices on seed and variety selection to benefit from both knowledge bases.

4.4.5 Climate change coping strategies according to extension staff

Extension staff were asked to state the IK based coping strategies adopted by households to cope with climate change. The results are summarized in Table 13.

Table 13

Indigenous Knowledge Based Climate Change Coping Strategies according to Extension Staff

Coping Strategy	**Frequency**	**Percentage**
Planting at the onset of rains/early planting	5	45.5
Use of dry feeds	2	18.2
Feed conservation	3	27.3
Destocking	4	36.4
Water harvesting	3	27.3
Food preservation	3	27.3
Terracing	2	18.2
Migration	3	27.3
Use of IK based weather information in farming	3	27.3
Seed selection	2	18.2
Controlled grazing	4	36.4
Planting drought resistant crops	3	27.3

(n=11)

From Table 13, households engaging in livestock enterprises adopted mainly controlled grazing and destocking each at (36.4%). The implication according to the findings is that households practicing livestock enterprises use strategies that regulate pasture utilization and livestock numbers to ensure continuous grazing throughout the year while maintaining carrying capacity of the pasture fields. The practices ensure reduced loss of livestock as a result of insufficient pasture while destocking regularly provide income that sustain their household food security through access. In addition, they also apply other IK based practices like feed conservation (27.3%), migration (27.3%) and use of dry feeds (18.2%) to supplement green feeds on their livestock. The implication is that feed conservation, use of dry feeds and migration provide alternative feeds especially during dry season when pastures are scarce there by sustaining their livestock numbers and health beyond drought periods. Besides, they relied on IK based weather forecasting to obtain early warning signals on weather conditions that was to prevail and be able to prepare accordingly. The implication is that, livestock farmers are conscious of the environmental changes and prepare adequately to counter the effects of the climate change through controlled grazing, destocking, feed conservation, use of dry feeds, migration and reliance on IK based weather forecasting to provide information that prepares the households to cope with prevailing situations.

The dominant indigenous knowledge based practices among the crop farming households according to the results of the study (Table 13) is early planting at the onset of rains (45.5%). This has the advantage of enabling the crops to benefit from the nitrogen flush and also maximize the available rains before the dry spell begins especially if the expected rains is insufficient. The strategy also allows crops to escape from the adverse effects of pests and drought they grow and mature faster due to the nitrogen flush and utilization of available rain water. This has a bearing in the agricultural production since food will be available for the households hence achieving food security. Other major IK based practices adopted according to the results include; Use of IK based weather forecasting (27.3%), food preservation (27.3%), water harvesting (27.3%) and planting drought resistant crops (27.3%). Further, the households used practices such as terracing (18.2%) and seed selection (18.2%) as IK based practices for coping with climate change. The results agrees findings from a study conducted in Tanzania by Kihila (2017) that mixed cropping, crop diversification and water harvesting and terracing part of the indigenous practices by communities to cope with climate change. Salami (2010) consent to the fact that indigenous systems are resilient to climatic conditions.

The adoption of the IK based strategies (Table 13) on crops implied that weather forecasting provided information to guide households on when and what to plan so that they maximize production and minimizes losses as far as food is concerned. The practice also determines seed selection for planting and the type of crops to be planted. Similarly, food preservation for households ensured continuous supply of food while water harvesting provided water for irrigation to guarantee household food security. According to Ponge (2013), indigenous farming systems bring about resilience through their diversified practices. The results of this study (Table 13) therefore supports the assertions by UNCTAD (2011) that indigenous knowledge based practices reflected sustainable agriculture while Ogega (2017) described them as climate smart initiatives. Sustainable agriculture and the climate smart practices are the cornerstones for the attainment of household food security.

4.4.6 Climate change coping strategies according to observation checklist

Observation checklist was used to record some of the visible IK based strategies that households used to cope with climate change. Table 14 provide a summary of observations made.

Table 14

Climate Change Coping Strategies by Households as Observed by the Researcher

Strategy	Frequency	Percentage
Water harvesting/irrigation	16	84.2
Crop diversification	18	94.7
Mixed farming	19	100.0
Mulching	14	73.7
Terracing	13	68.4
Seed mixing	17	89.5
Organic farming	16	84.2
Indigenous livestock	19	100.0
Local breeds	17	89.5

(n=19)

The major observed IK based coping strategies for climate change on Table 14are mixed farming (100%) and keeping indigenous livestock (100%), crop diversification (94.7%), keeping of local breeds (89.5%) seed mixing (89.5%), organic farming (84.2%) and water harvesting for irrigation (84.2%). Other important practices are mulching (73.7%) and terracing (68.4%). The observation made revealed some common practices according to the results from the household heads and extension staff. Results from the household heads, extension staff and observation guide indicated that, mixed farming and diversification of farming enterprises were commonly used to cope with climate change effects. The implication is that, households employ the IK practices to spread risks and uncertainties in their farms and to increase chances of improving agricultural production in the farm to achieve household food security. The different enterprises in the farm from both livestock and crops cumulatively raises food quantity and incomes that eventually contribute to food availability and access which are significant to the achievement of household food security. This is consistent with Ponge (2013) explanation that, for poor farmers, the crop diversity is their safety net for household food security.

Similarly, the results of this study agrees with those of Ogega (2017) who established that, communities living in the Kenyan coast widely adopted indigenous practices like diversification in crop types and varieties, widespread use of organic farming, increased awareness on and uptake of climate –smart agriculture initiatives including the concept of conservation agriculture. This study results and those of the aforementioned scholars are indicative of the efforts that communities strive to cope with climate change using variety of indigenous knowledge based practices. Kumar (2014) asserts that, communities can provide the various tools and the means to tackle present problems because of their historical expertise to cope with variability of local climate. Indigenous knowledge according to the scholar could save million lives if purposefully and logically applied with scientific skills and technology. According to United Nations Educational Scientific and Cultural Organization (UNESCO, 2018), indigenous knowledge systems and practices are the major resource for coping with climate change.

4.4.7 Climate change coping strategy index

In order to test the hypothesis of the study, coping strategy index (CCSI) was generated using a set of 19 closed ended rating type items based on how frequently households practiced the coping strategies. A 5 point rating scale (Never:1, Rarely:2, Occassionally:3, Often:4, Very often:5) was used where respondents were to indicate how frequently they practiced each of the coping strategy in the farms. The means and standard deviations of the individual and the overall coping strategies which according to this study assumed the CCSI were computed. Table 15 summarizes the results.

Table 15

Indigenous Knowledge Climatic Change Coping Strategies Index

Coping Strategy	n=117	Mean	SD
Terracing	113	2.82	1.22
Mixed farming	115	4.28	0.78
Fallow cultivation	113	2.80	1.30
Use of organic manure	117	3.48	1.33
Mixing seed varieties	117	3.18	1.30
Indigenous weather forecasting (observing plants, animals, stars)	116	3.68	1.16
Planting drought resistant crops	117	3.92	0.85
Crop diversification	113	3.81	1.07
Irrigation	114	2.51	1.63
Mulching	116	2.66	1.35
Planting cover crops (sweet potatoes, cowpeas)	117	3.15	1.43
Early planting	116	4.03	0.89
Destocking	113	2.66	1.14
Migration	115	1.65	0.93
Use of common properties forage (road reserves, forests, schools)	111	2.72	1.20
Social network (distribute animals to relatives and friends)	114	2.59	1.08
Keeping livestock that can withstand drought (goats, camels)	116	3.91	1.16
Livestock diversification (cattle, chicken, goats, sheep, bees)	116	4.35	0.82
Use of crop residue as livestock feed	113	3.99	1.03
Indigenous knowledge climatic change coping strategies index	**117**	**3.22**	**0.50**

Legend: n= Sample Size, M= Mean, SD= Standard Deviation

The means of each of the individual indigenous knowledge based coping strategies ranged from 1.65 (SD=0.93) to 4.35 (SD =0.82) out of the possible 5. The highest item means (above the midpoint value of 3.00) were on livestock diversification (M=4.35, SD= 0.82); mixed farming (M=4.28, SD=0.78); early planting (M=4.03, SD= 0.89); use of crop residue for feeding livestock (M=3.99, SD=1.03); planting drought resistant crops (M=3.92, SD=0.85); keeping drought resistant livestock (M=3.91, SD=1.16); practicing diversification of crops

(M=3.81, SD=1.07); applying indigenous weather forecasting (M=3.68, SD=1.16); use of organic manure (M=3.48, SD=1.33); Mixing seed varieties (M=3.18, SD=1.30) and planting cover crops (M=3.15, SD=1.43). Similarly, most of the standard deviations of the frequently applied IK strategies are relatively low (below 1) implying that the variation in the use of the practices are narrow suggesting that utilization of those practices among the farmers is comparable.

The results (Table 15) therefore imply that households apply more frequently IK based strategies that first focus on reduction of risks and uncertainties associated with climate change by spreading the risks through diversification and mixed farming practices. Secondly, households employ practices that aim at escaping the adverse effects of climate change such as early planting, drought resistant varieties and breeds, organic farming as well as applying IK weather forecasting to guide in farming activities. The practices in the long run enables the households to cope with climate change effects and improve food security. This is consistent with Ponge (2013) assertion that IK practices brings about resilience against effects of climate change like drought. According to Ogega (2017), diversification, wide spread use of organic farming, increased awareness on and uptake of climate smart agriculture initiatives including the concept of conservation agriculture was widely adopted by farmers.

This demonstrates the dynamic and innovative nature of indigenous knowledge and the variety of options that households in the study area have at their disposal to cope with climate change and to achieve household food security. Similarly, the study findings explains the ability of indigenous communities to understand and master their environment by developing strategies that enhance food availability and access through increased production as well as ensure sustainable livelihood practices for the achievement of household food security.

The items that recorded lower means (Table 15) were migration (M=1.65, SD=0.93), irrigation (M=2.51, SD=1.63), social network (M=2.59, SD=1.08), mulching (M=2.66, SD=1.35), destocking (M=2.66, SD=1.14), use of common property forage (M=2.72, SD=1.20), fallow cultivation (M=2.80, SD=1.30) and terracing (M=2.82, SD=1.22). The results imply that the practices were less frequently used as coping strategies perhaps because some of practices like fallow cultivation, migration and use of common property forage are no longer popular among most households owing to change in terms of land tenure system with most farmers having individual land ownership and also limited land owned to accommodate the practices. The standard deviations are also relatively high implying that the practices were not commonly used among the households hence not comparable.

The climate change coping strategy index (overall mean) was above 3.22 with a standard deviation of 0.5 implying that on average the households applied the practices to cope with climate change. The results are also indicative that the practices were not absolutely used as the coping strategies suggesting blend of both indigenous and modern practices to cope with climate change. The results are in agreement with the UNFCCC (2013) argument on the need to build a synergy between indigenous knowledge and science for improved climate change coping mechanisms. Similarly, Ponge (2013) recommended the importance of appreciating that modern and indigenous knowledge are complementary in their strengths and weaknesses and combined may achieve what neither would alone. Incorporating indigenous knowledge based practices into scientific knowledge systems through extension services could result insubstantial benefits to the farmers as far as yield is concerned. This could also enhance a complementary role of the two knowledge systems to increase agricultural production for improved food security at household level.

In addition, the low standard deviation meant that there was minimal variation in the responses towards the items implying that the indigenous knowledge based practices findings were thus employed by households to cope with climate change though the frequency of use for each practice differed. UNCTAD (2011) indicated that the indigenous knowledge practices were a reflection of a sustainable agriculture which according to the author included: organic agriculture, agro ecology and regenerative agriculture, composting, mulching, crop rotation, intercropping, agroforestry, biological pest control measures, green manure, integrating livestock into farming systems, preventing erosion and water harvesting.
These strategies demonstrate a high level of indigenous knowledge expertise present in the rural community which are crucial for sustainable development and food security. This knowledge could be integrated into the formal extension to enable the community members reap the benefits of the indigenous knowledge as far as agriculture and food security is concerned. The aforementioned authors agree with this study by suggesting that indigenous knowledge based strategies for coping with climate change are widely adopted across the

globe implying that it has the potential for transforming agriculture and sustaining household food security.

WORD (2015) further established that mixed cropping used by most indigenous farmers brought about diversity and ensured continuous harvest of food crops round the year to meet the family food needs and that the practice works in the local climatic conditions and can withstand drought like conditions. Indigenous knowledge has therefore shown to be of great importance in agriculture and development practices for rural communities as it helps the communities to come up with practices and means to cope with the effects of disasters such as starvation besides being mainly practical in nature particularly in such fields as agriculture (Magni, 2016; Siambombe et al., 2018; UNFCCC, 2013).

4.5 Food Security Status of Households in the Study Area

In order to establish the status of food security at household level, household heads were asked series of questions on the food stuffs they produced and grow both the crop and livestock related.

4.5.1 Crop and Livestock Related Food Stuffs Produced by Households

House hold heads were asked to name the crop and livestock related food stuffs that they produced in their farms. The results are summarized in Table 16.

Table 16

Main Crop and Livestock Related Food Stuffs Produced by Households

Category	Food Stuff	Frequency	Percentage
Crop Based	Maize	112	95.7
	Beans	93	79.5
	Millet	71	60.7
	Sorghum	42	35.9
	Green grams	25	21.4
	Vegetables	15	12.8
	Cow peas	40	34.2
	Potatoes	22	18.8
	Fruits	23	19.7
	Cassava	19	16.2
	Groundnuts	14	12.0
Livestock related	Milk	106	90.6
	Meat	111	94.9
	Eggs	53	45.3
	Honey	23	19.7
	Fat	10	8.5
	Butter	2	1.7

(n=117)

The main crop food stuffs from households own production include maize (95.7%), beans (79.5%), millet (60.7%), sorghum (35.9%), cow peas (34.2%) and green grams (21.4%). Other crop food stuffs are fruits, potatoes, cassava, vegetables and groundnuts. On the other hand, livestock food stuffs encompass milk (90.6%), meat (94.9%), eggs (45.3%) and honey (19.7%). Others include fat and butter. The results (Table 16) indicates that the households concentrate mainly on the production of maize, beans, milk, meat, millet, eggs and sorghum which were considered as staple food in the study area. The results also reflects diversification in production and diet. Besides, drought resistant crops like millet and sorghum according to the study guards against food losses associated with climate change especially drought effects. The variety of food sources produced by households according to the results are indicative of the efforts by households to increase food production and income sources through diversification to enhance food availability and access hence promoting household food security. Tweheyo (2018) observed that diversification was an indigenous land use practices for sustaining food production and household food security.

4.5.2 Means of accessing food by households

Household heads were asked to indicate the means of accessing food for their families. Table 17 show the results.

Table 17

Sources of Food According to Household Heads

Food source	Frequency	Percentage
Produced	114	97.4
Bought	105	89.7
Relief	20	17.1
Gathered	40	34.2
Relatives/well wishers	63	53.8

(n=117)

The major source of household food (Table 17) is through own production (97.4%) while (89%) were obtained through purchase. The implication is that household heads combine both own production and through purchase to meet their household food security obligation. Income for purchasing food could be sourced from sale of cash crops and livestock. Other sources of food (Table 17) are through relatives (53.8%), gathering (34.2%) and reliance on relief (17.1%). The results indicate that, most households engage in farm production to satisfy household food needs. The results further imply that, the income from the diversified crop enterprises were used by households to generate incomes to access food through purchase for their households. This also suggest that, households supplemented what they produced from their farms with purchases from the diversified income sources emanating from the variety of crop enterprises thus enabling the households to maintain a stable food security even in times of food scarcity. The diversification of enterprises by households was strategic in supplying physical food stuffs and access of food through incomes from the different sources of enterprises.

However, in some cases, the households supplemented their food from relatives and also gathering wild foods especially during extreme situation of drought. Relief food was ranked least (17.1%) perhaps because households' ability to meet their household food needs through their own production, purchase and from relatives. The variety of food sources by households is a demonstration of the ability of households to plan and organize themselves well in advance to face any situation of food scarcity resulting from climate change effects. This agrees with arguments by Gaoshebe (2014) and Ponge (2013) that, local people have over the years developed indigenous food security strategies and mechanisms to cope with uncertainties and achieve food security.

4.5.3 Food crops grown by the households

Household heads and extension staff were further asked to state the food crops grown in the study area. In addition, observation checklist was also used by the researcher to observe the actual crops and produce in the household farms and store. The results are presented in Table 18.

Table 18

Food Crops Grown by the Households

Crop	Households (n = 117)		Extension staff (n = 11)		Observation (n = 19)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Maize	101	86.3	11	100.0	15	78.9
Beans	90	76.9	10	90.9	10	52.6
Millet	74	63.2	9	81.8	13	68.4
Sorghum	26	22.2	6	54.5	8	42.1
Cassava	12	10.3	5	45.5	-	-
Green grams	9	7.7	5	45.5	-	-
Cow peas	11	9.4	7	63.6	6	31.6
Sweet potatoes	9	7.7	5	45.5	3	15.8
Fruits	7	6.0	5	45.5	-	-
Vegetables	6	5.1	6	54.5	4	21.1

The results in Table 18 indicate that the popular crops grown by most households in order of priorities were maize, beans, millet and sorghum. Results from all the three different categories of data collection instruments are in agreement on the four food crops. The results implied that the four crops were the main staple and food security crops at household level. In addition, the crops demonstrated the diversity nature of household farm enterprises for coping with climate change and food insecurity. The merits of diversification according to a number of authors include the supply of continuous harvest of food crops to meet family needs besides improving both household food and income levels hence reducing hunger gap among households(WORD, 2015); It enables vulnerable producers to enable resilience to climate and price shocks (MOAIWD, 2016); The practice improves soil fertility and controls pests, diseases as well as bringing yield stability, nutrition diversity, and health (Lin, 2011); In addition, diversification act as an adjustment to cope with household food insecurity, scarce resource situation and unforeseen farm problems like droughts while maintaining subsistence production levels (Ogega, 2017; Ponge, 2013).

As an indigenous knowledge based coping strategy, diversification of farm enterprises therefore serves as a safety net for households particularly in ASAL areas by enabling them cope with challenges like climate change and food insecurity. Tweheyo (2018) asserts that, local farmers plan their land use to sustain food production using their indigenous practices like diversification.

Besides diversification of enterprises for food security, households according to the study also planted drought resistant crops like millet and sorghum in their farms. The implication of this IK based practice enabled them to cope with adverse effects of climate change. Such crops are drought resistant and are therefore, suitable for ASAL regions, a characteristic of the study site. Households according to the results of the study have knowledge of their environment in terms of what does best as far as their food security is concerned and were therefore, careful of what they grew in terms of adaptability to their environment, nutrition and household’s food security as evidenced by the variety of crops grown in their farms. A study by Mafongoya and Ajayi (2017) revealed that, communities in hazard prone areas have developed a good understanding and knowledge of disaster prevention and mitigation because indigenous knowledge is based on facts that are known or learnt from experience or acquired through observation and practice and is handed down from generation to generation.

4.5.4 Livestock kept for food production

In order to establish the strategies that households use to secure food security, respondents were asked to indicate the livestock kept by the households. Observation checklist was also used to observe physically the animals kept by households. The findings are presented in Table 19.

Table 19

Livestock Kept for Producing Food by Households

Animal	Households (n = 117)		Extension officers (n = 11)		Observation (n = 19)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Cattle	113	96.6	10	90.9	18	94.7
Sheep	103	88.0	11	100.0	16	84.2
Goats	107	91.5	10	90.9	18	94.7
Chicken	87	74.4	10	90.9	13	68.4
Bees	5	4.3	3	27.3	2	10.5
Camel	-	-	1	9.1	-	-
Pig	-	-	1	9.1	-	-

The major livestock kept by households according to the study findings were cattle, sheep, goats and chicken. Bee keeping was also found to be among the livestock kept. Keeping of livestock and growing of crops is a form of diversification that households used as a coping strategy against climate change effects so as to ensure food security through diversified foods and incomes. This implied that households are aware of risks related to climate change and are in a position to strategically prepare to cope with the dangers that may hit their households. The interdependence between crops and livestock according to Ponge (2013) is a characteristic of indigenous farming systems.

Diversification according to the study findings was a common phenomenon among the households as a way of improving food production, increased income sources and averting risks associated with climate change. Diversification of farming enterprises therefore characterizes indigenous agriculture practices which are significant for improving food security. According to Ogega (2017), diversification and increased awareness and uptake of climate smart agriculture initiatives was a widely adopted strategy to cope with climate change effects. Kumar (2014) recommended the need to preserve and expand indigenous knowledge and skills to fight climate change by indicating that, the expertise of local communities to cope with variability of local climate can provide various tools and means to tackle climate change.

4.5.4 Household food security status in the study site

In order to establish the food security status of households in the study site, household heads and extension staff were required to state the food situation using a five point rating scale which ranged from very good to very poor. A very good and good response is an indicative of a stable food security status while moderate status indicated average conditions as far as food security is concerned. On the contrary, poor and very poor status indicate unstable food security status of household. The results of the food security status of households are presented in Table 20.

Table 20

Results on Status of Food Security of Households in the Study Site

Status	Household Head (n=117)		Extension Staff (n=11)	
	Frequency	Percentage	Frequency	Percentage
Very good	17	14.5	0	0.00
Good	34	29.0	2	18.2
Moderate	43	36.8	5	45.5
Poor	14	12.0	2	18.2
Very Poor	9	7.7	2	18.2

Majority of the households (80.3%) according to Table 20 had moderate to very good food security status while 19. 7 percent indicated poor to very poor food security status. Similar results were also revealed by extension staff who indicated that majority (63.5%) of the households ranged between moderate to good food security status while (36.4%) indicated poor to very poor food security status of the households. The implications of the results of the study is that, most households were in good to very conditions in terms of food security. Diversification of farming enterprises (Table 16) and perhaps use of indigenous knowledge based strategies may have had positive influence in the availability and access to food by households that may have eventually improved household food security status. Tweheyo (2018), indicated that local farmers use their indigenous practices to sustain their food production while Lin (2011) posits that indigenous practices like crop diversification brings about yield stability which according to WORD (2015) improve both household food and income levels.

4.5.5 Food security index (FSI) of households

Food security was measured using a set of 20 close ended items. The items were based on how frequently they practiced specified indicators of food security. The responses to the items were scored using a five point rating scale (Never:5, Rarely:4, Occassionally:3, Often:2, Very often:1). The mean of each item was computed and the average mean from all the items translated into Food Security Index (FSI). A mean of 3.00 and above from individual item was an indicative that the practice was not popularly applied by the households. An overall mean average of 3.00 and above indicated that on average the practices were not undertaken which also implied that the households were food secure. On the contrary, an overall mean below 3.00 indicate that the practices were often practices hence the households are food insecure. Table 21 summarizes the results.

Table 21

Food Security Index (FSI) of the Household Heads

Practice	**N=117**	**Mean**	**SD**
Borrowing food	116	1.94	1.00
Relying on less preferred or less expensive food	116	2.75	1.04
Seek help from a relatives/friends to access food	117	2.24	0.96
Purchasing food on credit	115	2.26	1.04
Gathering food (wild fruits, hunt, harvest immature crops)	117	2.04	1.14
Consuming seed stock held for next season	114	2.44	1.20
Sending household members to eat elsewhere	116	1.56	1.00
Sending household members to beg	115	1.48	0.99
Limiting amount of food eaten during meals	114	2.21	1.06
Restricting consumption by adults in order to allow children to eat	117	1.99	1.07
Reducing the number of meals eaten in a day by the household	117	2.32	1.06
Going for an entire days without eating	116	1.72	0.93
Worried that the household does not have enough food	115	2.73	1.37
Family members not able to eat the kinds of foods they prefer	117	1.85	0.99
Household eating limited variety of food	116	2.50	0.99
Family eating food that they do not want to eat	117	1.85	0.99
Eating smaller quantities than needed	117	2.23	0.87
Forced to eat fewer meals in a day	116	1.97	1.01
No food for the house hold	115	1.74	0.97
Household going to sleep at night hungry	116	1.72	1.00
Household going for a whole day without eating	117	1.64	0.93
Food Security Index	117	**2.06**	**0.64**

The food security index (Table 21) revealed that the individual item mean range between 2.75 to 1.48 which fell below the midpoint of 3.00 implying that the practices were applied more often. The overall mean is also lower than the midpoint thus suggesting that the households are food insecure. The standard deviations of the individual means are relatively low implying that the practices are comparable. In addition, the overall standard deviation is low (0.64) indicating a low variations among households in terms of the practices, hence comparable. Table 21 indicate that household are food insecure despite applying the coping strategies. The results of the study however contradict Mafongoya and Ajayi (2017) assertion that, communities in hazard prone areas have developed a good understanding and knowledge of disaster prevention and mitigation, early warning preparedness and response and post disaster recovery which should enable households to attain food security. According to this study findings, the application of IK coping strategies does not improve food security situation instead they remain food insecure.

The results (Table 21) do not also support assertions by Singh and Singh (2017) and Siambombe et al. (2018) that, indigenous agricultural practices have regained the increased attention worldwide as climate smart approach because IK practices in agriculture are essential in food production. Similarly, the argument by Asogwa et al. (2017) that, indigenous knowledge has enabled rural communities to sustain their household food security is not also supported by the study findings.

Household heads were further provided with a list of possible factors affecting food security where frequency counts and percentages were computed. The data was necessary to establish the challenges the households faced that undermine the achievement of household food security given that the food security index was just above average. The results are presented in Table 22.

Table 22

Factors that Affect Household Food Security

Statement	Frequency	Percentage
Poverty/Financial constrains	15	12.8
Pests	63	53.8
Diseases	68	58.1
Drought	52	44.4
Climatic change	18	15.4
Poor quality seeds	11	9.4
Soil erosion	7	6.0
Post-harvest losses	6	5.1
Unpredictable weather	26	22.2
Labour shortage	5	4.3
Methods of storing/preserving food	7	6.0
High cost of inputs	9	7.7
Insecurity	11	9.4
Predators	5	4.3
Farming methods	8	6.8
Health of the population	7	6.0
High dependency ratio	5	4.3
Poor state of infrastructure	9	7.7

(n=117)

The key factors affecting food security at household level according to the results of the study (Table 22) were diseases (58.1%), pests (53.8%), drought (44.4%), unpredictable weather (22.2%), climate change (15.4%) and poverty (12.8%). These factors, according to the study were responsible for lowering agricultural production and hindered the attainment of food security. The finding are in agreement with what other studies have established that extreme weather variability has resulted in increased incidences of drought, floods, pests and diseases which have undermined the performance of agricultural sector by reducing food supply, availability, access and incomes leading to food insecurity (Economic Survey, 2015; FAO, 2013; GOK, 2015; Kungu, 2014). Ponge (2013) suggest that, the diversified, resilient indigenous farming systems could cope with the farm problems such as climate change and other associated factors.

Household heads were also asked to give their suggestions on how to improve food security at household levels. This was deemed necessary to generate useful information for future policy implication. The results are presented in Table 23.

Table 23

Suggested Ways of Improving Food Security according to Household Heads

Suggestion	Frequency	Percentage
Adopt modern farming technologies	7	6.0
Agriculture Diversification	5	4.3
Enhance capacity of households to store/preserve food	31	26.5
Avail water (irrigation, livestock)	38	32.5
Control crop and livestock diseases	25	21.4
Use certified seeds	8	6.8
Control pests	29	24.8
Early preparation (land, planting)	26	22.2
Maintain peace (control insecurity)	5	4.3
Construct infrastructure (roads, social amenities)	6	5.1
Improve health of households	8	6.8
Practice crop rotation (improve productivity)	3	2.6
Plant drought resistant crops	6	5.1
Strengthen extension services	7	6.0
Control soil erosion	5	4.3
Encourage households to plant trees to attract rain	4	3.4

(n=117)

Table 23 reveal that, availing water for both irrigation and livestock use ranked high (32.5%) followed by enhancing capacity of households to store and preserve food (26.5%). Pest control (24.8%), early land preparation and planting (22.2%) and control of crop and livestock diseases (21.4%) were also key suggestions that according to the respondents would enhance household food security. Availability of water according to the results may have been prompted by the desire to increase off season production by households to increase food and incomes sources to improve household food security. The capacity to store and preserve food also scored high which according to the study implies that households face post-harvest losses that lowers the quantity of their food.

However, results on the use of certified seeds (6.8%), adopting modern farming technologies (6.0%) and strengthening extension services (6.0%) scored low as far as improving food security at household level is concerned. This could be as a result of poor access to extension services due to the low extension to farmers ratio may have resulted in lack of awareness on better farming practices such as use of certified seeds and other appropriate technologies for improving agricultural production and food security. Demand driven extension may have also affected negatively the perception of households towards public extension services due to associated costs of seeking extension services. As a consequence, households resorted to other available options like indigenous knowledge based practices. Asogwa et al. (2017) argue that, indigenous agricultural knowledge practices are time tested, evolved through trial and error hence could provide sustainable solutions to farmers' problems.

4.5.6 Indigenous climate change coping strategies and household food security

Influence of indigenous climatic change coping strategies on household food security was established using simple linear regression. This involved regressing the indigenous climate change Strategy Index (CCSI) in Table 15 with Food Security Index (FSI) in Table 21. The regression test results are summarized on Table 24.

Table 24

Regressing Climate Change Coping Strategies on Household Food Security

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**p-value**
	B	**Std. Error**	**Beta**		
Constant	1.700	.383		4.435	.000
Indigenous climate change coping strategies	.111	.118	.088	.942	.348
R = .088 , R^2 = .008, F(1, 115) = .888, p = .348					

*Significant at alpha α= <0.05.

The regression test results on Table 24 revealed a positive relationship existed between indigenous knowledge based climate change coping strategies and household food security (r = .088). The results also revealed that the predictor variable accounted for only 0.8% (R^2 = .008) variation in food security. Further, the results indicated that indigenous climate change coping strategies had no statistically significant influence on household food security at .05 level, $F (1, 115) = .888$, $p > 0.05$. The results fail to reject the null hypothesis since the p-value of 0.348 is greater than $\alpha = 0.05$ implying that indigenous knowledge based climate change coping strategies do not influence household food security.

The results of the hypothesis testing contradict the findings of a study by Chege et al. (2018) which indicated that there was a significant relationship between food security and practices of indigenous knowledge. The study also concluded that indigenous knowledge was necessary for enhancing food security. Gaoshebe (2014) in a study on African indigenous food security strategies and climate change adaptation in South Africa also had the view that, the extent to which the impacts of climate change are felt on food security depend to a great extent on culturally specific adaptation strategies a community or cultural group has developed in response to climate change. The fact that indigenous climate change strategies do not influence food security as reflected in this study findings does not necessarily mean that indigenous practices are not employed in the farmer's farms.

4.6 Indigenous Knowledge Based Production Strategies and Food Security

Objective two of the study sought to establish the influence of indigenous knowledge based production strategies on household food security. Food stuff of most households were crop and livestock related. This means that supply of food depended on ability of households to grow crops and keep animals. Growing crops and keeping animals for food is a process that involves several activities. The household heads and extension staff were therefore asked to state the activities they engage in during food production process and the indigenous strategies applied.

4.6.1 Indigenous knowledge based production strategies by household heads

In order to establish the indigenous knowledge based production strategies index (PSI), household heads were provided with eleven (11) possible indigenous knowledge based strategies related to production in both crops and livestock. Respondents were then required to indicate the ones they practice in their farms using a five point rating scale. The means and standard deviations of each of the strategies was calculated. The overall mean for all the strategies was also computed which translated into the Indigenous Production Coping Strategy Index (PSI). The index was later regressed with food security index to test the hypothesis. The results of PSI are presented in Table 25.

Table 25

Indigenous Knowledge Production Strategies Index

Scale	Strategy	N=117	Mean	SD
Crop	Clearing the farm by burning	116	3.67	1.16
	Use of hoes to dig	117	3.60	1.33
	Use of oxen to plough	117	1.27	0.60
	Plants own preserved seeds	114	3.28	1.19
	Use of compost manure when planting	117	2.23	1.55
	Practices inter cropping	117	3.85	1.05
	Using hoes to weed	116	3.92	3.04
	Maintains soil fertility through mulching, rotten grass, leaves	116	2.77	1.17
Livestock	Selects local breeds	116	2.84	1.19
	Use of free range feeding	113	4.27	1.05
	Use of crop stovers to feed livestock	116	3.94	0.98
	Indigenous food production strategies index	**117**	**3.21**	**0.60**

Based on the results (Table 25) on the indigenous production strategies index, the mean of the individual item range between 4.27 and 1.27. The items with higher means (above 3.00) on a rating scale of 1-5 were use of free range feeding (M=4.27, SD=1.05); use of stovers for feeding livestock (M=3.94, SD=0.98); using hoes to weed (M=3.92, SD=3.04); intercropping (M=3.85, SD=1.05); clearing by burning (M=3.67, SD=1.16); using hoes to dig (M=3.60, SD=1.33) and use of own preserved seeds (M=3.28, SD=1.19). These indigenous practices with higher means according to the study are frequently employed by most households in their farming activity perhaps because the practices are easy to carry out and most households have adopted the practices for longer periods of time. According to Lin (2011), indigenous agricultural production practices brings about yield and income stability which are essential for household food security. The practices with lower means like use of oxen to plough

(M=1.27, SD=0.60) use of compost manure (M=2.23, SD=1.55); mulching (M=2.77, SD=1.77) and selection of local breeds (M=2.84, SD=1.19) are indicative of less popular practices perhaps because of adoption of improved technologies like tractor drawn implements such as disc plough which has replaced ox plough due to its speed and performance. In addition, the adoption of local breed selection may have been overtaken by superior breeds with better performance. The standard deviation of majority of the items was relatively high (above 1) which implied the practices were not comparable.

The overall mean for the items was 3.21 which is average on a 1-5 point rating scale. This imply that the practices were averagely used by the households in their farm. However, it is perhaps an indication that the practices were not absolutely applied but households could be applied the blended indigenous and scientific practices. The overall standard deviation is 0.60 indicates that the practices are comparable.

Similarly, extension staff were asked to indicate crop production activities where indigenous knowledge was applied in the farms. Table 26 provides a summary of the results.

Table 26

Crop Production Activities where Households Apply Indigenous Knowledge

Activity	**Frequency**	**Percent**
Planting (broadcasting seeds, use of uncertified seeds, spacing)	2	18.2
Pests and diseases control (ash, magadi, neem leaves-soke)	7	63.6
Land preparation (burning, use of hoes and oxen)	4	36.4
Seed selection (according to size)	2	18.2
Selection of agricultural practices (Crop rotation, shift cultivation, mixed farming)	5	45.6
Weeding (use of hoes, burning)	3	27.3
Weather forecasting (behaviour of certain trees)	2	18.2
Produce storage/preservation (drying, soot, ash, herbs)	3	27.3

(n=11)

The results on Table 26 indicate that indigenous knowledge was majorly used in pest and disease control (63.6%), followed closely by selection of agricultural practices such as crop rotation (45.6%) and land preparation activities (36.4%). Extension staff responses were in agreement with what the study established from the household heads that revealed that pest and disease control was the main area of the application of indigenous knowledge. The results are also consistent with what Ndwandwe (2013) posit regarding the application of indigenous knowledge in pest and disease control in their farms that, smallholder farmers use IK for pest management including use of paraffin, salt solution, aloe and smoke soot.

The study findings further revealed that indigenous knowledge was also applied in other areas of farming activities including weeding, storage and preservation of produce, planting, seed selection and weather forecasting. This agrees with the views by Nnadi et al. (2013) in their study undertaken in Nigeria that, there was an extensive use of indigenous knowledge in areas such as mulching, use of organic manure, sun drying, roasting and frying food, use of sacks, mixture of red pepper and placing under fire. This implied that indigenous knowledge still remains active and in use in agriculture among rural farmers. Similar findings were also established by Abioye et al. (2011) who observed that the application of indigenous agricultural farming has been reflected in the area of methods of maintaining soil fertility, methods of controlling pests and diseases, soil preparation and planting materials, methods of controlling weeds and methods of harvesting and storage. Mugwisi (2016) further established that indigenous knowledge was used extensively in agricultural innovations.

In related findings also, Rankoana (2017) found that, indigenous knowledge practices that farmers use in agriculture involve improvement of soil fertility and structure, maintenance of crops and seed selection and storage for future planting which according to the author could be helpful in the achievement of household food security. Farmers according to WORD (2015) select, collect and grade seeds to ensure quality seeds. Similarly, UNCTAD (2011) enumerates indigenous knowledge practices that enhances sustainable agriculture to include mulching, crop rotation, intercropping, biological pest control measures, integrating livestock into farming systems and water harvesting.

The practices that are based on indigenous knowledge systems emerged over centuries of cultural and biological evolution and represent the accumulated experiences of indigenous farmers which have provided communities with sustainable food resources (Rankoana, 2017). It is perhaps the impressive results of IK coupled with the time tested practices together with its cost effective nature that has made it popular among rural communities in ASAL areas as a solution to perennial food insecurity. Further, based on the findings of this study, it is evident that IK is used across all the food production chain from initial land preparation to harvesting and storage hence an important component of food production and security of households.

4.6.2 Application of indigenous knowledge in livestock production activities

The extension staff were further asked to indicate the livestock activities that households in the study area apply indigenous knowledge. Table 27 summarizes their responses.

Table 27

Livestock Production Activities where Indigenous Knowledge is Applied

Area	Frequency(n=11)	Percentage
Parasites and diseases control (herbs, hand picking)	6	54.4
Breed selection	4	36.4
Housing (cattle shed, use of log hive)	2	18.2
Weather forecasting (behavior of animals, internal organs)	2	18.2
Feeding (free range, tethering)	5	45.6
Storage/preservation of livestock products (drying, salt)	2	18.2

The key activities of livestock keeping where indigenous knowledge was applied according to the study findings include parasite and disease control (54.4%), feeding (45.6%), breed selection (36.4%), weather forecasting, livestock housing and storage and preservation of livestock products (18.2%) each. As in the case with crops, indigenous knowledge was also applied in livestock production and in particular, parasites and diseases control. This implied that, there exist indigenous experts and specialists who are knowledgeable in pests, parasites and disease control in the communities who offer special herbal medicine and in which the communities have trusted. This demonstrates the value and the confidence with which indigenous knowledge is held in the communities under study. Extension staff could tap and document such potential indigenous knowledge based practices and integrate into extension service for dissemination to farming households.

According to Ndwandwe (2013), farmers have mastered a key factor for pest control by using concoctions with sharp odour which have the potential to repel and/or kill pests yet are not poisonous to the farmers themselves. The IK practices according to the author have the potential for informing the green economy that leads to minimal use of the external inputs, an essential component for promoting sustainable development and climate change mitigation. The application of indigenous knowledge practices for controlling pests, diseases and parasites is supported by the findings by Mafongoya and Ajayi (2017) whose findings revealed that communities in hazard prone areas have developed a good understanding and knowledge of disaster prevention and mitigation which is based on facts that are known or learnt from experience or acquired through observation and practice.

Similarly, farmers according to Tweheyo (2018) have failed to adopt modern technologies due to high costs associated with them and increasing levels of poverty. Application of indigenous knowledge is thus considered relatively cheap especially for rural resource poor households. Indigenous knowledge practices according to Ihenacho et al. (2019) are safe and have proved successful for centuries and therefore recommended that they be integrated into the modern practices of agriculture since its benefits are enormous.

4.6.3 Indigenous knowledge based food production strategies and household food security

The second hypothesis stated that indigenous knowledge based food production strategies do not significantly influence household food security. Simple linear regression performed at .05 level of significance was tested where indigenous production strategy index (Table 25) was regressed against food security index (Table 21) and the findings reflected in Table 28.

Table 28

Regressing IK Food Production Strategies on household Food Security

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
Constant	1.517	.318		4.764	.000
Indigenous food production strategies	.169	.098	.159	1.726	.087
$R = .159$, $R^2 = .025$, $F(1, 115) = 2.978$, $p = .087$					

*Significant at alpha α= < 0.05

The results in table 28 indicate a positive relationship (r = .159) existed between indigenous knowledge based food production strategies and household food security. Indigenous knowledge based food production strategies explained 2.5% (R^2 = .025) variation in food security. The influence of indigenous knowledge based food production strategies on household food security was not statistically significant, F (1, 115) = 2.978, p>0.05. The results fail to reject the null hypothesis since the p- value of 0.087 is greater than α=0.05. This implied that indigenous knowledge based production strategies do not influence household food security. The results are therefore in harmony with the second null hypothesis which stated that indigenous knowledge based food production strategies do not significantly influence household food security in Baringo County, Kenya.

The results contradicted findings by Chege et al. (2018) who established that, household heads practicing indigenous knowledge were more food secure adding that, most farmers and local communities used indigenous knowledge to ensure food security in various ecosystems. Similarly, Chirimuuta and Mapolisa (2011) emphasized the need for a paradigm shift in terms of agricultural food security that would emphasize a thrust on the promotion, adoption and utilization of indigenous knowledge and technologies because IK based practices according to the study promote food security. The contradiction of the present study findings with the scholars aforementioned could be attributed to the different geographical locations of the studies which differ in terms of the level of use of IK practices and the level of exposure of modern extension services to the communities as well as the overlap of the effects of the application of both indigenous and scientific knowledge bases in agricultural activities in which case the outcome of influence could not be solely attributed to indigenous knowledge based practice.

4.7 Indigenous Knowledge Based Pest, Parasites and Diseases Control Strategies on Food Security

The third objective of this study sought to establish the influence of indigenous knowledge pest, parasite and disease control coping strategies on household food security. In order to answer adequately the objective and subsequently test the hypothesis, the respondents were asked series of questions.

4.7.1 Use of IK based strategies by households to control pests, parasites and diseases

Household heads were asked to state whether they used indigenous knowledge strategies to control pests, parasites and diseases in their farms. The results are summarized in Table 29.

Table 29

Use of Indigenous Strategies by HH to control Pests, Parasites and Diseases

Response	Frequency	Percent
Yes	101	87.8
No	14	12.2

Majority (87.8%) of the households according to the study findings indicated that they used indigenous knowledge strategies for controlling pests, parasites and diseases with only (12.2%) being of the contrary opinion. This implied that the community trusted the indigenous knowledge practices especially with regard to control of pests, parasites and diseases and perhaps that have over time proved the practices to be working well. Farmers use indigenous homemade solutions because they are cost effective, innovative and effective approaches in controlling pests, parasites and diseases in the farm (Siambombe et al., 2018; Tweheyo, 2018; WORD, 2015).

4.7.2 Common crop pests and IK based control strategies

Household heads and extension staff were asked to name the common pests affecting crops in their farms. Data from the extension staff was necessary to ascertain the common pests in the study area. The results are presented in Table 30.

Table 30

Crop Pests in Household Farms

Pest	Household heads (n = 117)		Extension staff(n = 11)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Worms (cut, army)	60	51.3	10	91.0
Aphids	63	53.9	7	63.6
Flies	18	15.4	5	45.5
Weevil	31	26.5	2	18.2
Birds	18	15.4	1	9.1
Rodents	39	33.3	2	18.2
Mite	17	14.5	6	54.5
Trips	31	26.5	2	18.2
Game animals	11	9.4	-	-
Stalk borer	38	32.5	2	18.2
Locust	8	6.8	-	-
Ants	3	2.6	2	18.2
Termites	16	13.7	-	-
Grain borer	3	2.6	-	-
Spider	4	3.4	2	18.2
Stem borer	5	4.3	-	-

Results from household heads (Table 30) reveal that, the common crop pests in the household's farms in order of prevalence were: Aphids (53.9%), worms (51.3%), Rodents (33.3%), stalk borers (32.5%), weevils (26.5%), trips (26.5), birds (15.4%), flies (15.4%), mites (14.5%), termites (13.7%) and wild animals (9.4%). Other pests include locusts, stem borers, spiders, ants, and other insects like grain borers. Similarly, extension officers were also in agreement with the household heads findings on the prevalence of worms, aphids, flies and mites as major pests in the farmers' farms. Table 30 also revealed that some pests were known to the farmers but unknown to extension staff like the game animals, locusts, termites, grain borers and stem borers.

Findings by UNCCD (2005) indicated that aphids, stem borers of cereals, birds, and rats were important pests in crop production areas. There is therefore consistency of the findings from this study with what other scholars in other parts of the world have established. The implication of the presence of pests in the farms is the negative impact on the quantity and quality of food crops as the yields of crops will decline and the quality of produce lowered. As a consequence of decreased yields due to pest attack, household food availability will be reduced which may further lead to household food insecurity. Similarly, reduced crop quality implies reduced market prices of such commodities which further lowers income levels thus affecting negatively on food access by households.

Household heads and extension staff were asked to name indigenous knowledge based strategies applied for controlling crop pests. Data from the extension staff was necessary to ascertain the results from the household heads. The results are reflected in Table 31.

Table 31

Indigenous Knowledge Based Strategies used to Control Crop Pests

Strategy	Household heads (n = 117)		Extension Officers (n = 11)	
	Frequency	Percentage	Frequency	Percentage
Ash	37	31.6	7	63.6
Tobacco	29	24.8	4	36.4
Herbs	11	9.4	3	27.3
Early Planting	6	5.1	-	-
Pepper	12	10.3	2	18.2
Crop rotation	10	8.5	1	9.1
Fallow cultivation	6	5.1	-	-
Predators	4	3.4	2	18.2
Pyrethrum waste/dust	4	3.4	-	-
Scarecrow	7	6.0	-	-
Trapping	18	15.4	1	9.1
Drying	7	6.0	-	-
Detergent (soap, omo)	4	3.4	-	-
Soil	5	4.3	2	18.2
Killing	7	6.0	1	9.1
Soot/Smoking	4	3.4	1	9.1
Aloe vera	4	3.4	-	-
Neem	-	-	1	9.1

The results in Table 31 reveals that the popular indigenous knowledge based strategies for controlling crop pests according to household heads include use of Ash (31.6%), use of Tobacco (24.8%), Trapping (15.4%), use of pepper (10.3%) and use of herbs (9.4%). Similarly, extension staff indicated the use of Ash (63.6%), Tobacco (36.4%), use of herbs

(27.3%), use of pepper solution (18.3%), use of predators and soil (18.2%) each. The implication is that farmers in the study site have wide spread use of indigenous practices at their disposal to control pests in their farms. The study established that pepper, ash, tobacco, aloe vera and concoctions from mixture of herbs repelled crop pests like aphids, thrips, weevils and fowl army worms. In addition, detergents like omo and application of soil controlled fowl army worm and stalk borer. Similarly, soot/smoke controlled weevils while birds were trapped and scared away using scare crows.

Ndwandwe (2013) in his study on the contribution of indigenous knowledge practices to household food production and security in South Africa indicated that small holder farmers have mastered use of IK for pest management where they use anything with sharp smell or with the ability to repel or kill pests. Siambombe et al. (2018) revealed that farmers use indigenous homemade solutions such as ash, urine, acacia leaves and chilli peppers to control pests in the farms. Tweheyo (2018) and WORD (2015) observed that indigenous strategies for controlling pests were cheap and effective. Farmers according to these findings are intelligent enough in establishing what works in their farms as far as pest control is concerned and they keep on perfecting their farm trials with time. In so doing, farmers strive to achieve their household food security using indigenous means.

4.7.3 Crop diseases and IK control strategies

Household heads and extension staff were also asked to state the common crop diseases. The results presented in Table 32.

Table 32

Common Crop Diseases According to Household heads and Extension staff

Disease	Household heads (n = 117)		Extension staff (n = 11)	
	Frequency	Percentage	Frequency	Percentage
Blight	41	35.0	6	54.5
Head smut	29	24.8	4	36.4
Chlorosis	23	19.7	1	9.1
Wilt	21	17.9	2	18.2
Rust	20	17.1	-	-
MNLD	19	16.2	2	18.2
Leaf spot	14	12.0	-	-
Anthracrose	11	9.4	1	9.1
Maize streak	10	8.5	-	-
Powdery mildew	5	4.3	3	27.3
Coffeeberry (CBD)	4	3.4	4	36.4
Cassava mosaic	3	2.6	-	-
Damping head	3	2.6	-	-
Greening (oranges)	-	-	2	18.2
Cyst nematodes (potatoes)	-	-	1	9.1
Leaf rust	-	-	3	27.3

The diseases noted by the house hold heads (Table 32) include: Blight (35.0%), head smut (24.8%), Chlorosis (19.7%), wilt (17.9%), leaf rust (17.1%), Maize Lethal Necrotic Disease (MLND) (16.2%), Leaf spot (12.0%), Anthracnose (9.4%) and maize streak virus (8.5%). Other diseases include powdery mildew, coffee berry disease, cassava mosaic and damping head disease.

Extension staff shared similar opinions with the household heads as far as diseases observed in farms were concerned. It was evident from the findings of the study that, blight and head smut were very common crop diseases in the study site. Other diseases however varied in their prevalence. The implication of the results of this study is that the prevalence of crop diseases varies according to the geographical location where respondents were located and the type of enterprise undertaken. For instance, Coffee Berry Disease (CBD) was common among farmers in the coffee growing region while maize growing farmers reported Maize Lethal Necrotic Disease (MLND) as common disease. Similarly, some diseases were unknown to farmers like greening, cyst nematodes and leaf rust yet extension staff had knowledge on the diseases.

The common diseases in the farms according to the UNCCD (2005) are both fungal and viral infestations which are similar to the findings in this study. Farmers have mastered the relationship between the incidence of pests and diseases and the breeding cycles in relation to the prevailing weather and seasons (UNCCD, 2005). This is a revelation of the evidence on the challenges that farmers face in the crop farms as far as diseases are concerned. As James et al. (2010) argue, pests and diseases are among the critical challenges in production systems as they cause significant losses. Pests and diseases cause food losses by lowering yields and quality of crop produce which further decrease food availability and access at household levels consequently leading to household food insecurity. Reduction of food losses according to Aulakh and Regmi (2013) is a critical component of ensuring food security.

The control strategies for crop diseases was sought from both household heads and extension staff. The results are summarized in Table 33.

Table 33

Indigenous Strategies for Controlling Crop Diseases

Strategy	Household heads (n = 117)		Extension Officers (n = 11)	
	Frequency	Percentage	Frequency	Percentage
Uprooting	23	19.7	3	27.3
Ash	20	17.1	3	27.3
Crop rotation	18	15.4	3	27.1
Burning	15	12.8	2	18.2
Herbs	9	7.7	3	27.3
Tobacco	9	7.7	1	9.1
Detergents (soap, omo)	5	4.3	-	-
Guard rows	3	2.6	-	-
Plant resistant crop varieties	2	1.7	1	9.1
Spacing	2	1.7	-	-
Soot/smoke	-	-	1	9.1
Pepper	-	-	2	18.2
Diversification	-	-	1	9.1
Fallow cultivation	-	-	1	9.1

The findings in Table 33 indicate that the prevalent IK strategies for controlling crop diseases according to household heads are uprooting (19.7%), use of ash (17.1%), crop rotation (15.4%) and burning (12.8%), use of herbs (7.7%) and use of tobacco (7.7%). Similar results were also cited by the extension staff. Most of the practices for controlling crop diseases were also used to control crop pests. For instance the study established that ash and use of soot/smoke controlled mainly storage pests particularly weevils while at the same time reducing high moisture content thus controlling rotting that is responsible for increased afflotoxin levels in the stored produce. Similarly, the study found that fallowing and uprooting were used as a strategy for minimizing problematic pests and diseases like nematodes in potatoes and head smut among maize farmers. Tobacco, detergent and pepper solutions according to the study were effective in their repellant characteristics especially for controlling Fowl army worm and other disease causing organisms. Ash was also spread around the coffee trees to reduce the damage from Coffee Berry Disease. The study however did not attempt to investigate the chemical content of the solutions and their effectiveness in the control of the diseases. The strategies according to the study had multiple function of controlling both crop pests and diseases and their continuous use in both cases is an evidence of its effectiveness in the control of both cases.

4.7.4 Livestock parasites in farms

Household heads and extension staff were asked to name the livestock parasites that were common in farmers' farms. The results are presented on Table 34.

Table 34

Common Livestock Parasites According to Household heads and Extension Staff

Parasite	Household heads (n = 117)		Extension staff (n=11)	
	Frequency	Percentage	Frequency	Percentage
Tick	81	69.2	10	90.1
Worm	40	34.2	5	45.5
Fleas	31	26.5	4	36.4
Tsetse fly	30	25.6	-	-
Lice	25	21.4	1	9.1
Liver fluke	17	14.5	-	-
Mites	12	10.3	1	9.1
Leaches	4	3.4	1	9.1
Predators	3	2.6	1	9.1

Table 34 indicates that, the most prevalent livestock parasites according to both household heads and extension staff were ticks (69.2% & 90.1%), Worms (34.2% & 45.5%), Fleas (26.5% & 36.4%) respectively. Other significant pests according to the household heads include tsetse flies (25.6%), lice (21.4%) and mites (10.3 %). There is consistency with the data from both the household heads and extension staff as far as common livestock parasites are concerned. The parasites according to the study lowers the quantity and quality of livestock products that in turn lead to household food insecurity. Parasites further transmit livestock diseases that could lead to death of the productive livestock as well as increasing cost of rearing livestock through the control measures against the parasites. FAO (2013) indicated that pests, parasites and diseases were the leading causes of food insecurity.

Household heads and extension staff were further asked to state the IK based strategies for controlling livestock parasites. The results are summarized in Table 35.

Table 35

Indigenous Knowledge Based Livestock Parasites Control Strategies

Strategy	Household heads (n = 117)		Extension staff(n = 11)	
	Frequency	Percentage	Frequency	Percentage
Herbs	25	21.4	6	54.6
Burning	15	12.8	1	9.1
Picking	12	10.3	4	36.4
Predators	7	6.0	-	-
Paraffin	3	2.6	-	-
Soil	3	2.6	-	-
Tobacco	3	2.6	1	9.1
Ash	3	2.6	1	9.1
Detergents (Omo/Soap)	3	2.6	-	-
Magadi	2	1.7	-	-
Maintaining hygiene in sheds	2	1.7	1	9.1
Drugs	-	-	1	9.1
Pepper	-	-	1	9.1
Rotational grazing	-	-	1	9.1

Two major strategies used to control livestock parasites according to both household heads and extension staff (Table 35) include the use of herbs (21.4%) and (54.6%) and hand picking of parasites (10.2%) and (36.4%) respectively. Other important strategies were burning and use of predators. Use of paraffin, soil, tobacco, pepper and detergents like Omo was found to have significant use in the control of parasites like ticks and mites. Concoctions from a variety of herbs and use of *Magadi* solution were found to be useful in controlling internal worms like flukes and tape worms. Smearing of soap directly on a parasite like ticks were also found to be useful in its control. Households also picked and burned external parasites like ticks to control them. The study therefore indicated that households applied a combination of strategies to control parasites in their farms. These resulted from trials of various methods to determine their effectiveness followed by adoption of the strategy based on its effectiveness.

The household heads and extension staff were also asked to state diseases that attack livestock in the farms. The results are summarized in Table 36.

Table 36

Livestock Diseases in the Farms

Livestock Diseases	Household heads (n = 117)		Extension Officers (n = 11)	
	Frequency	Percentage	Frequency	Percentage
East coast fever (ECF)	51	43.6	6	54.6
Foot and mouth	46	39.3	7	63.6
Anthrax	31	26.5	2	18.2
Lumpy skin	23	19.7	4	36.4
Coccidiosis	17	14.5	1	9.1
New castle	10	8.5	1	18.2
Mastitis	9	7.7	1	9.1
Pneumonia	9	7.7	1	9.1
Brucellosis	8	6.8	-	-
Heart water	7	6.0	-	-
Foot rot	7	6.0	1	9.1
Anaplasmosis	6	5.1	1	9.1
Rift valley fever	6	5.1	1	9.1
Nagana	5	4.3	-	-
Cow blindness	3	2.6	-	-
Diarrhea	3	2.6	-	-
Red water	-	-	1	9.1

Among the prevalent livestock diseases according to both the household heads and extension staff (Table 36) include East Coast Fever (43.6% & 54.6%), Foot and Mouth Disease (39.3% & 63.6%), Anthrax (26.5% & 18.2%) and Lumpy skin disease (19.7% & 36.4%) respectively. Other diseases were Coccidiosis, Newcastle, Mastitis, Pneumonia, Brucellosis, Heart Water, Foot Rot, Anaplasmosis, Rift Valley Fever, Nagana, Cow Blindness, Diarrhea. Both categories of respondents agreed on the prevalent livestock diseases in the study site. This implied that the livestock diseases were equally observed and noted by both households and extension staff. The prevalence of variety of livestock diseases was an indication on the challenges that livestock keeping households face from the effects of the diseases. The diseases according to the study increases cost of production, lowers the quality of livestock products, reduces incomes from livestock sources besides causing losses through deaths thus affecting negatively on household food security. According to Ogega (2017) increased occurrence of diseases raises mortality of livestock and impacts negatively on livelihoods of households. Diseases are the main agents of food losses and are among the critical challenges in the production systems as they cause significant losses (James et al., 2010; Waithaka, 2011).

Livestock disease control strategies were sought from household heads and extension staff. The results are presented in Table 37.

Table 37

Indigenous Knowledge Based Livestock Diseases Control Strategies

Strategy	Household heads (n = 117)		Extension Staff (n = 11)	
	Frequency	Percentage	Frequency	Percentage
Herbs	41	35.0	8	72.7
Quarantine	13	11.1	-	-
Rotational grazing	11	9.4	1	9.1
Routine management	10	8.5	-	-
Maintaining hygiene (clean sheds)	9	7.7	-	-
Magadi	8	6.8	1	9.1
Local brews (Busaa, changaa)	7	6.0	4	36.4
Ash	6	5.1	-	-
Dispose affected animal	-	-	1	9.1

Based on the findings in Table 37, the use of herbs to control livestock diseases was the major indigenous strategy used as indicated by the results of 35.0% and 72.7% by both household heads and extension staff respectively. Use of local brews like '*busaa*' made from soaked mixture of fermented maize and millet flour was cited popularly (36.4%) among extension staff as another important indigenous strategy for controlling livestock diseases. For instance, Busaa was cited as an effective strategy for controlling Foot and Mouth Diseases. Concoctions from Aloe Vera and Neem tree according to the study were effective in controlling ECF. Quarantine was applied when there was occurrence of strange and deadly diseases like Foot and Mouth and Anthrax. Rotational grazing and routine management practices were used to control diseases like ECF which is transmitted by vectors like ticks. Use of *Magadi and Ash* were also cited as strategies for controlling livestock diseases like Diarrohea, New Castle and Coccidiosis. Mafongoya and Ajayi (2017) observed that communities in hazard prone areas had developed a good understanding and knowledge of their environment based on facts that were known or learnt from experience or acquired through observation and practice. Communities were therefore in constant experimentations and trials on indigenous strategies for controlling diseases in their farms and over time, the results of their trials and observations enabled them to adopt effective strategies to mitigate against dangers related to diseases affecting their livestock.

Observation guide also collected data on the visible indigenous knowledge based coping strategies found in the households farms. The summary of the results are presented on Table 38.

Table 38

Observed Indigenous Knowledge based Crops Pests, Parasites and Diseases Control Strategies

Strategy	Frequency (n=19)	Percentage
Herbs	6	31.6
Tobacco	6	31.6
Pepper	3	15.8
Ash	3	15.8
Early planting	1	5.3
Burning	3	15.8
Crop rotation	5	26.3
Sun drying	6	31.6
Trapping	3	15.8

The results in Table 38 reveals the use of herbs (31.6%), tobacco solutions (31.6%), sun drying (31.6%) and crop rotation (26.3%) as the major indigenous knowledge based coping strategies for controlling pests, parasites and diseases among most households. The implications are that the practices were effective in the control of the same. Other strategies include; use of pepper solution (15.8%), use of ash solution (15.8%), burning (15.8%), Trapping (15.8%) and early planting (5.3%). Some of the practices were cultural methods such as crop rotation and early planting which required the households to cultivate the practices of mastering the breeding cycle of the pests and diseases so as to apply strategies that would effectively control them.

4.7.5 Indigenous knowledge based pest, parasites and disease control strategies index

A range of strategies were given to respondents in the households' category to indicate whether they applied the strategies in their farms to control pests and diseases. The mean and standard deviations for each strategy was obtained together with the overall mean and standard deviation. A mean of 3.0 and above on the individual item indicated that the strategy was commonly adopted while means of below 3.0 meant that the practices were either not applied or least applied by the respondents. The overall index was used to generalize the results on whether the overall items were applied. An overall index of above 3.0 was an indication that the practices used were generally indigenous strategies to control pests and diseases while an index below3.0 implied that the practices were least used or not used at all. The results of the study are summarized in Table 39.

Table 39

Indigenous Knowledge Based Pest, Parasites and Disease Control Strategies Index

Strategy	n	Mean	SD
Clear land using the slash and burn	116	3.52	1.26
Seed selection (clean seeds)	117	3.65	1.08
Early planting	117	4.13	0.91
Growing nitrogen fixing trees to enrich soil fertility	117	2.67	1.48
Erecting structures in farms for perching birds which prey on pests	116	3.06	4.02
Traditional repellants	114	2.70	1.39
Ash to preserve crop produce	115	3.24	1.25
Herbs	115	3.03	1.37
Concoctions to treating animals (pepper, local brews/ *busaa*)	115	2.94	1.24
IK pests, parasites and diseases control coping strategies index	**117**	**3.18**	**0.79**

The findings from Table 39 indicate that practices like early planting (M=4.13), use of clean seeds (M=3.65), clearing land by slash and burn (M=3.52), use of ash to preserve produce (M=3.24), erecting structures in the farms for perching birds to prey on pests (M=3.06) and use of herbs (M=3.03) had means of above 3.00 implying that they were commonly used indigenous knowledge based strategies for controlling pests, parasites and diseases by households in their farms. The overall mean for the strategies was 3.18 suggesting that the practices were generally used by majority of households to cope with pests, parasites and diseases. The overall standard deviation was also low (0.79) meaning the variation in the use of the practices was not wide generally hence the practices were comparable among the households. Households therefore applied IK practices perhaps because of what Salami (2020) observed that IK practices help to reduce incidences of pests and diseases in the farm.

4.7.6 Indigenous knowledge based pest, parasites and diseases coping strategies

Simple linear regression was performed to establish whether indigenous knowledge based pest, parasites and diseases coping strategies influenced food security. The PPDCSI (Table 39) was regressed on FSI (Table 21). The results of the regression test are summarized in Table 40.

Table 40

Regression Results on IK Pests/Parasites & Diseases Control Strategies on Food Security

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**p-value**
	B	**Std. Error**	**Beta**		
Constant	1.619	.245		6.605	.000
Indigenous pests, parasites and diseases control strategies	.138	.075	.169	1.839	.068
R = .169, R^2 = .029 , F(1, 115) = 3.384, p = .068					

*Significant at alpha α= < 0.05

The relationship (r = .169) between indigenous knowledge pests, parasites and diseases control strategies and food security of households was positive. It explained 2.9% (R^2 = .029) variation in food security. The influence of indigenous knowledge based pests, parasites and diseases control strategies on food security was however, not statistically significant, F (1, 115) = 3.384, p >0.05. The results therefore fail to reject the third null hypothesis because the p- value of 0.068 is higher than α=0.05 thus confirming the third hypothesis that indigenous knowledge based pests, parasites and diseases control strategies do not significantly influence household food security. This contradict findings from a study by Salami (2020) on the role of indigenous knowledge in sustainable urban agriculture and urban food security in Minna, Nigeria who established that indigenous knowledge is significant in the reduction of pests and diseases in the farm and that hence IK has bearing on household food security. Tweheyo (2018) further observed that indigenous knowledge would offer cost effective solutions for achieving food security. This could be explaining why households continue with the IK practices despite results showing no significant influence on household food security.

4.8 Indigenous Knowledge Based Preservation and Storage Strategies on Food Security

Objective four sought to establish the influence of the indigenous knowledge based preservation and storage strategies on household food security. This involved examining crop and animal related food stuff of the households, storage facilities and preservation strategies. How frequently the indigenous knowledge based preservation and storage strategies were practiced was also established. The influence of indigenous knowledge based preservation and storage strategies on household food security was then determined using simple linear regression where indigenous preservation and storage strategy index (PSSI) was regressed against FSI.

4.8.1 Food stuff preserved and stored

The household heads were asked to indicate crops and animal related food stuff that they preserved and stored**.** The Results are summarized in Table 41.

Table 41

Crop Food Stuff Preserved and Stored by Household

Foodstuff	Frequency(n=117)	Percentage
Maize	99	84.6
Millet	70	59.8
Sorghum	31	26.5
Cow peas	20	17.1
Green gram	13	11.1
Vegetables	3	2.6
Beans	86	73.5
Ground nuts	4	3.4

The study findings in Table 41 revealed that the major food stuffs preserved in order of priority were maize (84.6%), beans (73.5%), millet (59.8%), sorghum (26.5%), cow peas (17.1%) and green grams (11.1%). Other food stuffs like groundnuts and vegetables were however reported to be part of the preserved foods though not significant as others. The four food stuffs: maize, beans, millet and sorghum according to the researcher were food security food stuffs and therefore majority of the households seemed to plan well to ensure that food for the households were sufficient all the time. The findings provide evidence that indigenous knowledge was widely used to store and preserve food at household level to ensure food availability and access at all time for healthy life thus ensuring sustainable food security. The study findings agree with views by Asogwa et al. (2017) who opined that, advancing and applying indigenous knowledge on food processing, preservation and storage could address the problem of inadequate food for a healthy and active life. The author further indicated that high post-harvest food losses, arising largely from limited food preservation capacity was a major factor constraining food and nutrition security. Further, Kamwendo and Kamwendo (2014) argue that indigenous food preservation and food storage strategies played a critical role in contributing to household food security.

Indigenous knowledge technologies and know-how according to Tweheyo (2018) and Tanyanyiwa and Chikwamba, (2011) have an advantage over science in that they rely on locally available skills and materials that are cost effective compared to exotic technologies from outside sources and therefore these indigenous practices could provide sustainable solutions for achieving food security. The community according to the study findings seemed to value their indigenous knowledge practices for storage and preservation of household food and have proved more effective over time than the modern technologies. In addition, indigenous storage strategies are simple, low cost and effective hence preferred by most households who are faced with challenges of poverty. Since Africa is blessed with various types of food produce and also possesses diverse indigenous knowledge systems for their preservation and storage (Asogwa et al., 2017), using IK in solving food shortage therefore remains a powerful means of sustaining household food security.

Similarly, household heads were asked to list livestock related food stuffs which they preserve and store. The findings are presented in Table 42.

Table 42

Livestock Related Food Stuff Stored and Preserved by Household

Foodstuff	Frequency (n=117)	Percentage
Meat	97	82.9
Fat	33	28.2
Milk	85	72.6
Honey	28	23.9
Eggs	19	16.2

The findings (Table 42) revealed that meat was the major (82.9%) livestock food stored and preserved followed by milk (72.6%), fat (28.2%), honey (23.9%) and eggs (16.2%). The livestock food stuffs also served as food security foods. Storage and preservation of the food stuffs therefore ensured that there was a continuous supply of food to household throughout the year hence enhancing household food security. Indigenous knowledge methods of food preservation such as sun drying, fermentation, germination and soaking are time tested and have been used by locals over generations to preserve their produce after harvest thereby serving as a survival strategy against food insecurity (Asogwa et al., 2017).

In related findings, Tweheyo (2018) cited smoking as one of the trusted traditional methods of preserving food in most communities in Africa adding that local people have precise knowledge of smoking food items such as meat, fish, maize, and cassava among others. According to the author, smoking meat is performed as a means of preserving it as smoke itself according to the respondents acts as an acidic coating on the surface of meat which prevent the growth of bacteria. Moreover, Ihenacho et al. (2019) reported other indigenous knowledge strategies for preserving and storage of food to include hanging maize, sorghum and millet cobs from the hut roof and sometimes seeds are mixed with the ash of *Aloe* and stored into clay-pots and baskets which enable the seeds to last for more than five seasons. The indigenous practices on preservation and storage enable households to increase the shelf life of food stuffs which ensures continuous supply and availability of food throughout the year hence improving household food security.

4.8.2 Indigenous preservation strategies and storage facilities

Data on preservation strategies and storage facilities were collected using the household heads and extension staff questionnaires and through observation guide. The observation guide was used to observe visible structures for food storage and preservation. This was necessary to ascertain whether the data from each category of the instrument was in harmony in order to generalize the results of the findings. The results generated by the three instruments on preservation strategies are summarized on Table 43.

Table 43

Indigenous Knowledge Based Food Preservation Strategies

Preservation	Households n = 117		Extension Officers = 11		Observation n = 19	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Smoking	115	98.3	9	81.8	12	63.2
Sun drying	117	100.0	11	100.0	15	78.9
Use of Honey	67	57.3	2	18.2	-	-
Salting	116	99.1	4	36.4	13	68.4
Fermenting	98	83.8	2	18.2	4	21.1
Roasting	114	97.4	2	18.2	6	31.6
Frying	112	95.7	-	-	2	10.5
Use of Pepper	113	96.6	-	-	2	10.5
Cold places	-	-	2	18.2	2	10.5
Boiling	78	66.7	-	-	5	26.3
Use of Ash	115	98.3	4	36.4	10	52.6

The findings revealed that households employed a variety of indigenous storage/preservation strategies to ensure food security at household level. Sun drying (100.0%) for household heads and extension staff and (78.9%) in the observation checklist suggested that the strategy was commonly used for food preservation and could be an effective strategy among the community members. Salting (99.1%), smoking and use of ash (98.3%) each, roasting (97.4%) use of pepper (96.6%) and frying (95.7%) among the household heads were also cited as key strategies for food preservation which is also in agreement with the data from extension staff and observation checklist.

The findings support Asogwa and Kaya (2016) and Asogwa et al. (2017) assertions that Africa possess diverse indigenous knowledge systems for preservation and storage of food which if utilized would solve food shortage and remain a powerful means of sustaining household food security. The authors further observe that, acknowledging and applying indigenous knowledge, skills and practices in food processing, preservation and storage could address problems associated with post-harvest losses and improving household food security.

Ponge (2013) also established that resilience was found on indigenous agricultural systems while Umar and Musa (2015) established that indigenous knowledge practices were found to work out well for communities. The use of variety of IK practices for preservation and storage of food demonstrates that rural communities strive to improve their household food security by employing indigenous strategies that increase the shelf life of food. In addition, the indigenous practices are cost effective as they are cheap and easy to apply, requires fairly simple skills and procedure and are environment and human friendly. Households according to the study findings are innovative with variety of workable food preservation and storage strategies at their disposal to achieve better results of sustaining household food security.

Data was also collected from the household heads, extension staff and observation guide on the storage facilities that households used. Table 44 presents a summary of the results.

Table 44

Food Storage Facilities

Storage	**Households n = 117**		**Extension staff n = 11**		**Observation n = 19**	
	Freq	**Percentage**	**Freq**	**Percentage**	**Freq**	**Percentage**
Gunny bags	69	59.0	6	54.5	9	47.4
Granary	81	69.2	4	36.4	14	73.7
Traditional containers (calabash, gourds, skin bags)	15	12.8	9	81.8	17	89.5
Improvised metallic/plastic containers	11	9.4	3	27.3	-	-
Traditional store with crib	-	-	5	45.5	3	15.8
Modern store	8	6.8	2	18.2	-	-

Traditional granaries, gunny bags and traditional containers ranks among the most prevalent storage facilities for storing food stuffs. The practices were aimed at increasing the shelf life of the food stuffs to ensure food availability to households when needed and hopes to ensure food security of households. Indigenous people according to the results on Table 44 are conscious of enhancing future food security obligation through variety of effective storage facilities. This has implication on availability and access to food for household consumption. According to Rankoana (2017), asserts that local community members sustain their future household food security by using indigenous knowledge storage means.

The use of indigenous storage strategies could provide solution to the perennial food insecurity by increasing the availability of the main staple foods which according to Muriuki et al. (2016) has been plagued by post-harvest losses leading to frequent food shortages. The source further recommends the use of strategies that are cheap and harmless for humans and environment for controlling pests including storage pests which according to this study fits indigenous knowledge practices. Farmers according to the findings of this study can be a source of the agricultural information as far as storage of food is concerned which can supplement modern knowledge base to enhance food security at household level. Farmers use indigenous knowledge at their disposal to innovate strategies that are useful for storing food for future supply and they keep on improving these practices through on farm trials and experimentation. Swiderka et al. (2016) argue for greater support for indigenous peoples' innovations and practices to ensure such knowledge is not lost.

4.8.3 Indigenous food storage and preservation strategies index

In order to develop the storage and preservation strategy index that would be useful to perform regression test with food security index, household heads were provided with a variety of indigenous food storage and preservation items to indicate which practice they apply within their households. The mean for each of the practice was calculated together with the standard deviation for each item. The overall mean was also worked out which represented the indigenous knowledge based storage and preservation strategies index (PSSI). The mean for the standard deviation was also worked out. The results are presented on Table 45.

Table 45

Indigenous Knowledge Based Food Storage/Preservation Strategies Index

Strategy	(n=117)	Mean	SD
Sun drying	116	4.16	1.06
Salting	116	2.76	1.12
Fermentation	115	2.53	1.23
Sugaring	114	1.54	1.02
Burying in moist soil	116	2.17	1.43
Use of ash	114	3.19	1.25
Mixing with pepper	112	2.48	1.40
Smoking/Placing near fire place	115	3.63	1.10
Use of granaries	117	3.98	1.31
Traditional containers	117	2.49	1.14
Roasting	117	2.69	1.29
Frying	114	2.81	1.37
Indigenous knowledge storage/preservation index	117	**2.83**	**0.73**

Table 45 reveals that the popular methods of food storage and preservation used by most households according to the mean values are Sun drying (4.16), use of granaries (3.98), Smoking (3.63) and use of ash (3.19). The individual means of these storage and preservation strategies were above 3.0 implying that they were employed by majority of households to preserve food. However, the average indigenous storage/preservation index (PSSI) was 2.83 which was below the mid-point 3.0 implying that the practices were not widely used for storage and preservation and could suggest use of other alternative scientific methods. The implication could be suggesting a blend of both indigenous and scientific storage and preservation strategies whose outcome could not be attributed to indigenous means alone. Households could perhaps be blending both indigenous and scientific storage /preservation strategies because a combination of both strategies yielded better results as they each play a complementary role.

4.8.4 Indigenous knowledge based preservation and storage coping strategies

In order to establish whether indigenous knowledge based preservation and storage coping strategies influenced household food security, a linear regression test was performed where by PSSI (Table 45) was regressed against FSI (Table 21). The results are presented in Table 46.

Table 46

Regressing IK Based Preservation and Storage Coping Strategies on Household Food Security

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**p-value**
	B	**Std. Error**	**Beta**		
Constant	1.374	.228		6.015	.000
Indigenous food preservation and storage strategies	.242	.078	.277	3.089	.003
R = .277, R^2 = .077 , F(1, 115) = 9.543, p = .003					

*Significant at alpha α= < 0.05

The relationship (r = .277) of indigenous knowledge based storage and preservation strategies on household food security was positive. Indigenous knowledge based storage and preservation strategies explained 7.7% (R^2 = .077) variation in food security. Further, the influence of the explanatory variable on food security was statistically significant, F (1, 115) = 9.543, p = .003. The null hypothesis four was therefore rejected because the p-value is less than α= 0.05. The alternative hypothesis was accepted implying that indigenous knowledge based storage and preservation coping strategies influence household food security.

These findings are consistent with the assertion by Tweheyo (2018) that, local people have precise knowledge of storing and preserving food items both from crops and livestock sources. Similarly, Salami (2020) further indicated that indigenous storage systems were resilient and effective hence essential for food security. In addition, Concern Worldwide (2020) indicated that, incorporating indigenous storage strategies help preserve micronutrients and prolongs shelf life of food. Asogwa et al. (2015) further established that, indigenous agricultural knowledge is of immense value in improving food storage and preservation and therefore recommended the recognition, promotion and utilization of IK skills and practices in food processing, preservation and storage as it would help to arrest the high post-harvest losses and promote food security. Tweheyo (2018) observed that indigenous storage structures can store food for quite long thus guaranteed household food security because traditional granaries are constructed at a raised level to allow air flow and smeared with cow dung to prevent grains from being attacked by weevils and pests. Besides, the author further argue that harvested grains are first sun dried to reduce moisture content before putting them in the granary. This demonstrates that indigenous storage and preservation strategies work out well among communities to sustainably maintain household food security. It therefore implies that indigenous communities have mastered storage and preservation strategies that have over the time been proved effective in the preservation and storage of food stuffs for households use.

Kamwendo and Kamwendo (2014) and Mugwisi (2016) described indigenous knowledge in relation to food security as knowledge about food preservation, processing and storage techniques. It is evident from the author's description that rural communities develop strategies that are geared towards the achievement of their household food security and which enable them survive disasters through effective food preservation and storage strategies. Siambombe et al. (2018) and Magni (2016) argue that local people resort to strategies that work best to make them survive disasters for example by modifying agricultural practices to reduce damage to crops from harm. Others use homemade solutions such as ash water, urine, acacia leaves and chili peppers to control storage pests and diseases (Siambombe et al., 2018).

The vital role of indigenous knowledge in storage and preservation cannot therefore be overemphasized as far as household food security is concerned. The aim of any agricultural programme is to improve processing, storage and preservation to retain nutritional value, shelf life and food safety, to reduce seasonality of food insecurity and post-harvest losses and to make healthy foods convenient to prepare (MOAIWD, 2016). Asogwa et al. (2017) suggested the recognition, promotion, and utilization of African indigenous knowledge, skills and practices across food security value chain as one way of arresting huge losses and improving food security. United Nations Convention to Combat Desertification (UNCCD, 2005) further argued that traditional technologies are dynamic and have built in mechanisms for innovation and growth of new dimensions according to changing challenges and circumstance.

Indigenous people are well informed about their own situations, their resources, what works and what does not work hence their approaches are time tested as far as technology, know-how and practices on adaptation, transfer and extension are concerned (UNCCD, 2005). Findings from WORD (2015) established that food scarcity and nutritional deficiencies persists for almost six months in a year due to loss of indigenous knowledge system. The present study findings therefore demonstrate that utilization of indigenous knowledge in food storage and preservation could reduce the food insecurity at household level.

Food losses and wastage emanating from poor storage and preservation techniques hinders the achievement of food and nutrition security by undermining attainment of availability, access, utilization and stability which are the critical elements of food security (Berjan et al., 2018). Melchias (2001) concluded that indigenous knowledge refer to what indigenous people know and do and what they have known and done for generations – practices that evolved through trial and error and proved flexible enough to cope with change. It is thus important to acknowledge that indigenous knowledge and innovations are core competencies of rural farmers and any planned interventions ought to build on farmers' experiences and knowledge for better results (Tweheyo, 2018). Indigenous knowledge based strategies for preservation and storage work to sustain household food security and impressing the practices is significant to rural societies.

4.9 Integration of Indigenous Knowledge Based Strategies into Agricultural Extension

Objective five of this study sought to establish the extent to which indigenous knowledge based strategies were integrated into agricultural extension services. Agricultural practices that reflected a blend of both indigenous and scientific based strategies were examined and related to integration into agricultural extension. Extension staff were asked to indicate the type of knowledge that they imparted to farming household. The results are presented in Table 47.

Table 47

Type of Knowledge Disseminated to Farming Households by Extension Staff

Knowledge disseminated	Frequency	Percent
Modern	9	81.8
Indigenous	2	18.2
Total	**11**	**100.0**

(n=11)

Majority (81.8%) of the extension staff disseminate modern knowledge to farming households while minority (18.2%) offered indigenous knowledge. It is however significant to note that both knowledge bases are disseminated to farming households by extension staff. Despite the low number of those of the contrary opinion, indigenous knowledge base is still a valued knowledge, recognized by extension staff as critical to the success of the agricultural activities which contradicts the assertions by Naanyu (2013) that Indigenous knowledge is undervalued and considered as less progressive by the modern societies. The results (Table 47) therefore supports the argument by Ponge (2013) who indicated that, it is justifiable to integrate both indigenous and scientific knowledge systems for effective output and eventual sustainability.

When extension staff were asked to indicate the type of knowledge that household heads applied in their farms (Table 6), the results indicated that a sizeable percentage (45.5%) used modern knowledge, (27.3%) employed indigenous knowledge while (27.3%) engaged both indigenous and modern knowledge bases in their farming activities. This according to the study was an indicative of a blend of both knowledge bases by households though informally. Similarly, extension staff seems to have recognized and regarded indigenous knowledge as vital for the success of agricultural activities. The results agree with Ponge (2013) assertion that, local people identify themselves more with new technologies if their knowledge has been integrated into the whole knowledge generating process and their ideas, experiences and creativity have been assimilated in the process. The results also indicated a diversified knowledge use by farming households perhaps because of the net effect in terms of output accruing from the use of both knowledge bases. Further, the results demonstrated the confidence and appreciation of indigenous knowledge in agriculture and dynamism in the use of both indigenous and modern knowledge bases. It is also a reflection of the use of both the bottom up and top down approaches in extension as far as farmer and scientific research based knowledge sharing is concerned.

When households and extension staff were asked to state the type of storage facilities for storing produce (Table 44), Majority (59.0%) of households, (54.5%) of the extension staff and (47.4%) of the observed cases in the checklist respectively indicated the use of gunny bags for storage of farm produce. Similarly, the use of modern stores accounted for 6.8 percent and 18.2 percent of households and extension staff respectively. The implication is that households blend both the indigenous and scientific strategies to store their food stuffs. It is also implied based on the results of this study that extension staff supported the application of both knowledge practices perhaps because it resulted in better yields. Physical observation of storage facilities further demonstrated the improvised use of storage facilities where both indigenous and scientific considerations in terms of construction designs and materials were often integrated.

Among the challenges highlighted by the household heads for integrating indigenous knowledge in extension are among others the negative publicity with which the younger generation and the general society accord indigenous knowledge often regarded as 'backward' practice. Secondly, indigenous knowledge according to the household heads lacked proper documentation to store IK information and avail it for future generation. Thirdly, indigenous knowledge lack the champions to integrate and mainstream IK based practices into the formal extension policy and service delivery.

Focus group discussants indicated that storage structures in the study site blended both knowledge bases to ensure that their storage facility was safe enough to safe guard their food stuffs from damage due to weather conditions and pests, parasites and disease attack. For instance they raised their granaries using stones indigenously designed to prevent ants from destroying the produce in store while the roofing materials were corrugated iron sheets, an indication of blended indigenous and scientific skills leading to improved storage facilities.

The FGD also indicated the need to strengthen extension services by integrating indigenous knowledge to benefit farmers and ensure that the knowledge does not get extinct. The discussants of FGD did indicate the application of both knowledge bases at individual households' farms but lacked documentation to enable the practices to be properly mainstreamed into formal extension services. However indigenous weather forecasters according to the focus group discussants were working in collaboration with the meteorological experts to disseminate weather information jointly to the community. This implied that the value of indigenous knowledge is recognized in the early warning initiatives and weather predictions which significant for food security.

According to the FGD, community in the study site employed knowledge borrowing from both scientific and indigenous bases and integrate into their farming activities. For instance, most farmers combined commercial chemicals and drugs with indigenous concoctions to control pests, parasites and diseases in their farms. Similarly, they combined indigenous and scientific strategies in the storage of their produce. According to the FGD, farmers through experience, have over time known what worked best from both knowledge bases and integration of the two was the alternative strategy to achieve best results.

On the extent to which indigenous knowledge was integrated into agriculture extension services, the staff indicated that, despite the use of IK practices by households, its documentation and mainstreaming into formal extension still lacked behind. One of the strategies for integration was the collaboration of IK and scientific weather forecasters to provide a more reliable information to the farming community.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary of the key findings of the study, conclusions and recommendations. It also presents suggestions for further research.

5.2 Summary

The purpose of this study was to establish the influence of indigenous knowledge based coping strategies on household food security and the extent to which they are integrated into agricultural extension services in Baringo County, Kenya. Qualitative and quantitative data collection and analysis methods were used in the study. Regression test was tested at 0.05 level of significance.

The first objective sought to establish influence of indigenous knowledge based climate change coping strategies on household food security. It was established that households blended both indigenous and scientific knowledge in their farming activities. Indigenous knowledge was applied in weather forecasting, growing crops, water conservation, livestock keeping, pests, parasites and diseases control, and preservation and storage. Extreme temperatures (85.5%), erratic rainfall patterns (85.2%) and drought (81.1%) characterized climate change phenomenon according to the respondents.

With regard to food security, the main sources of food for the households was from their own production. Main food produced were maize, beans and millet while from livestock sources were meat and milk. Households enhanced food security by engaging in diverse enterprises including mixed farming and cropping which improved both food and income sources besides diet diversity. In addition, storage and preservation strategies were diversified and social network systems were used to improve both food and income status of households. Food security index was 2.06 on a 1-5 point rating scale implying that households were food insecure. Hypothesis testing revealed a positive relationship ($r = .0088$) and a statistically insignificant ($p>0.05$) influence of indigenous knowledge based climate change coping strategies on household food security. Results failed to reject the null hypothesis.

The second objective examined the influence of indigenous knowledge based production strategies on household food security. The components of food production examined were land preparation, weeding and pests and disease control. Majority of the households (63.6%) applied indigenous knowledge strategies to control crop pests and disease while 54.4% used it in the control of livestock parasites and diseases. Majority of households also applied IK production strategies in feeding livestock and breed selection were the common indigenous knowledge based strategies applied in livestock. Indigenous knowledge based food production strategy index was 3.21 on a 1-5 point rating scale. The relationship between indigenous knowledge based production strategies and household food security was positive ($r = .159$). The results of the regression test showed that IK based food production strategies had an insignificant influence on food security ($p > 0.05$). The results failed to reject the null hypothesis.

The third objective sought to find out whether indigenous knowledge based pest, parasites and disease control strategies significantly influenced household food security. The main crop pests were Aphids (53.9%), army and cut worms (51.3%). The results indicated that Ash (31.6%) and Tobacco solution (24.8%) were the most common IK based strategies for controlling crop pests. The results also indicated that ticks (69.2%) and worms (34.2%) were the most common livestock parasites. These were controlled using herbs (54.6%) and picking (36.4%). The results further indicated that blight (35.0%) head smut (24.8%) were the main crop diseases. The IK strategies used to control crop diseases were uprooting and use of ash.

East Coast Fever (43.6%), Foot and Mouth disease (39.3%) and Anthrax (26.5%) were the common livestock diseases. These were controlled using herbs (35.0%) and quarantining (11.1%). The indigenous knowledge based pests, parasites and disease control strategies index (PPDCSI) was 3.18 on a 1-5 point rating scale. A positive relationship ($r = .169$) existed between indigenous knowledge pest, parasites and disease control strategies and household food security. Regression test showed that influence of IK pests, parasites and disease control strategies was not significant ($p>0.05$) hence failed to reject the null hypothesis.

The fourth objective established the influence of indigenous knowledge based storage and preservation strategies on household food security. The results indicated the major indigenous based strategies for preserving food were sun drying (100.0%), salting (99.1%), smoking (98.3%), use of ash (98.3%), roasting (97.4%), use of pepper (96.6%) and frying (95.7%). The main storage facilities included granaries (69.2%), use of gunny bags (59.0%) and use of traditional containers (12.8%). Indigenous knowledge preservation and storage strategy index (PSSI) was 2.83 when rated on a 1-5 points rating scale. A positive relationship ($r = .277$) between the two constructs was observed. The hypothesis results showed that indigenous knowledge based preservation and storage strategies significantly influenced household food security ($p < 0.05$). The null hypothesis was rejected.

The fifth objective sought to establish the extent to which indigenous knowledge based strategies were integrated into agriculture extension service for household food security. Results indicated that at the farm level, 27.3% of households used blended both indigenous and scientific knowledge strategies in their farming activities. Majority of extension staff (36.0%) indicated that households used scientific knowledge (use of commercial chemicals and drugs) to control crop pests and diseases while (27.3%) used meteorological weather briefs to supplement the indigenous weather forecast. Similarly, (41.0%) of households vaccinated and used drugs to control livestock diseases and parasites. On storage of household food stuffs, majority (59.0%) of households, (54.5%) of extension staff and (47.4%) of the observed households using checklists indicated the use of modern gunny bags to store their produce.

5.3 Conclusions

The results obtained in this study led to the following conclusions:

i. Households in Baringo County employ indigenous knowledge based climate change coping strategies such as weather forecasting to sustain their livelihoods. This is evidenced in diversification of farming enterprises and blending of both indigenous and scientific knowledge systems in the farm. Even though indigenous knowledge based climate change coping strategies did not significantly influence household food security, it has contributed to mitigate food insecurity in the county.

ii. Indigenous knowledge based production strategies employed by households in Baringo include selection of breeds, livestock feeding, selection of agricultural practices and in the control of pests, parasites and diseases. Adoption of these IK strategies did not significantly influence household food security. However, the strategies have contributed towards improving the livelihoods of households in the County.

iii. A variety of indigenous knowledge based strategies, besides scientific knowledge, were used to control crop and livestock pests, parasites and diseases. These include use of ash, *busaa*, tobacco solution, herbs and crop rotation. The influence of these strategies on food security was not significant, however, they contribute towards production of crops and livestock. These strategies thus contribute towards household food security.

iv. Indigenous knowledge based storage and preservation strategies have also been adopted by households besides scientific ones. Such strategies include use of Und drying, roasting, salting and use of granaries. These are time tested strategies that are cost effective and environmental friendly that significantly influence household food security.

v. Households in Baringo County use both indigenous and scientific knowledge based strategies in their farming activities. Minority of the households have integrated IK at the farm level. Similarly, only minority of the extension staff have integrated IK into extension messages. This means households in Baringo do not enjoy the benefits associated with the blended extension service such as adaptation to climate change, adoption of technologies for improved production and food security.

5.4 Recommendations

Based on the conclusions of the study, the following recommendations were drawn:

i. The findings be disseminated through conferences, workshops and community meetings that involve small holder farmers, local leaders, county and national government, agriculture, livestock and fisheries officials. The stakeholders are linked and policies and mechanisms that promote climate change coping strategies are developed and implemented. This requires the support of local leaders and county and national government agriculture, livestock and fisheries ministries.

ii. Both IK and SK are employed in food production in Baringo. However, the focus is on SK. There is need to strengthen IK to complement SK. This can be achieved by linking IK experts with extension service providers and research institutions such as KALRO and universities. The IK strategies be documented and workshops that involve farmers be organized where they are sensitized. This requires the support, of local leaders, research institutions and county and national government agriculture, livestock and fisheries ministries.

iii. Forums be created through community meetings, extension staff and local leaders initiatives where farmers are made aware of indigenous knowledge pests, parasites and diseases strategies and share their IK experiences.

iv. Promote adoption IK storage and preservation strategies amongst farmers by organizing forums such as community meetings, model farms, and field days. This requires of extension service providers, local leaders and offices of county and national government agriculture, livestock and fisheries ministries.

v. Smallholder farmers who are experts in IK need to be linked up with extension service providers and be facilitated to develop a document that integrates IK into formal extension services. Research institutions such as KALRO and universities can be incorporated in the integration process due to their expertise in such areas. This requires the support of county and national government and donors.

5.5 Suggestions for Further Research

The results of this study suggest the need for future researchers to better understand the influence of indigenous knowledge on food security. Consequently, the following suggestions for further research were made:

i) This study focused only on examining the link between indigenous knowledge based coping strategies and household food security. It did not take into consideration scientific knowledge despite its key role in food production. There is need for a study that examines both scientific and indigenous knowledge strategies and food security. This would give a more holistic picture of the influence of knowledge on food security.

ii) The study was based on the premise that climate change coping, food production, pests, parasites and disease control, and preservation and storage strategies were determinants of food security. The results did not however, support that line of thought except for preservation and storage strategies. There is need to establish the factors which influence food security in the study area.

iii) The study was conducted in Baringo County and as a result the findings are only generalizable to that location. There is need to validate these finding by replicating the study using a larger sample drawn from all counties in Kenya. This would improve the generalizability of the findings.

iv) The researcher established that a variety of herbs were used to control pests, parasites and diseases. However, these were not investigated further to determine the active agents in these herbs. Therefore there is need for a study on the chemical analysis of the herbs and the efficacy of the active agents in controlling pests, parasites and diseases.

REFERENCES

Abegaz, K. H. (2017). Determinants of food security: evidence from Ethiopian Rural Household Survey (ERHS) using pooled cross‑sectional study. *Agriculture and Food Security,1*(6), 70-86

Abioye, A., Zaid, Y., & Egberongbe, H. (2011). *Documenting and disseminating agricultural indigenous knowledge for sustainable food security: The efforts of agricultural research libraries in Nigeria.* A conference paper presented in the 78 information systems for indigenous knowledge in agriculture, Nigeria.

Adejo, P. E., Okwu, O. J., & Ibrahim, M. K. (2012). Challenges and Prospects of privatization of agricultural extension service delivery in Nigeria. *Journal of Agricultural Extension and Rural Development 4(*3*),* 6-68.

African Union. (2016). *Guideline on CAADP Country implementation under Malabo Declaration:* African Union.

African Union. (2014).*Malabo declaration on accelerated agricultural growth and transformation for shared prosperity and improved livelihoods:* African Union.

Agbamu, J. U. (2005). Problems and Prospects of Agricultural Extension Services in Developing Countries. *In: Agricultural Extension in Nigeria S. F. Afolayan (ed) Ilorin AESON,* P.159 -169.

Agidew, A. A., & Singh, N. N. (2018). Determinants of Food Insecurity in the Rural Farm Households in South Wollo Zone of Ethiopia: The Case of the Teleyayen Sub-Watershed. *Agricultural and Food Economics 6* (10), 1-23.

Agrawal, A. (1995). Dismantling the divide between Indigenous and Scientific Knowledge. *Development and Change, 26*(3)*, 413–439.*

Aker, J. C. (2011). Dial "A" For Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries. *Agricultural Economics, 42*(6), 631-647.

Alexandratos, N., & Bruinsma, M. (2012). *"World Agriculture towards 2030/2050:* The saving water. From field to fork-curbing losses and wastage in the food chain 2012 revision." Working paper: FAO: ESA No 12-03 p 4.

Alexander, G. (2012). *Food Security. A mapping of European approaches*. Research paper no.5.http://www.gppi.net/fileadmin/media/pub/2012/gaus_2012_GMF_food_security.pdf. (Accessed on 20/6/2016).

Aluga, M., & Kabwe, G. (2016). *Indigenous Food Processing, Preservation and Packaging technologies in Zambia.* Conference paper.

Anaeto, F. C., Asiabaka, C. C., Nnadi, F. N., Aja, O. O., Ajaero, J. O., Ukpongson, M. A., & Ugwoke, F. O. (2013).Integrating indigenous knowledge systems in extension education: The potential for sustainable agricultural development in Nigeria. *Research Journal of Agricultural and Environmental Management, 2*(11), 332-340.

Anyira, I. (2010).*The role of libraries in the preservation and accessibility of indigenous knowledge in the Niger Delta Region of Nigeria.* Library philosophy and practice.

Asiabaka, C. C. (2010). *Scaling-up agricultural technologies for food security and poverty reduction: Whose knowledge counts*: The Farmer or the scientist? 16th inaugural lecture of the Federal University of Technology. Owerri, (FUTO Imo State).

Asogwa, I. S., Okoye, J. I., & Oni, K. (2017). Promotion of indigenous food preservation and processing knowledge and the challenge of food security in Africa. *Journal of Food Security 5*(3),75-87.

Aulakh, A., & Regmi, A. (2013). Post-Harvest Food Losses Estimation-Development of Consistent Methodology: Food and Agriculture Organization of the United Nations Rome, Italy.

Awuor, P. (2013). Integrating Indigenous Knowledge for Food Security: Perspectives from Millennium Village Project at Bar-Sauri in Nyanza Province in Kenya. *Paper presented to the African Research and Resource Forum (ARRF) held in Kampala Uganda, on 16 – 17 November 2011.*

Baker, T. L. (1994).*Doing social research* (2nd Ed.). New York: McGraw-Hill Inc.

Baringo Food Security Report. (2013). B*aringo County 2013 long rains food security assessment report 5th -9thAugust, 2013.* Nairobi, Kenya.

Bartenge, G. (2013). *Food processing opportunities in Baringo County*. Ministry of Agriculture, Livestock & Fisheries Development. Baringo County Government.

Bellamy, R., & Hulme, M. (2011). Beyond the tipping point: Understanding perceptions of abrupt climate change and their implications. *Weather, Climate, and Society, 3*(1), 48-60.

Berjan, S., Capone, R., Debs, P., & Elbilali, S. (2018). Food Losses and Waste: A global Overview with a focus on Near East and North Africa Region: *International Journal of Agricultural Management and development (IJAMAD.*

Bernard, H. R. (2002). *Research Methods in Anthropology: Qualitative and quantitative approaches* (3rd ed.).Walnut Creek, CA. Alta Mira Press.

Best, J. W., & Khan, J. V. (2006), *Research in education.* New Delhi, Prentice Hall: India.

Beyene, F., & Muche, M. (2010). Determinants of Food Security among Rural Households of Central Ethiopia: An Empirical Analysis. *Quarterly Journal of International Agriculture 49* (4), 299-318.

Bhattacherjee, A. (2012). *Social science research: Principles, methods and practice. Text books collection.3*.http://scholarcommons.usf.ed/oa_textbooks/3 (accessed, 2/8/2017).

Borg, W. R., & Gall, M. D. (1989). *Educational research. An introduction* (5th ed.). White Plains, New York: Longman.

Bourne, M., Lobry de Bruyn, L., & Prior, J. (2020). Participatory Versus Traditional Agricultural Advisory Models for Training Farmers in Conservation Agriculture. A comparative Analysis from Kenya. *The Journal of Agricultural Education and Extension*,*1*(10)1080-1389.

Brouwers, J. H. A. M. (1993). Rural people's response to soil fertility decline: The Adja case (Benin), *Wageningen Agricultural University Papers,* 93-4.

Campbell, J. R. (2006). *Traditional disaster reduction in pacific island communities'* science report 2006/038. Institute of geological and nuclear sciences, Lower Hutt, New Zealand.

Chavula, H. K. (2014). The role of ICT in Agricultural Production in Africa. *Journal of Economic Commission for Africa , 6* (7), 279-289.

Chege, J. M., Semenye, P. P., & Lemba, J. K. (2018). Influence of indigenous knowledge on household food security status among the small holder farmers in Kilifi sub county, Kenya. *Journal of Advances in Research 14*(6), 1-8.

Chinedum, N., Tambi, N. E., & Bangali, S. (2015). *State of knowledge on CSA in Africa*. Case studies from Nigeria, Cameroon and Democratic Republic of Congo. Forum for agricultural research in Africa, Accra, Ghana.

Chippungahelo, M. S. (2015). Knowledge Sharing Strategies on Traditional Vegetables for Supporting Food Security in Kolosa District, Tanzania. *Library Review, 64*(3),229-247.

Chirimuuta, C., & Mapolisa, T. (2011). Centering the Peripherised Systems: Zimbabwean Indigenous Knowledge Systems for Food Security. *Zimbabwe International Journal of Open and Distance Learning, 1* (2), 52-56.

Christoplos, I. (2010). *Mobilizing the potential of rural and agricultural extension. Food and agriculture organization of the United Nations and the global forum for rural Advisory services.* Rome, Italy.

Concern Worldwide. (2020). *9 Solutions to Global Hunger to get us to 2030.* USA, Inc.

Danso-Abbeam, G., Eliakpor D. S., & Aidoo, R. (2018). Agricultural Extension and its effects on farm productivity and income: Insight from Northern Ghana. *Journal of Agriculture and food security, 7*(74), 20-25.

Dewes, W. (1993). 'Introduction'. P3 in '*Traditional Knowledge and Sustainable Development*'. In Danis, S. H and Ebbe, K (eds). Proceedings of a conference held at the World Bank Washington, D. C., September 27-28. Environmentally Sustainable Development Proceedings Series no. 4

Dlamini, N & Kaya, H. O. (2016). Environmental Security, Indigenous Knowledge Systems and Implications for Food Security in South Africa. *Journal of Human Ecology, 53(2), 135-140.*.

Doubleday, N. C. (1993).Finding common ground: Natural law and collective wisdom. *International program on traditional ecological knowledge*. Ottawa, Canada.

Douglas, M. (1966). *Purity and danger: An analysis of concepts of pollution and taboo.* Vol. 2. Routledge, 188 pp.

Drost, E. A. (2011). Validity and reliability in social science research. *Education research and perspective, 38*(1), 21-54.

Economic Survey. (2018). *Kenya National Bureau of Statistics*. Government Printer. Nairobi, Kenya.

Economic Survey. (2015). *Ministry of Devolution and Planning*. Republic of Kenya. Government Printer. Nairobi, Kenya.

Edwards, A. W. (2006). *Non Experimental Quantitative Research*: Columbus Ohio, USA.htt/www.karen.com. Accessed 6/10/2015.

Epeju, W. F. (2003). *Farmers' and agricultural advisors' perceptions on the role of education in sweet potato (Ipomeabatatus* L*) Production in Teso, Uganda.* Unpublished PhD thesis. Egerton University, Njoro.

Esipisu, I. (2016, March, 12). *Weatherman, rainmakers team up to offer crop farmers accurate forecast.* Daily Nation newspaper. Nairobi, Kenya: Nation Media group ltd.

Eyong, C. T. (2003). *Indigenous Knowledge and Sustainable Development in Africa*: Case Study on Central Africa.

Famine Early Warning Systems Network. (2018). *Kenya Food Security Outlook*: Poor 2017 Long Rains Mark Second Consecutive Season of Drought. https://www.fews.net/kenya (Accessed on 14/10/2020).

Farzana, F. D., Rahman, A. S., Raihan, M. J., Haque, M. A., & Waid, J. L. (2017). Coping Strategies related to food insecurity at household level in Bangladesh. *PLoS ONE* 12 *(4)*: e0171411.

Fasoyiro, S. B., & Taiwo, K. A. (2012). Strategies for Increasing Food Production and Food Security in Nigeria. *Journal of Food and Agricultural Information, 13*(4), 338-355.

Fernandez, P. G. (1994). Indigenous seed practices for sustainable agriculture. *Indigenous Knowledge Development & Monitoring, 2*(2), 9–12.

Food & Agriculture Organization. (2020). *The State of Food Insecurity and Nutrition in the World 2020*. Food and Agriculture Organizations of the United Nations.

Food & Agriculture Organization, International Fund for African Development, United Nations international Children Education Fund, World Food Programme and World Health Organization. (2019). *The State of Food Security & Nutrition in the world 2019.* Safeguarding against Economic Slowdowns and down turns, Rome, FAO.

Food & Agriculture Organization. (2017). *E-Agriculture in Action*. Food and Agriculture Organization of the United Nations.

Food & Agriculture Organization. (2014). *Second International Conference on Nutrition; Better Nutrition-better lives*. Rome, Italy,.

Food & Agriculture Organization. (2013). *Resilient livelihoods: Disaster risk reduction for food and nutrition security framework programme.* Food and Agriculture Organization of the United Nations. Rome, Italy.

Food & Agriculture Organization. (2012). *Small Livestock, big Impact*. http://ilri/category/livestock_challenges/Indigenoeous_breeds/. (Accessed 24/6/2016).

Food & Agriculture Organization. (2006). *Livelihood adaptation to climate variability in drought-prone areas of Bangladesh: Developing institutions and options.* Food and Agriculture Organizations of the United Nations. Rome, Italy.

Food & Agriculture Organization. (2000). *The state of food insecurity in the world 2000:* Food and Agriculture Organization of the United Nations. Rome, Italy.

Forest Society of Kenya. (2010). *Forests for agriculture, energy and water*. Forest Society of Kenya. Nairobi, Kenya.

Fryrear, A. (2015). What *is a Good Survey Response Rate*? Survey gizmo resources.

Gaoshebe, T. (2014). African Indigenous Food Security Strategies and Climate Change adaptation in South Africa. *Journal of Human Ecology, 48*(1), 83-96.

Goodrich, R. L., & St. Pierre, R. G. (1979). *Opportunities for studying later effects of follow through.* Cambridge, MA: ABT Associates.

Government of Kenya. (2019). Baringo County: 2019 *Long Rains Food and Nutrition Security Assessment Report, July 2019*: Report by the Kenya Food Security Steering Group (KFSSG) and Baringo County Steering Group.

Government of Kenya. (2015). *Baringo County statistical abstract 2015*. Kenya national bureau of statistics: Nairobi, Kenya: Government printer.

Government of Kenya. (2014). *Baringo County Government annual development plan 2015/16*. Nairobi, Kenya: Government printer.

Government of Kenya. (2012). *National Agriculture Sector Extension Policy (NASEP). Agriculture Sector Development Strategy 2010-2020.* Ministry of Agriculture Coordination Unit. Nairobi, Kenya: Government Printer.

Government of Kenya. (2010 a). *Constitution of Kenya 2010*. Nairobi, Kenya: Government Printer.

Government of Kenya. (2010 b). *Growth and food security through increased agricultural productivity and trade:* A Medium-Term Investment Plan for Kenya's Agricultural Sector: 2010-2015. Based on Kenya's Agricultural Sector Development Strategy and CAADP Compact. Government Printer, Nairobi, Kenya.

Government of Kenya. (2009). *The National Policy on Traditional Knowledge, Genetic Resources and Traditional Cultural Expressions, 2009.* Nairobi, Kenya: Government printer.

Gross, J. L & Rayner, S. (1985). *Measuring Culture:* A paradigm for the analysis of social organization: Columbia University Press, 146 pp.

Gupta, P., Singh, K., Seth, V., Agarwal, S., & Athur, P. (2015). Coping Strategies adopted by households to prevent food insecurity urban slums of Dheli, India. *Journal of food security, 3*(2), 6-10.

Guye, M. (2014). Sustaining the Agriculture: Practices, Challenges and Opportunities of Integrating Indigenous and Modern Methods of Soil Fertility Management in rural Ethiopia. The case study of Bore District, Southern Ethiopia. *Int. Res. J Agric. Sci. Soil Sci. 4*(7), 124-138.

Gustavsson, J., Caterberg, C., Sonesson, U., Van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food wastages: Extent causes and prevention.* Food and Agriculture Organization of the United Nations. Rome, Italy.

Gwambene, B., & Liwenga, E. (2016). Smallholder Farmers' Pathway to Resilience: Achieving Food Security through Adaptation Strategies in Southern Highland of Tanzania. *Journal of Agricultural Economies and Rural Development, 3*(2), 105-111.

Hall, A. (2007). *Influence: The Essence of Leadership*. Nebraska University-Lincoln Extension. USA.

Havas, K., & Salman, M. (2011) 'Food security: its components and challenges', *International Journal of Food Safety, Nutrition and Public Health*, *4*(1), 4–11.

Haynes, K. (2005). *Exploring the Communication of Risk during a volcanic crisis:* A case Study of Montserrat, WI. Unpublished PhD. thesis, University of East Anglia, Norwich.

Heidhues, F., & Obare, G., (2011). Lessons from Structural Adjustment Programmes and their effects in Africa. *Quarterly journal of International Agriculture, 50(*1*), 55-64*

Ihenacho, R. A., Orusha, J. O., & Onogu, B. (2019). "Rural Farmers Use of Indigenous Knowledge Systems in Agriculture for Climate Change Adaptation and Mitigation in Southeast Nigeria". *Annals of Ecology and Environmental Science, 3(*1*)*, 1-11

International Fund for Agricultural Development. (2009). Smallholder Agriculture and Food Security in the 21st Century. In Vargaslundius, R. (ed). *Proceedings of the Governing Council Round Tables.*

Ilaboya, I. R., Atikpo, E., Omofuma, F. E., Asekhame, F. F., & Umukoro, L. (2012). Causes, effects and way forwards to food insecurity. *Iranica journal of Energy and Environment, 3*(2), 180-188.

Iloka, N. G. (2016). Indigenous Knowledge for Disaster Risk Reduction: An African Perspective. *'Jamba' journal of Disaster Risk Studies*, *8* (1), 272.

International Food Policy Research Institute. (2016). 2015 *Global hunger index: Armed conflict and the challenge of hunger*. International Food Policy Research Institute. Washington, DC.

International Food Policy Research Institute. (2014). 2013 *Global hunger index: The challenge of hunger*. Building resilience to achieve food and Nutrition security. IFPRI issue brief. Washington, DC.

International Food Policy Research Institute. (2012). *2011 Global Food Policy Report.* International Food Policy Research Institute. Washington, DC.

Intergovernmental Panel on Climate Change. (2014). *Climate change 2014*: *Impacts, adaptations and vulnerability*. Fifth assessment report: Cambridge University press.

Jigyasu, R. (2002). *Reducing Disaster vulnerability through local knowledge and capacity:* The case of earthquake prone rural communities in India and Nepal. Norwegian University of Science and Technology, Trondheim.

Jalloh, A., Nelson, G. C., Thomas, T. S., Zougmore, R., & Roy-Macauley, H. (2013). *West African agriculture and climate change:* A comprehensive analysis. IFPRI research monograph, Washington DC: International Food Policy Research Institute.

James, B., Atcha –Ahowe, C., Godonou, I., Baimei, H., Goergen, H., Sirikou, R., & Toko, M. (2010). *Integrated Pest Management in Vegetable Production. A guide for Extension Workers in West Africa.* International Institute of Tropical Agriculture (IITA); Ibadan Nigeria; 120pp

Kaegi, S. (2015). *The Experiences of Indias' Agricultural Extension Systems in reaching a large number of farmers with rural advisory services.* Background paper to the SDC face the face workshop ''Reaching the millions!'' in Hanoi, Vietnam.

Kamwendo, G., & Kamwendo, J. (2014). Indigenous Knowledge Systems and Food Security: Some examples from Malawi. *J Hum Ecol, 48(*1*),* 97-101.

Kaya, H. O., & Koitsiwe, M. (2016). African Indigenous Knowledge Systems and Natural Disaster Management in North West Province South Africa. *Journal of Human Ecology, 53*(2), 101-105.

Kihila, J. M. (2017). Indigenous Coping and Adaptation Strategies to Climate Change of Local Communities in Tanzania. A review. *Climate and Development, 10*(5), 406-416. https://doi.org/10.1080/17565529.2017.1318739.

Kimani, E. W., Ogendi, G. M., & Makenzi, P. M. (2014). An Evaluation of Climate Change Indigenous Coping and Adaptation Strategies for Sustainable Agro-pastoral based livelihoods in Baringo County, Kenya. *Journal of Environmental Science, Technology and Food Technology, 8*(8), 38-58.

Kiplangat, J. N., & Rotich, D. C. (2008). Mapping and Auditing of Agricultural Indigenous Knowledge in Uasin Gishu and Keiyo Districts in Rift Valley Province, Kenya. World Conference on Agricultural Information and Information Technology; IAALD, AFITA, WCCA 2008. Tokyo University of Agriculture, 24-27 August, Tokyo, Japan. http://www.cabi.org/gara/FullText(Accessed on 27/4/2020).

Kipsang, W. (2014, June 3). *Irrigation plan to fight hunger in Baringo*. Daily nation newspaper. Nairobi, Kenya. Nation media group ltd.

Kipterer, J. K., & Ndegwa, M. C. (2014). Livelihood vulnerability assessment in context of drought hazard: A case study of Baringo County, Kenya. *International Journal of Science & Research, 3* (3), 346-349.

Kenya National Bearueu of Statistics & Society for International Development. (2013). *Exploring Kenya's inequality: Pulling a part of pooling together in Baringo County*. KNBI/SID. Nairobi, Kenya.

Kothari, C. R. (2004). *Research methodology*: *Methods and techniques* (2nd ed.). New Delhi: Wishwa prakashan.

Klennert, K. (2009). *Achieving food and nutrition security.* Actions to meet the Global Challenge. A training course reader. Germany: In Went Capacity Building International.

Kumar, V. (2014). *Role of Indigenous Knowledge in Climate Change Adaptation Strategies*: A study with special.

Kungu, M. O. (2014). *Determinants of Household Food Security in Lugari and Makueni Sub Counties, Kenya.* MA Thesis. University of Nairobi.

Kurukulasuriya, P. (2006). Will Africa Agriculture Survive climate change*? World Bank economic review* 20 (*3*), 367-388.

Lentz, E. C., Barret, C. B., & Hoddonott, J. (2005*). Food Aid and dependency: Implications for Emergency Food Security Assessment.* Emergency food programme desk study.

Lin, B. B. (2011). Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change. *Bioscience 2011*; 61-183

Lunga, W., & Musarurwa, C. S. (2016). Indigenous Food Security Revival Strategies at the Village level: The Gender Factor Implications. *Jamba Journal of Disaster Risk Studies* 8 (*2*), 175.

Luseno, W. K., McPeak, J. G., Barrett, C. B., Little, P. D., & Gebru, G. (2003). Assessing the value of climate forecast information for pastoralists: Evidence from Southern Ethiopia and Northern Kenya. *World Dev, 31*(*9*), 1477-1494.

Macharia, C. W., Makau, K. W., & Muroki, N. M. (2010). A comparative study on nutritional status of children (6-59 months) in a world vision project area and a non-project area in Kathonzweni Division, Makueni District Kenya. *African Journal of Food, Agriculture, Nutrition and Development, 5*(*1*), 7-8.

Maddison, D. (2006). *The perception of an adaptation to climate change in Africa Report*. Discussion paper No. 10. Pretoria. CEEPA Publications, P 47.

Madukwe, M. C. (2006). *Delivery of Agricultural Extension Services to Farmers in Developing Countries.* A discussion paper for basic agricultural services (BAS). Natural resources institute. University of Greenwich, United Kingdom vol. 1 66.

Mafongoya, P. L., & Ajayi, O. C. (editors). (2017). *Indigenous Knowledge Systems Climate change Management in Africa*, CTA, Wageningen, The Netherlands, 316pp.

Magni, G. (2016). Indigenous Knowledge and Implication for Sustainable Development Agenda: Background paper prepared for 2016 Global Education Monitoring Report, UNESCO.

Magocha, M., Soundy, P., Muchie, M., & Magocha, B. (2019). Reviewing the Applications of Indigenous Knowledge Systems in Innovative Crop Production. *African Journal of Indigenous Knowledge Systems, 18*(2), 229-244.

Maina, M, W. (2015). *Application of indigenous framing practices towards elimination of food insecurity among farmers in Kikuyu Sub-County, Kenya.* Unpublished MA Thesis. Nairobi University, Kenya.

Maina, I., Newsham, A., & Okoti, M. (2013). *Agriculture and climate change in Kenya: Climate chaos, policy dilemas.* Future Agricultures working paper No. 070.

Manikandan, D. (2018). Application of Behavioural Economics for Promotion of Environment-friendly Agricultural Practices for Food Security and Enhanced Farm Income. *Journal of Agricultural Extension Management XIX* (1), 1-12.

Mbakaya, B., Ndengu, D., & Dalo, N. (2018). Implementation of Household Approach 'Views from Key Informants': Case of Chalwita Model Village, Rumphi, Malawi. *Journal of Agricultural Extension Management, 9*(1), 31-43.

Melchias, G. (2001). *Biodiversity and Conservation*. Science Publishers, Inc., Enfield.

Meles, T., & Meseret, M. M. (2016). Assessment of Food Security Status and Factors Influencing Food Security in Hawi Guddina District, Ethiopia. *Int. Sch. Journal 3* (3), 167-173.

Midgley, S. (2011). *Integrating Local and Indigenous Knowledge into river basin management for effective climate change adaptation.*

Ministry of Agriculture, Irrigation and Water Development. (2016). *Agriculture Sector Food and Nutrition Strategy.* Zero Draft. Government Printer,

Ministry of Agriculture. (2004). *Ministry of agriculture strategic plan 2005-2009.*Ministry of Agriculture. Nairobi, Kenya. Government printer.

Mishra, P. K., & Rai, S. C. (2013). Use of Indigenous Soil and Water Conservation Practices among Farmers in Sikkim Himalaya. *Indian Journal of Traditional Knowledge, 12*(3), 554-564.

Morris, A. (2009, January 16). *New grant to increase food security in Kenya*: The standard, newspaper. Nairobi, Kenya. The standard group ltd.

Mota, A. A., Lachore, S. T., & Handiso, Y. H. (2019).Assessment of food insecurity and its determinants in the rural households in Damot Gale Woreda, Wolaita zone, southern Ethiopia. *Agriculture and Food Security, 3*(8), 1-1.

Mozumdar, L. (2012). Agricultural Productivity and Food Security in the Developing World. *Bangladesh journal of agricultural economics XXXV (1 & 2),* 53-69.

Mugenda, O. M., & Mugenda, A. G. (1999). *Research methods*: *Quantitative and Qualitative approaches*. Nairobi, Kenya: ACTS press.

Mugwisi, T. (2016). *Applying Indigenous Knowledge in Agricultural Extension*: The Case of Agritex Workers in Zimbabwe.

Mukiibi J. K. (2001). *Agriculture in Uganda*. National Agricultural Research Organization (NARO), Fountain Publishers, Kampala.

Muok, B., Ochieng, A. A., Kariuki, J. K., & Tonui, C. (2012). *Case study on climate compatible development (CCD) in agriculture for food security in Kenya*. Nairobi, Kenya: ACTS press publication.

Muriuki, N, O., Munyua, C. N., & Wanga, D. (2016). Communication Channels in Adoption of Technology with a Focus on the use of Purdue Improved crop Storage (PICS) among small scale farmers in Kenya. *Journal of Biology, Agriculture and health care,* 6*(*18*)* 8-12.

Musa, M. W. (2006). *Indigenous resource management systems (IRMS) among rural communities in north-west zone of Nigeria and their relevance for participatory poverty reduction.* Unpublished PhD Thesis. Ahmadu Bello University, Zaria, Nigeria.

Mutunga, E. J., Ndungu, C. K., & Muendo, P. (2017). Smallholder Farmers' Perceptions and Adaptations to Climate Change and Variability in Kitui County, Kenya. *J Earth Sci Clim Change, 8(3) 389.* doi: 10.4172/2157-7617.1000389.

Naanyu, M. (2013). *Integration of Indigenous Knowledge with Information and Communication Technologies in coping with effects of Climate Change and Variability on Agriculture in Kajiado County, Kenya*. Unpublished MSc Thesis. University of Nairobi.

Nassiuma, D. K. (2000). *Survey Sampling*: *Theory and Methods.* Njoro, Kenya: Egerton University Press.

Ndwandwe, S. (2013). *The Contribution of Indigenous Knowledge Practices to Households Food Production and Food Security*. A case of Okhahlamba Local Municipality, South Africa. MSc Thesis, Pietermaritzburg, South Africa.

Nduti, L. W. (2014). *Viability of indigenous knowledge based strategies in mitigation of drought in Gachoka Division, Embu County, Kenya.* Unpublished Msc Thesis, University of Nairobi.

New Partnership for African Development. (2009). *Comprehensive African Agriculture Development Programme (CAADP) pillar III.* Framework for African Food Security (FAFS). New Partnership for African Development (NEPAD). Midrand, South Africa.

Ngara, R. (2013). Shangwe Music for spiritual rituals: A symbolical enactment. *Studies Tribes and Tribals, 2*(3), 127-133.

Ngulube, P. (2017). *Hand book of Research on Theoretical Perspective on Indigenous Knowledge Systems in Developing Countries.* Hashley PA, USA: IGI Global.

Nigerian Environmental Study Action Team. (2011). *Climate Change Adaptation Technical Report (CCCATR).*NEST, Ibadan, Nigeria.

Njomo, L. M., Arnolds, C., & Ngek, S. P. (2019). Enhancing Indigenous Agricultural Management Techniques: A framework to Minimize Post Harvest Losses in Potato Farming in Bui Division, North West Region of Cameroon. *International Journal of Management and Humanities,3(*9*),* 46-55.

Nnadi, F. N., Chikaire, J., & Ezudike, K. E. (2013). Assessment of Indigenous Knowledge Practices for Sustainable Agriculture and Food Security in Idemili South Local Government Area of Anambra State, Nigeria. *Journal of Resources Development and Management*, *1*(4),14-21.

Odero, K. (2011). *The role of indigenous knowledge in responding to climate change: Local-global perspective*. In panel 10: Roles of local and indigenous knowledge in addressing climate change. Africa Adapt Climate Change Symposium Pp 28.www.adaptation 2011.net.

Ogalleh, S. A., Vogl, C. R., Eitzinger, J., & Hauser, M. (2012). Local Perceptions and Responses to Climate Change and Variability: The Case of Laikipia District, Kenya. *Journal of Sustainability,2*(4), 3302-3325.

Ogega, O. M. (2017). *Use of Scientific and Indigenous Knowledge in Adapting to Climate Change and Variability at the Kenyan Coast*. An MSc Thesis. University of Nairobi. Nairobi, Kenya.

Olurankinse, C. A. (2014). Strategies for sustainable food processing and preservation. *Journal of Environmental Science Toxicology and food technology, 8*(6),31-36.

Osman, H. M. (2013).*Role of natural forage plants diversity in pastoral and agro-pastoral communities' livelihood:* PR-325-Sudan Working paper.

Otieno, D. (2018). *Securing Food Security through Improved Investment in the Agricultural Extension System*. Tegemeo Institute of agricultural policy and development.

Otolo, R. A., & Wakhungu, J. W. (2013). Factors Influencing livelihood zonation in Kenya. *International Journal of Education and Research, 1*(*12*), 1-10.

Pazvakavambwa, S. C., & Hakutangwi, M. B. K. (2006). *Agriculture Extension.* In Rukuni, M., Tawonezvi, P, Eicher, C., Munyuki-Hungwe, M & Matondi, P (eds). Zimbabwe Revolution Revisited. Harare. University of Zimbabwe publications pp.217-234.

Ponge, A. (2013). *Integrating indigenous knowledge for food security:* Perspectives from the millennium village project at Bar-sauri in Nyanza Province in Kenya.

Posey, J. (1985). Farmers' extension practice and technology adaption: Agricultural Revolution in the 17th– 19th century Britain. *Agric. Hum. Values.8* (1 &2), 132-148.

Rajasekaran, B., Martin, R. A., & Warren, D. (1994). A framework for incorporating indigenous knowledge systems into agricultural extension organizations for sustainable agricultural development in India. *Journal of International Agricultural and Extension Education, 1*(2), 25-31.

Rajasekaran, B., Martin, R. A., & Warren, D. (1993). *A framework for incorporating indigenous knowledge systems into agricultural extension organizations for sustainable agricultural development in India.* Outstanding graduate student research paper from the ninth Annual meeting of the association for international Agricultural and extension Education. Arlington, VA, USA. March 18, 19 & 20, 1993.

Rankoana, S. A. (2016). Perceptions of climate change and the potential for adaptation in a rural community in Limpopo Province, South Africa. *Sustainability, 8*, 672.

Raygorodetsky, G. (2011). *Why traditional knowledge holds the key to climate change*; Climate variability, culture & religions: Japan. United Nations University.

Rembold, F., Hodges, R., Bernard, M., & Leo, O. (2011). *The African Post-Harvest Losses Information System (APHLIS).* European Union, Luxembourg.

Rivera, W. M., Qamar, M. K., & Crowder L. V. (2001). *Agricultural and rural extension worldwide: Options for institutional reform in developing countries*. UN Food and Agricultural Organization, Rome.

Saina, C. K., Cheserek, G. J., Kimwolo, A. K., & Omondi, P. (2012). Impacts of external food aid on indigenous food security strategies in Marigat District, Kenya: *Journal of Emerging Trends in Economics and Management Sciences (JETEMS), 3*(6), 893-900.

Salami, R. (2020). The Role of Indigenous Knowledge in Sustainable Urban Agriculture and Urban Food Security in Minna, Nigeria. *Library Philosophy and Practice* (e-journal). 3019. https://digitalcommons.unl.edu/libphilprac/3919 (accessed on 26/3/2021)

Sen, A. K. (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press.

Shivakoti, B. R., Lopes-Casero, F., Kataoka, Y., &Shrestha, S. (2015). *Climate Change, Changing rainfall and increasing water scarcity: An integrated Approach for planning adaptation and building resilience of smallholder subsistence livelihoods in Nepal.* IGES Research Report 2014-07, Institute for Global Environmental strategies (IGES), Hayana, Japan.

Shukla, S., Barkman, J., & Patel, K. (2017). Weaving indigenous agricultural knowledge with formal education to enhance community food security: School competition as a pedagogica space in rural Anchetty, India. *Pedagogy, Culture & Society, 25*(1), 87-103.

Siambombe, A., Mutale, Q., & Muzingili, T. (2018). Indigenous knowledge systems: a Synthesis of Batonga People's Traditional Knowledge on Weather Dynamism. *African Journal of Social Work, 8*(2),46-54

Sigei, J. (2014). *The Contribution of Agricultural Extension Services to Food Security of Smallholder Households in Nandi County, Kenya*. MA Thesis. Nairobi University.

Simwaka, K., Ferrer, S., & Geoff Harris, G. (2010). Coping strategies for AIDS-affected households facing food security problems in Malawi: Evidence from integrated household surveys. *Journal of Development and Agricultural Economics, 2*(12), 416-431.

Singh, R., & Singh, G. S. (2017). Traditional agriculture: a climate-smart approach for sustainable food production.*Energy, Ecology and Environment*, *2*(5), 296–316.

Swiderska, K., Argumedo, A., Song, Y., Rastogi, A., Gurung, N., & Wekesa, C. (2016). *SDG2: Achieving Food Security, Sustainability and Resilience using Genetic Diversity and Indigenous Knowledge*: IIED Briefing.

Tanyanyiwa, V. I., & Chikwanha, M. (2011). The role of indigenous knowledge systems in the management of forest resources in Mugabe area, Masvingo, Zimbabwe. *Journal of Sustainable Development in Africa, 13*(12), 132-149.

Tirivangasi, H. M., & Tayengwa, D. (2017). Indigenous Knowledge Systems (IKS) and food securityin South Africa: Is Land Reform a pre-requisite? *Journal of Human Ecology 57*(3), 118-124.

Ting, Z. (2015). Smallholder Farming Practices and their impact on Environment in Rural China. *A paper presented at Globalization Studies, Groningen University, The Netherlands.*

Tweheyo, R. (2018). *Indigenous Knowledge and Food Security:* Enhancing Decisions of Rural Farmers. Published PhD Thesis. University of Groningen, the Netherlands.

Umar, S., & Musa, M. W. (2015). Determinants of the use of indigenous coping strategies against climate change among smallholder farmers in Katsina state, Nigeria. *Journal of Agriculture and Ecology Research International, 3*(1), 24-32.

United Nations Conference on Trade and Development. (2011). Unctad press. Unctad organization.

United Nations Convention to Combat Desertification. (2005). *Revitalizing Traditional Knowledge.* A compilation of UNCCD Documents and Reports from 1997-2003. UNCCD, Bonn, Germany. 150 pp.

United Nations Economic Commission for Africa. (2010). *An overview of the food security situation in Eastern Africa:* A publication of the United Nations Economic Commission for Africa.

United Nations Educational, Scientific and Cultural Organization. (2018). *Local and Indigenous Knowledge for Climate Change Decision-Making.* UNFCCC-Multi stakeholder workshop on implementing the Functions of the Local communities and Indigenous Peoples (LCIP) platform, Bonn, 1st May, 2018.

United Nations Framework Convention on Climate Change. (2013). *Best Practices and Available tools for the use of Indigenous and Traditional Knowledge and Practices for adaptation, and the application of gender sensitive approaches and tools for understanding and assessing impacts, Vulnerability and adaptation to climate change:* UN Framework convention on climate change. Technical paper. United Nations.

United States Agency for International Development. (2020). *Food Assistance Fact Sheet-Kenya (April 2020)*. USAID.

United States Agency for International Development. (2014). *Kenya food insecurity fact sheet No. 1.* Fiscal Year 2014.United States of America International Development.

Waithaka, M. (2011). *The role of indigenous knowledge in sustainable food production: A case of post-harvest practices in maize preservation in Mua Hill Location, Eastern, Kenya.* Unpublished Msc Thesis. Wageningen, University.

Wasudha, M. S., Ori, L., Wolfgang, J., & Vanwing, T. (2018). Agricultural Extension Services using Participatory Approach in vegetable growing areas in Suriname. *International journal of Agricultural Extension and Rural Development Studies, 5*(1), 20-33.

Wipo, O. (2005). *Intellectual Property and Traditional Knowledge*. Booklet 2. New York.

Wole, O. M., & Ayabonde, O. F. (2009). Use of indigenous knowledge by Women in Nigerian rural community. *Indian journal of traditional knowledge, 8*(2), 287-295.

Women's Organization for Rural Development. (2015). *Engaging with Community for Restoration on Traditional Agriculture for Food Security*. India programme Learning Document.

World Bank. (1998). *Indigenous knowledge for development: a framework for action.* Knowledge and learning Centre, African region. http://www.worldbank.org/afr/ik/guidelines/generalguides.pdf. (Accessed 27/05/ 2011).

World Food Programme. (2009). *Kenya food security update*. New York. United Nations.

World Vision Kenya. (2013). Baringo *County smart nutrition survey*. World Vision Kenya. Nairobi, Kenya.

Worth, S. (2006). Agriflection: A learning Model for Agricultural Extension in South Africa. *Journal of Agricultural Education and Extension*, *12*(3), 179-193.

APPENDICES

Appendix A: Questionnaire for Household Heads

Dear Household Head,

My name is Shadrack K. Cheplogoi, a PhD student at Egerton University. I am currently conducting a research titled "*Influence of Indigenous Knowledge Coping Strategies on Household Food Security in Baringo County, Kenya"* as part of the course work. I believe you have information that can contribute significantly to the success of the study. I am kindly requesting you to participate in the study by filling this questionnair. Please note that any information provided will be treated with utmost confidentiality and used for academic purposes only.

Thanks in advance for your kind support.

Shadrack K. Cheplogoi

Instructions

i. Do not write your name on the questionnaire.
ii. Indicate your response by placing a tick (√) in the selected cell/box or provide the requested information in the given spaces.

Section A: Respondent's Characteristics

1. Sex: Male ( ) Female ( )
2. Age group: 21-30 ( ) 31 - 40 ( ) 41-50( ) 51-60 ( ) Above 61 ( )
3. Highest Educational level: No formal education**(**) Primary ( ) Secondary ( ) Tertiary ( ) University ( ) Others specify ( )
4. Size of the household ………………………………………………………………
5. Size of land owned in acres …………………………………………………………
6. Aware of Indigenous knowledge Yes [ ] No [ ]
7. Do you apply Indigenous knowledge strategies when carrying out the farming activities listed below:
   i. Weather forecasting - [ ]
   ii. Crop farming - [ ]
   iii. Water conservation - [ ]
   iv. Livestock keeping - [ ]
   v. Pest and diseases control - [ ]
   vi. Storage/preservation of produce [ ]

vii. Others (specify) ………………………………………………………………

Section B: Climate Change Strategies

1. a) Have you noticed any significant changes in the climate in the recent years

   Yes [ ]   No [ ]

   b) If yes, indicate the frequency with which you have experienced below listed climatic change related phenomenon

Climate Change Strategy	**Very Often**	**Often**	**Occasionally**	**Rarely**	**Never**
Floods					
Drought					
Extreme temperatures					
Erratic rainfall patterns					
Others (Specify)					

2. Have the changes in the climate affected your food production   Yes [ ]   No [ ]

3. The items in the below table are on indigenous knowledge climatic change coping strategies. Indicate how frequently you practice them in your farm. Use the given scale: Never, Rarely, occasionally, Often, Very Often

I.K. Climate Change Strategy	**Very Often**	**Often**	**Occasionally**	**Rarely**	**Never**
Terracing					
Mixed farming					
Fallow cultivation					
Use of organic manure					
Mixing seed varieties					
Traditional weather forecasting (observing plants, animals, stars)					
Planting drought resistant crops					
Crop diversification					
Irrigation					
Mulching					
Planting cover crops (sweet potatoes, cowpeas)					
Early planting					
Destocking					
Migration					
Use of common properties forage e.g road reserves forests, schools					

Social network (distribute animals to relatives and friends)					
Keeping livestock that can withstand drought (goats, camels etc)					
Livestock diversification (cattle, chicken, goats, sheep, bees etc)					
Use of crop residues as livestock feed					
Others (Specify)					

Section C: Indigenous Knowledge Food Production Strategies

1. Do you produce food crops in your farm Yes [ ] No [ ]
2. Food Crops grown
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
3. Livestock kept (chicken, cattle, goats, sheep, camel, donkeys, bees)
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
4. Products from livestock
....
....
....
5. The items in the below table are on Indigenous knowledge strategies of food production. Indicate how frequently you practice them in your farm. Use the given scale: Never, Rarely, occasionally, Often, Very Often

Indigenous Knowledge production strategy	Very Often	Often	Occasionally	Rarely	Never
Clearing the farm by burning					
Use of hoes to dig					
Use of oxen to plough					
Plants own preserved seeds					
Use of compost manure when planting					
Practices inter cropping					
Using hoes to weed					
Maintains soil fertility through mulching, rotten grass , leaves					
Selects local breeds					
Use of free range feeding					
Use of crop stovers to feed livestock					
Others (Specify)					

Section D: Indigenous Knowledge Weeds, Pest, Parasites and Diseases Control Strategies

1. List common crop pests in your farm
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………..
2. State the common crop diseases in your farm
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
3. List common livestock parasites in your farm
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
4. List common livestock diseases in your farm
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
5. List the methods that you use to control the following in your farm Crops

i. Crop pests
   …………………………………………………………………………………………
   …………………………………………………………………………………………

ii. Crops diseases

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

iii. Animal parasites

………………………………………………………………………………………………
…………………………………………………………………………………………….

iv. Animal diseases

………………………………………………………………………………………………
…………………………………………………………………..……………………….

6. Do you use indigenous knowledge strategies to control pests and diseases in your farm Yes [ ] No [ ]

7. The items in the below table are on Indigenous knowledge strategies used to control weeds, pests, parasites and diseases. Using the given scale, indicate how frequently you practice them in your farm. Scale: Never, Rarely, occasionally, Often, Very Often

Indigenous knowledge pests, parasites and diseases control Strategies	**Very Often**	**Often**	**Occasionally**	**Rarely**	**Never**
Clear land using the slash and burn					
Seed selection (clean seeds)					
Early planting					
Growing nitrogen fixing trees to enrich soil fertility					
Erecting structures in farms for perching birds which prey on pests					
Traditional repellants					
Ash to preserve crop produce					
Herbs					
Concoctions to treat animals(pepper, busaa)					
Others (Specify)					

Section E: Indigenous knowledge Food Storage Strategies

1. State the food stuff which you store/preserve in your farm: Crop based

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

2. Livestock based
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

3. List the storage facilities that are used to store the food stuff (granaries, gunny bags etc)
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

4. How frequently do you apply the Indigenous Knowledge food storage and preservation strategies listed in the table below. Use the given scale.
Scale: Never, Rarely, occasionally, Often, Very Often

Indigenous Knowledge food storage and preservation strategies	**Very Often**	**Often**	**Occasionally**	**Rarely**	**Never**
Sun drying					
Salting					
Fermentation					
Sugaring					
Burying in moist soil					
Use of ash					
Mixing with pepper					
Smoke/Placing near fire place					
Use of granaries					
Traditional containers					
Roasting					
Frying					
Others (Specify)					

Section F: Food security

1. Main food stuff (Crop based)

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

2. Livestock related
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

3. Sources of food (Indicate the response by placing a tick (√) in the box):

Produced [ ]

Bought [ ]

Relief [ ]

Gathered [ ]

Relatives/ Well wishers [ ]

Others (Specify) …………………………………………………………….

4. Rate your household's access to food using the following Scale: Very Poor, Poor, Moderate, Good, Very Good)

Maize…………………………………………………………….

Beans…………………………………………………………….

Sorghum………………………………………………………….

Milk…………………………………………………………….

5. The items on the table below are on household food security. How frequently have you found yourself in those situations in the last one year. Use the given scale

Scale: Never, Rarely, occasionally, Often, Very Often

Statement	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Often**
Borrowing food					
Relying on less preferred or less expensive food					
Seek help from a relatives/friends to access food					
Purchasing food on credit					
Gathering food (wild fruits, hunt, harvest immature crops)					
Consuming seed stock held for next season					
Sending household members to eat elsewhere					
Sending household members to beg					
Limiting amount of food eaten during meals					
Restricting consumption by adults in order to allow children to eat					
Reducing the number of meals eaten in a day by the household					
Going for an entire days without eating					
Worried that the household does not have enough food					
Family members not able to eat the kinds of foods they prefer					
Household eating limited variety of food					
Family eating food that they do not want to					

eat					
Eating smaller quantities than needed					
Forced to eat fewer meals in a day					
No food for the house hold					
Household going to sleep at night hungry					
Household going for a whole day without eating					
Others (Specify)					

Section G: Qualitative data

i. State utmost three major food security challenges

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

ii. Give utmost three suggestions that can be used to enhance household food security

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

Thank you

Appendix B: Key Informants Focus Group Discussion Guide

A. Details of the discussion

1. Location of the discussion ……………………………………………..
2. Date …………………………………………………………………
3. Participants Personal details
   ……………………………………………………………………………………
   …………………………………………………………………………………

B. Introduction

1. Researcher welcomes the group, introduces himself and explains to participants the purpose of the study
2. The reserchers explains to the participants the discuss process/guidelines

C. Indigenous knowledge

1. Engage participants in a discussion so as to establish the Knowledge (modern and IK) strategies and specific areas applied
   …………………………………………………………………………………
   …………………………………………………………………………………
   ………………………………………………………………………………….

D. Climate Change strategies

1. Seek information on climate (drought, floods, erratic rainfall, high temperatures unpredictable wheather conditions etc)
   ………………………………………………..
   ……………………………………………………………………………………
2. Focus the discussion on strategies adopted to cope with climate changes (I.K and modern)
   ……………………………………………………………………………………
   ……………………………………………………………………………………

E. Food production

1. Discuss the main stapple food (crops and livestock based) of household in the county
   ……………………………………………………………………………………
   ……………………………………………………………………………………
2. Examine the food production (crops and livestock based) practices of households (use of modern approached and indigenous knowledge based)
   …………………………………………………………………………………..
   ....

F. Pests, Parasite and diseases control

1. Examine common pests, parasite and diseases (crops and livestock)
   ……………………………………………………………………………………
   ……………………………………………………………………………………

2. Specific methods used to control pests, parasite and diseases ………………………………………………………………………………………………………
………………………………………………………………………………………………………
   a. Indigenous Knowledge strategies
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   b. Modern knowledge strategies
   ………………………………………………………………………………
   ………………………………………………………………………………

G. Food Storage

1. Discuss food storage and preservation methods practiced by households (facilities, processes and practices)
   ………………………………………………………………………………………
   ………………………………………………………………………………………
2. Focus on indigenous knowledge strategies (identify the strategy, purpose and process)
   ………………………………………………………………………………………
   ………………………………………………………………………………………

H. Food security

1. Discuss the staple food of the households (crop and livestock based)
   i. Food production (crops and livestock)
   ii. Food accessibility in a given year
   iii. Strategies adopted to ensure food security

I. Integration of Indigenous knowledge into extension services

1. Probe on the extent of integrating indigenous knowledge into agricultural extension service

NOTE: The discussion should take around 45 minutes and the proceedings be recorded on paper, and using an audio or video recorder

Appendix C: Extension Staff Questionnaire

Dear Extension Staff,

My name is Shadrack K. Cheplogoi, a PhD student at Egerton University. I am currently conducting a research titled "*Influence of Indigenous Knowledge Coping Strategies on Household Food Security in Baringo County, Kenya"* as part of the course work. I believe you have information that can contribute significantly to the success of the study. I am kindly requesting you to participate in the study by filling this questionnair. Please note that any information provided will be treated with utmost confidentiality and used for academic purposes only.

Thanks in advance for your kind support.

Shadrack K. Cheplogoi

Instructions

i. Do not write your name on the questionnaire.
ii. Indicate the response by placing a tick (√) in the selected cell/box or provide the required information in the given spaces.

Section A: Personal Information

1. Gender: Male ( ) Female ( )
2. Age group: Below 25 ( ) 25 - 40 ( ) Above 40 ( )
3. Ward ……………………………………………………………
4. Highest Educational level: Certificate **(**) Diploma ( ) Degree ( ) Post Graduate ( )
5. Number of years as an extension staff in the sub county
   Below 5 years ( ) 5-10 years ( ) Above 10 years ( )

Section B: Agriculture Knowledge

1. How frequently do you provide extension services to households engaged in farming?
   ………………………………………………………………………………………
   ………………………………………………………………………………………..
2. Indicate the agriculture knowledge that is imparted to local communities that are engaged in farming by extension staff Modern [ ] Indigenous [ ]
3. Indicate the knowledge that is used by local communities in their farming activities Modern [ ] Indigenous [ ]

4. List the Indigenous knowledge practices adopted by households
   Crop farming ……………………………………………………………………….
   …………………………………………………………………………………
   …………………………………………………………………………………
   Livestock keeping……………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………

Section C: Climatic Change

1. Have you noticed any significant changes in the climate in the recent years? Yes ( ) No ( )
2. If the answer to item C1 is "yes" indicate the changes noted:
   a. Unusual floods [ ]
   b. Frequent drought [ ]
   c. Extreme temperatures [ ]
   d. Erratic rainfall [ ]
   e. Unpredictable weather [ ]
   f. Others (specify)
   ………………………………………………………………………………..
3. Have the changes in climate affected the agriculture activities of local households? Yes ( ) No ( )
4. List the strategies that have been adopted by the local households engaged in agriculture to cope with the climatic changes
   a. Strategies based on indigenous knowledge
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
   b. Strategies based on modern knowledge
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………

Section D: Food Production

1. List the food crops by households in your Ward
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………

2. List the modern strategies used by the households to grow food crops during:
   Clearing land…………………………………………………………………
   Ploughing …………………………………………………………………
   Seed selection ……………………………………………………………
   Planting …………………………………………………………………
   Weeding………………………………………………………………….
   Harvesting…………………………………………………………………
3. State the indigenous knowledge strategies used by households in crop production during:
   Clearing land…………………………………………………………………
   Ploughing …………………………………………………………………
   Seed selection …………………………………………………………..
   Planting ……………………………………………………………...
   Weeding…………………………………………………………………
   Harvesting…………………………………………………………………
4. List the livestock animals kept by households in your Ward
   ………………………………………………………………………………
   ………………………………………………………………………………
   ………………………………………………………………………………
5. List the modern strategies used by the households to keep livestock in the areas given below:
   Breed selection …………………………………………………………..
   Feeding ……………………………………………………………………….
   Insemination ……………………………………………………………………..
   Parasites and diseases control ……………………………………………........................
6. State the indigenous knowledge strategies used by households to keep livestock in the areas given below:
   Breed selection …………………………………………………………..
   Feeding ……………………………………………………………………….
   Insemination ………………………………………………………………………
   Parasites, pests and diseases control …………………………………………...............

Section E: Pest, Parasites and diseases control

1. Give lists of the following:

   Common crop pests in the Ward……………………………………………………

   Crop diseases ……………………………………………………………………

   Livestock animal parasites ……………………………………………………..

   Animal diseases …………………………………………………………………
2. State indigenous knowledge strategies used by households to control crop pests
   ………………………………………………………………………………
   ………………………………………………………………………………
   ………………………………………………………………………………

3. List the indigenous knowledge strategies used by households to control crop diseases
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
4. What are indigenous knowledge strategies used by households to control livestock parasites?
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
5. List the indigenous knowledge strategies used by households to control livestock diseases
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

Section F: Food storage

1. List the facilities used by household to store food crops in the Ward
…………………………………………………………………………………………
…………………………………………………………………………………………
2. List the facilities used by household to store food products from livestock
…………………………………………………………………………………………
…………………………………………………………………………………………
3. Facilities/methods used to preserve crop products
…………………………………………………………………………………………
…………………………………………………………………………………………
4. Facilities/methods used to preserve livestock products
....
…………………………………………………………………………………………
5. Do households in the Ward use indigenous knowledge strategies to store /preserve food stuff
Yes [ ] No [ ]
6. It the answer to the above is "yes" state the storage facilities for:
- Crop products………………………………………………………………………
…………………………………………………………………………………..
…………………………………………………………………………………..
……………………………………………………………………………………
- Animal products ……………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
7. List the indigenous preservation methods/facilities used by the households for:
- Crop products………………………………………………………………………
…………………………………………………………………………………..

………………………………………………………………………………..
Animal products …………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

Section G: Food security of households

1. What are main food crops of households in the ward
   ………………………………………………………………………………
   ………………………………………………………………………………..

2. Animals kept by households in the Wards livestock
   ………………………………………………………………………………….
   ………………………………………………………………………………..

3. Rate your household's access to food using Very Poor [ ] Poor [ ] Moderate [ ], Good [ ] Very Good [ ]
4. Give at most three (3) major food security challenges faced by households in the ward
   ………………………………………………………………………………………
   ………………………………………………………………………………………

5. Give atmost three suggestions that can be used to enhance food security of households in the ward
   ………………………………………………………………………………………
   ………………………………………………………………………………………

H. Integration of indigenous knowledge into agricultural extension services

1. To what extent is indigenous knowledge integrated into agricultural extension services?
   ………………………………………………………………………………………
   ………………………………………………………………………………………
2. What strategies are used to integrate indigenous knowledge practices into agricultural extension service.
   ………………………………………………………………………………………
   ……………………………………………………………………………………….

Thank you

Appendix D: Indigenous Knowledge Strategies Observation Checklist

Division ________________________ **Ward____________________________**

A. Indigenous Knowledge Climate Change Strategies

i. Water harvesting/Irrigation ……………………………………………………….
ii. Crop diversity ………………………………………………………………
iii. Mixed farming ………………………………………………………………
iv. Mulching ……………………………………………………………………….
v. Terracing……………………………………………………………………..
vi. Seed mixing……………………………………………………………………..
vii. Organic farming…………………………………………………………...
viii. Livestock kept ……………………………………………………………….
ix. Breeds kept ……………………………………………………………………
x. Others (specify) …………………………………………………………..

B. Indigenous Knowledge Food Production Strategies

i. Crops
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

ii. Livestock
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

C. Indigenous Knowledge Processing/Storage/Preservation strategies

i. Crops products processing strategies
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

ii. Storage facilities for products from crops
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

iii. Preservation of products from crops
………………………………………………………………………………
………………………………………………………………………………
……………………………………………………………………………..…

iv. Livestock products processing strategies
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

v. Storage facilities for livestock products
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

vi. Preservation of livestock products
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

D: Indigenous Knowledge Pests and Diseases Control Strategies

i. Crops
…………………………………………………………………………………………
…………………………………………………………………………………………
………………………………………………………………………

ii. Livestock
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

E: Food Security

i. Land owned ………………………………………………………………….

ii. Land under crops ……………………………………………………………

iii. Crops grown ………………………………………………………………….

iv. Animals kept …………………………………………………………………

v. Stored food crops ……………………………………………………………

vi. Preserved livestock products ………………………………………………..

F: Other observations relevant to the study with respect to:

a. Quality of food accessible to the household ……………………………………

b. Quantity of accessible food …………………………………………………….

c. Acceptability of accessible food ………………………………………………….

d. Stability of accessible food ……………………………………………………

e. Diversity of accessible food ……………………………………………………

Appendix E: University Authorization Letter

EGERTON
Tel: Pilot: 254-51-2217620
254-51-2217877
254-51-2217631
Dir.line/Fax: 254-51-2217847
Cell Phone
Extension; 3606

UNIVERSITY
P.O. Box 536 - 20115
Egerton, Njoro, Kenya
Email: bpgs@egerton.ac.ke
www.egerton.ac.ke

OFFICE OF THE DIRECTOR GRADUATE SCHOOL

Ref.....ED12/0408/13 **Date:.......30th July, 2018**

The Director General
National Commission for Science Technology and Innovation
P. O. Box 30623-00100,

NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – SHADRACK K. CHEPLOGOI NO. ED12/0408/13

This is to introduce and confirm to you that the above named student is in the Department of Agricultural Education & Extension, Faculty of Education and Community Studies, Egerton University.

He is a bonafide registered PhD student in this University. His research topic is entitled **"Influence of Indigenous Knowledge Coping Strategies on Household Food Security in Baringo County, Kenya."**

He is at the stage of collecting field data. Please issue him with a research permit to enable him undertake the studies.

01 AUG 2018

Yours faithfully,

Prof. Nzula Kitaka
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

NK/ear

"Transforming Lives Through Quality Education"
Egerton University is ISO 9001:2008 Certified

Appendix F: NACOSTI Authorization Letter

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/96200/27220**

Date: **12th December, 2018**

Shadrack Kemboi Cheplogoi
Egerton University
P.O. Box 536-20115
NJORO

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"*Influence of indigenous knowledge coping strategies on household food security in Baringo County, Kenya*"** I am pleased to inform you that you have been authorized to undertake research in **Baringo County** for the period ending **12th December, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Baringo County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Baringo County.

The County Director of Education
Baringo County.

Appendix G: NACOSTI Research Permit

THIS IS TO CERTIFY THAT:
MR. SHADRACK KEMBOI CHEPLOGOI
of EGERTON UNIVERSITY, 0-20115
Egerton,has been permitted to conduct research in *Baringo County*

on the topic: *INFLUENCE OF INDIGENOUS KNOWLEDGE COPING STRATEGIES ON HOUSEHOLD FOOD SECURITY IN BARINGO COUNTY, KENYA*

for the period ending:
12th December,2019

Permit No : NACOSTI/P/18/96200/27220
Date Of Issue : 12th December,2018
Fee Recieved :Ksh 2000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 22351

CONDITIONS: see back page

Appendix H: Ministry of Education Letter

REPUBLIC OF KENYA

MINISTRY OF EDUCATION
STATE DEPARTMENT OF EARLY LEARNING & BASIC EDUCATION

OFFICE OF THE COUNTY DIRECTOR
(**BARINGO**).

Our Email:countyedubaringo@gmail.com
Tel / Fax: 053/21282

P.O. BOX 664
KABARNET

REF: BAR/CDE/RESEARCH.GEN/VOL.11/24

02/01/2019

Shadrack Kemboi Cheplogoi
Egerton University
P. O. Box 536 - 20115
Njoro

RE: RESEARCH AUTHORIZATION.

Reference is made to your request letter Ref No. NACOSTI/P/18/96200/27220 dated 12th December, 2018 on the above subject.

I am pleased to inform you that you have been authorized to carry out research on ***"Influence of indigenous knowledge coping strategies on household food security in Baringo County, Kenya"*** for the period ending **12th December, 2019**. The authorities concerned are therefore requested to give maximum support so that this research is completed within schedule.

I take this opportunity to wish you well during this research in our County.

For: COUNTY DIRECTOR OF EDUCATION
BARINGO
P. O. Box 664 - 30400
KABARNET

John Biwott
For : County Director of Education
Baringo County.

Appendix I: County Commissioner Authorization Letter

OFFICE OF THE PRESIDENT

Telephone. 053-21285
Fax. (053)-21285
E-Mail:
baringocountycommissioner@yahoo.com
baringocountycommissioner@gmail.com

When replying please quote:

MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT

COUNTY COMMISSIONER'S OF
BARINGO COUNTY,
P.O. BOX 1 - 30400
KABARNET.

REF.NO.ADM.18/2 VOL.II/42

2ND JANUARY, 2019

To whom it may concern:

RE: RESEARCH AUTHORIZATION

Reference is made to a letter Ref. No. NACOSTI/P/18/96200/27220 dated 12th December, 2018 from the Director-General/CEO NACOSTI.

This is to confirm that Shadrack Kemboi Cheplogoi of Egerton University has been authorized to carry out research on ***"Influence of indigenous knowledge coping strategies on household food security in Baringo County"*** *for* the period ending **12th December, 2019**

Please accord him the necessary support.

HENRY WAFULA
COUNTY COMMISSIONER
BARINGO COUNTY

COUNTY COMMISSIONER
BARINGO COUNTY
P.O.

NB: You are requested to submit a soft copy of research report to this office.

Appendix J: Journal Publications

International Journal of Scientific Research and Innovative Technology *Vol. 8 No. 4; May 2021*

Implications of Indigenous food storage and preservation strategies on household food security in Baringo County, Kenya

Cheplogoi, S. K., Udoto, M. O & Ombati, J. M

Egerton University, Department of Agricultural Education & Extension

Corresponding: Shadrack K. Cheplogoi. Email: shadrack.cheplogoi@egerton.ac.ke

Abstract

Post-harvest losses is one of the bottle necks for achieving household food security especially among small holder farmers. The fundamental elements of food security which include availability, access, utilization and stability demands proper food storage and preservation. This paper examined the implication of indigenous storage and preservation strategies on household food security in Baringo County, Kenya. The study surveyed 140 households randomly selected from four wards in Baringo North and South Sub counties of Baringo County. Regression test was performed to establish the influence of indigenous storage and preservation strategies on household food security. The results indicates that indigenous storage and preservation strategies significantly influenced household food security. It was also established that indigenous food storage and preservation practices targeted mainly staple foods. The outcome of the study could be useful in informing farmers, stakeholders and policy makers in the ministry of Agriculture to integrate indigenous knowledge based innovations on storage and preservation into extension messages.

Key words: Indigenous Knowledge, Food Security, food storage and preservation.

ijar
ISSN NO. 2320-5407
Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/13672
DOI URL: http://dx.doi.org/10.21474/IJAR01/13672

RESEARCH ARTICLE

DIVERSIFICATION OF INDIGENOUS AGRICULTURAL PRACTICES AND IMPLICATIONS ON HOUSEHOLD FOOD SECURITY: PRACTICES AND LESSONS FROM LOCAL COMMUNITIES OF BARINGO COUNTY, KENYA.

Cheplogoi S.K., Ombati J.M. and Udoto M.O
Department of Agricultural Education & Extension, Egerton University, Njoro, Kenya.

Manuscript Info

Manuscript History
Received: 31 August 2021
Final Accepted: 30 September 2021
Published: October 2021

Key words:-
Indigenous, Climate Change, Diversification, Household, Food Security

Abstract

An estimated 690 million people worldwide are hungry denying them the fundamental human right on food. Agriculture, which ought to play a crucial role of sustaining household food security is climate sensitive, hence suffer from the effect of climate change and variability.The fundamental elements of food security which include availability, access, utilization and stability have become untenable. This paper examined the indigenous agricultural diversification strategies and their implication on household food security in Baringo County, Kenya. Descriptive survey design was used in the study. A sample of 140 households and 12 Agricultural Extension staff were selected using purposive, proportionate and simple random sampling techniques. Questionnaire, Focus group discussion guide and observation checklist were used to collect data. The findings indicated that a wide range of diversification strategies including knowledge and skill based, enterprise based, diet based, food sources, farming routines and storage based diversification were adopted by households.The study concluded that diversification strategies were mitigation measure against climate change and food insecurity. The study recommended the up scaling best practices of diversification to improve household food security.

Introduction:-

Food insecurity is a global concern considering that over 690 million people worldwide still go to bed hungry each night (Food & Agriculture Organization [FAO], 2020). Agriculture, which is the main economic activity for most rural households plays an indispensable role in ensuring sustainable food security (Salami, 2020; Simatimbe et al., 2018). However, agriculture being climate sensitive is severely affected by climate change and increasing climate variability which negatively affect agricultural productivity and food production consequently impacting on food systems and rural livelihoods (FAO et al., 2019).Similarly, Gwambene and Liwenga (2016)opined that livelihoods of people who depend on climate sensitive agricultural resources are particularly vulnerable.