DETERMINANTS OF FOOD CROP DIVERSIFICATION AMONG SMALLHOLDER MAIZE FARMERS FOR ENHANCED FOOD SECURITY IN BOMET COUNTY, KENYA

EVERLYNE CHEROTICH MWANGANGI

A Thesis Submitted to the Board of Graduate Studies in Partial Fulfillment of the Requirements for the Conferment of the Degree of Master of Science in Agricultural Economics and Resource Management of the University of Kabianga

UNIVERSITY OF KABIANGA

FEBRUARY 2021

DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has not been presented for the conferment of a degree or award of a diploma in this or any other university:

Signature…… Date…….

EVERLYNE CHEROTICH MWANGANGI

AGR/PGEC/011/11

Approval

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

Signature…….. Date…….

PROF. CHRISTOPHER O. GOR

Department of Agricultural Economics and Agribusiness Management

Jaramogi Oginga Odinga University of Science and Technology

Signature…….. Date……..

PROF. MICHAEL E. OMUNYIN

Department of Horticulture

University of Kabianga

DEDICATION

I dedicate this work to my beloved husband Martin for his constant support, understanding and encouragement. This work is also dedicated to my children, Eddah, Patricia, Lyndah, Mary and Ines for enduring my minimal presence during my busy moments undertaking the study. Lastly, this is to my parents for laying the foundation of my education. I love you all.

ACKNOWLEDGEMENTS

All glory and honor be unto the Almighty God for giving me an opportunity and good health in my entire study and research period.

My gratitude goes to my supervisors Prof. Christopher O. Gor and Prof. Michael E. Omunyin for their dedication in guidance and follow-up throughout my proposal development, research and compilation of this thesis. My own efforts would not have yielded much without their assistance.

Thanks to the University of Kabianga for the opportunity to pursue my masters with a lot of flexibility. Special thanks to the academic staff for their tireless efforts and dedication in encouragement throughout the course and the Board of Graduate Studies headed by Prof. Joash Kibett for the constant encouragement and close follow-up on my work.

In addition, I thank all my respondents for providing information during research. The great help from research assistants who guided me through the research area to meet respondents on scheduled appointments will not go unrecognised; I really appreciate your dedication.

I also thank my classmates for their support and encouragement during my studies. My workmates are not forgotten for their support and encouragement too while undertaking my research and compiling this report. Finally, I appreciate the help of anyone unmentioned here who helped me in one way or another to accomplish this work, God bless you all.

ABSTRACT

Food crop production by smallholder farmers has encountered various challenges of which climate change (CC), pests and diseases are the most common. Global quest for enhancement of food security and reduction of poverty is evident as it is enshrined in policy statements such as the Green Revolution, Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). Overreliance on one type of food crop worsens the impact of CC on food security. Practicing diversification through production and utilization of alternative food crops is one of the key climate-smart strategies to mitigate risks from CC, pests and diseases. This study was undertaken with the three objectives namely to; determine the extent of food crops diversification, Identify factors influencing diversification of food crops production by smallholder maize farmers. This study explored diversification in the food crop subsector, an area that has not been ventured in by other researchers who majorly focused on diversification to the horticulture subsector. This study used cross-sectional survey and descriptive research designs. Stratified random sampling was used to sample three hundred and forty one (341) smallholder maize farmers in Sotik, Bomet East and Chepalungu Sub-counties from a target population of three thousand and ninety four (3094) maize farmers. Fifteen (15) ward extension officers were also targeted. Primary data was collected using an interview schedule for the maize farmers while a questionnaire was used for the extension staff. Secondary information was also obtained from the Agriculture directorate in the county. The Statistical Package for Social Science (SPSS) version 20, Microsoft excel and STATA version 14 was used to process data for analysis. Herfindahl Index was used to analyze the extent of diversification while Tobit regression model was applied to analyze its determinants. The pattern of diversification was deduced from the tabulated records of food crops grown in the area of study within the cropping year in consideration of the three previous years of production. Results from the study indicated that the maize farmers were low to moderately diversified on food crops production with a mean CDI of 0.4974. Socio-economic factors that influence food crop diversification were civil status of the household head, Age, Experience in farming and farm size. Access to credit and perceived availability of markets impacted positively on food crop diversification in the area of study with access to credit being the highest contributor to CDI with an impact of 18%. Additionally, extension service provision by private and public sector had a positive impact on food crop diversification. Food crop production pattern in the county was found to be bi-modal with Maize, sorghum, finger millet and beans while Irish and sweet potatoes were grown throughout the year. Based on the study results, the following recommendations were made; Encourage food crops production among the young and educated, improve access and control of land use, enhance extension service provision and foster public private partnership (PPP), provide farmer friendly credit products, Avail quality food crops production inputs on time, facilitate the farmers' groups on establishing market linkages and other forms of collective marketing and train farmers on record keeping. Finally, this research recommends further research on the economic efficiency of food crop diversification.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ASDS Agricultural Sector Development Strategy

AGRA Alliance for a Green Revolution in Africa

ASALs Arid and Semi-Arid Lands

AWSC African Women Studies Centre

CAADP Comprehensive Africa Agriculture Development Programme

CC Climate Change

CDI Crop Diversification Index

CEO Chief Executive Officer

CGoB County Government of Bomet

CSA Climate Smart Agriculture

FAO Food and Agricultural Organization

FAW Fall Armyworm

GDP Gross Domestic Product

GoK Government of Kenya

GTZ German Technical Cooperation Agency

HH Household

HHH Household Head

HVCs High Value Crops

KALRO Kenya Agriculture and Livestock Research Organization

KARI **K**enya Agricultural Research Organization

KES Kenya Shillings

KNBS Kenya National Bureau of Statistics

LH Lower Highlands

LM Lower Midlands

MASL Meters Above Sea Level

MDG Millennium Development Goals

MI Marghalef's Index

MM Millimeter

MLND Maize Lethal Necrosis Disease

MoA Ministry of Agriculture

NACOSTI National Commission for Science, Technology and Innovation

NCPB National Cereals and Produce Board

NEPAD New Partnership for Africa's Development

PPP Public Private Partnership

SAI	Sustainable Agricultural Intensification
SAPs	Sustainable Agricultural Practices
SDGs	Sustainable Development Goals
SSA	Sub Saharan Africa
SPSS	Statistical Package for Social Scientists
THI	Transformed Hefindhal's Index
UM	Upper Midland
UN	United Nations
UNDP	United Nations Development Programme
OSAA	Office of the Special Adviser on Africa
WFP	World Food Programme

DEFINITION OF TERMS

Diversification: The reallocation of resources, particularly arable land at the accessibility of farmers to accommodate a more varied cropping pattern. The opposite of diversification is specialization whereby firms concentrate their resources on one or a small number of enterprises.

Ceteris paribus: All factors held constant.

Climate change: Changes in Earth's climate system resulting in new weather patterns that remain in a place for an extended period of time

Climate Smart Agriculture: An integrated approach to managing landscapes to help adapt agricultural methods, livestock and crops to the ongoing human-induced climate change.

County: This is a devolved unit of government as defined in the Constitution of Kenya 2010 in Article 6 (1). In the context of this study, county refers to Bomet county.

Credit access: This is the access to financial services which include; loans – monetary or in kind, insurance and other risk management services.

Crop Diversification Index: a measure of crop diversification, otherwise known as Transformed Herfindahl Index

Food security: A situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life, as defined by the World Food Summit.

Household: A house and its occupants regarded as a unit (Dictionary definition). It is a domestic unit consisting of the members of a family who live together along with non-relatives (Sabila 2014). For this study, a household is a maize growing household.

Household head: The most responsible member of the household who makes key decisions on the household on a day to day basis and whose authority is recognized by all members of the household.

Smallholder farmer: Is defined as a farmer who lives and manages farm areas less not more than 2Ha hectares, though varied in different parts of the world. (FAO, 2015)

Sustainable Agricultural Intensification (SAI): a concept challenging global agriculture to achieve a doubling in world food production while sustaining the environment.

Sustainable Agricultural Practices (SAP): Farming practices that enable society to meet its food and textile requirement without

Food crop: A plant which provides food for human consumption, agriculturally cultivated by man

Extension: Process of disseminating information to users, in this case, dissemination of agricultural information to farmer.

Socio-economic factors: These are social and economic experiences and realities that mold characteristics, attitudes and lifestyle of a household.

Market related factors: Factors that affect the demand for of the price of a good or service hence influencing its production.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter provides the background information, statement of the problem, general and specific objectives of the study, hypothesis, justification, significance, scope, limitations and assumptions of the study.

1.2 Background of the Study

Over time, the world has been grappling with hunger and poverty. Every time these subjects arise, agricultural sector performance is viewed as a strategy to food security, economic growth and poverty reduction. In this regard, many countries in the world have strategized to eradicate poverty and hunger through agriculture development as documented in many global policy statements on hunger and poverty eradication. For example, the Green Revolution which was initiated in the 1960's to address the issue of malnutrition in the developing world (Sebby, 2010). This was a technological response to a world-wide food shortage which became a threat in the period after the World War 2. According to Fitzgerald & Parai (1996) (cited in Sebby2010), the green revolution transformed farming practices Fitzgerald & Parai (1996) in many regions of the tropical and sub-tropical regions where the principal food crops were rice, wheat and maize. The technology utilized the use of new high-yielding varieties of seeds as well as chemical fertilizers. The green revolution has been credited with increasing yields in many places where it was adopted, however, the benefits have been unequal across regions and groups (Sebby, 2010). This inequality in development is partly attributed to; global variation in resource endowment,

environmental degradation due to introduction of chemical pests and disease control on the more vulnerable new crop varieties and gender disparities in access to resources for production (FAO, 1995).

Second was the World Food Summit, Rome declaration in 1996. One hundred and eighty two (182) governments pledged to eradicate hunger in all countries with an immediate view to reducing the number of undernourished people to half their present levels then, not later than the year 2015 (FAO, 2001). This declaration used globalization of trade, communication and environmental management approach to achieve its goals. This strategy led to developed countries allocating of more resources to uplift the developing countries leading to reduced number of malnourished people globally, (FAO, 2009).

Third is the United Nation's (UN) Millennium declaration of the year 2000. One eighty nine (189) nations pledged to relief people of numerous deprivations, acknowledging every individual's right to dignity, freedom, equality as well as basic standards of living which include freedom from hunger and Violence (FAO, 2015). This declaration committed nations to a new global partnership to reduce extreme poverty and set out a series of eight time-bound targets that have become known as Millennium Development Goals (MDGs), with a deadline of 2015 (FAO, 2016a). The first of the eight MDGs was to eradicate extreme poverty and hunger. This was however met with many challenges such as; Gender inequality, climate change and environmental degradation, conflicts and inequality in access to basic service. MDGs gave way to Sustainable Development Goals which adopted and expounded on the unmet MDGs.

Sustainable Development Goals (SDGs), otherwise known as Global Goals were developed in 2015. SDGs are a universal call to action for poverty eradication, planet protection and ensuring all people enjoy peace and prosperity; building on the success of MDGs (UNDP, 2015b). The

second of these goals is to end poverty, achieve food security and improve nutrition and promote sustainable agriculture. It is however recognized that, eradicating poverty in all its forms and dimensions including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development (FAO, 2016b).

Globally, progress in the fight against hunger continues yet an unacceptably huge number of people are still food insecure (FAO, IFAD & WFP, 2015). The number of undernourished people in 2016 increased to 815 million which is higher than 777 million of 2015 (FAO, IFAD, UNICEF, WFP and WHO, 2017). In Kenya, 26% of children less than five years were stunted, depicting chronic undernourishment in 2017, which was also higher in Bomet county at 31-39%, (GoK, 2017).

In recognizing that agriculture is key to her development towards global goals of ending hunger and poverty, Africa developed a comprehensive policy framework for transformation of the sector; Comprehensive Africa Agriculture Development Programme (CAADP) also known as Maputo declaration, 2003. CAADP is Africa's policy framework for agricultural transformation, wealth creation, food and nutrition security, economic growth and prosperity for all. The framework advocates for reforms in the sector, key ones being a growth of 6% annually in Agricultural GDP and at least 10% allocation from the public expenditure to agriculture sector. Africa acknowledges that enhanced performance of the agricultural sector is key to economic growth and poverty reduction by directly contributing to job creation, increasing opportunities for women and youth, food and nutrition security and enhancing resilience (FAO 2016). Dr. Ibrahim Assane Mayaki, Chief Executive Officer (CEO) for the NEPAD agency, puts it clear when he remarked that agriculture is everyone's business and that national independence is anchored on its development because it enables countries to come out of the scourge of food

insecurity which plays a key role in defaming their sovereignty. In addition, he acknowledged agriculture as a key driver of growth whose power is also acknowledged by economists and political leaders since it is the sector offering enormous potential for poverty and reduction of inequality (NEPAD, 2015b).

Agriculture is the mainstay of the Kenyan economy and currently contributes 26 percent of the National GDP directly and another 25 percent indirectly. The sector is not only the driver of Kenya's economy but also the means of livelihood for the majority of Kenyan people (GOK, 2010). The country is a signatory to global and continental policy framework for development. In this regard, Kenya developed a blue print, Kenya Vision 2030, which begun in 2008 and ends in the year 2030. The objective of this blue print is to transform Kenya into a newly industrialized, middle income country providing high quality of life to all its citizens by the year 2030 (GOK, 2010). Under this blue print, Agricultural development is recognized as one of the Key sectors to contribute to a 10 per cent annual economic growth under the economic pillar. In this regard, Kenya's Agricultural Development Strategy (ASDS) was developed to position the sector as the key driver in delivering to the achievement of the vision's goals. The government also developed the Kenya Comprehensive Africa Agriculture Development Programme (Compact) which commits Kenya to vision, principles and strategy fundamentals of CAADP-NEPAD. ASDS and CAADP Compact acknowledges the agricultural sector as a potential engine for national economic growth and also as a critical component at household and community levels, thereby producing benefits for the entire economy (GOK, 2010)

Following the enactment of the new constitution in 2010, most of the agricultural sector's functions were decentralized to the county governments as specified in schedule 4 which is the development of agricultural policy and veterinary policy. Counties are therefore expected to

drive the double digit growth envisioned in the Kenya Vision 2030 in addition to ensuring food and nutritional security, in collaboration with the national government through resource allocation and implementation of policies and strategies (KIPPRA, 2016).

In Bomet county, agriculture is one of the key sectors targeted to bring out development in the county as documented in the County Integrated Development Plan (CIDP). Poverty and food insecurity however still remains a foremost challenge in the county (County Government of Bomet, 2013). Agriculture can alleviate poverty by enhancing food security, creating employment and generating income to the county's population.

The constitution of Kenya 2010 assures all Kenyans of the right to access safe food of adequate quality and quantity to satiate their nutritional requirements for ideal health. Despite the determinations by the government and other stakeholders to safeguard her citizens of this basic right to food security, agricultural sector is antagonized by numerous uncertainties. The sector is more susceptible to the impacts of climate change. Effects of climate trends on crop production are usually more devastating than positive (FAO, 2016a). Further, rain-fed agriculture is even more vulnerable to climate change about 90 percent of Sub-Sahara Africa population depends on rain-fed agriculture for food (AGRA, 2014). It is evident that the impact of climate change has detrimental socio-economic effects such as food shortages, disruption of water supplies, energy and other vital basic commodities and long term food insecurity. In addition, trans-boundary plant pests and diseases cause significant food crops damages consequently threatening food security. Spread of trans-boundary plant pests and diseases has increased in the recent past (FAO, 2017).

Effect of CC on food security is worsened by overreliance on one type of crop for food. Over time, food crop farmers in Bomet county have heavily depended on maize for food and income. Maize is the main staple food crop as well as great source of income and employment for most households in the county, (MOA, 2012). In this context, food security is the ability to produce rather than buy or import in order to meet consumption needs. Rural families in Bomet county grow most of what they eat, hence the crop varieties they grow should be of high nutrition content, high yielding and more resilient to effects of CC, drought and pests (NEPAD, 2015). This would foster self food sufficiency with surplus to sell for income to cater other household needs.

Maize production has faced a number of challenges in Bomet County owing to the prevalence of Maize Lethal Necrosis Disease (MLND) in the county. The first occurrence of MLND in Kenya was reported in September 2011 in the low altitude zones of Bomet county, Longisa division, (1900 meters above sea level- m.a.s.l) affecting 200 ha of second season maize crop. The effects of the disease were sudden; devastating and could not be explained. The cause of the problem was unknown (then); the local farmers called it 'Koroito' which is the vernacular name for plague. By the end of 2011 the disease had spread to high altitudes of the county -2100 m.a.s.l. In 2012, MLND was very severe in Bomet County causing up to 100% crop yield losses (MOA, 2012).

Maize Lethal Nechrosis Disease emerged rapidly as one of the deadliest maize diseases capable of causing a total yield loss under heavy attack (Wawa, 2015). Furthermore, the county also had an experience with Fall Armyworm (FAW) in 2017 (FAO, 2017). Attack on maize at vegetative stage can result to 100 percent crop loss if no control measure is taken (KALRO, 2017). According to Association of Kenya Insurers' survey, 2016, pests and diseases are the biggest

challenges faced by farmers at 67% while climate change is second at 36%. The situation of overreliance on maize should therefore change in consideration of all the catastrophes impacting on crop production currently for the county to attain food self-sufficiency.

1.3 Statement of the Problem

The objective of the agriculture sector in Kenya is achievement of national self-sufficiency in food security; in fact, food security is enshrined in the constitution of Kenya, 2010. This however cannot be attained if the households are not self-sufficient. For the last three years, production trends of maize in Kenya has been on the decline; In 2016, production was 38.8 million bags down from 42.5 million bags in 2015 and further down to 35.4 million bags in 2017 (KNBS, 2018). This was due to reduced rainfall amounts and prevalence of pests and diseases among other challenges.

In Bomet county, maize production has faced various challenges including unreliable rainfall patterns, MLND and FAW infestation. Despite of the favorable climatic conditions to various alternative food crops such as sorghum, finger millet, Irish potatoes, sweet potatoes and beans, Poverty and food insecurity levels in the county are still unacceptably high. Wakibi, Gichuhi, & Kabira (2015) on their report, food security score for Kenya, showed that Bomet county is 16.3% food insecure. Furthermore, there is seasonality in food availability in the county raising food insecurity further to 23% during low seasons of food availability, rendering 60% of female headed and youth headed households food insecure between January and April annually.

Diversification to alternative food crops which are drought tolerant, tolerant to pests and have high resistance to diseases is one of the key strategies of minimizing poverty and food insecurity and economically empower household by providing additional income. The potential of food

crop diversification however has not been fully exploited in the county. Furthermore, most of the studies focus on diversification in terms of movement from cereal crops or cash crops to production of horticultural crops that are normally referred to as High Value Crops (HVC). None of these studies has focused on diversification within the food crops sub-sector hence there is no study that has been undertaken to establish its determinants or ascertain its extent and pattern in the county.

The scourge of MLND and FAW infestation on the county's staple food and the adverse effects of CC therefore necessitate need for undertaking diversification within the food crop sector. This will ensure sustainability in agricultural production, enhance food security and improve the economic status of the rural households in the county. This study will therefore provide useful information to facilitate proper development of food security strategies to safeguard the county's population from the vicious cycle of food insecurity. Other stakeholders and regions with similar challenges will also benefit from the findings of this study.

1.4 General Objective

The general objective of this study was to establish the determinants of food crop diversification among smallholder maize farmers for enhanced food security in the County of Bomet.

1.5 Specific Objectives

This study was guided by four objectives as follows:

i. To determine the extent of diversification of food crops by smallholder maize farmers in area of study

ii. Establishing determinants of food crops diversification amongst smallholder maize farmers in the area of study.

iii. To determine the pattern of food crop diversification as a solution to seasonal food insecurity by the smallholder maize farmers of Bomet county.

1.6 Hypotheses

The following hypotheses were tested by the study.

i. Smallholder maize farmers in Bomet county have not diversified on food crop production.

ii. There are no factors influencing diversification of food crop production by smallholder maize farmers in Bomet county.

iii. There is no specific pattern of food crop diversification to solve seasonal food insecurity among smallholder farmers in Bomet county does not follow any pattern.

1.7 Justification of the Study

This study sought to establish the determinants of food crop diversification among smallholder maize farmers in Bomet county. This has helped bridge the information gaps in the area of study. Despite of the effect of CC, MLND and FAW on the county's staple food crop, maize, there was no documented study on the extent of food crop diversification or its determinants. This however is a very crucial matter that required attention and this study has provided knowledge that will contribute to intervention strategies on food insecurity in the county and beyond.

1.8 Significance of the Study

This study has provided information that will bridge present knowledge deficiency in the area of study. Several scholars have ventured into studying the determinants of diversification in several parts of the world including Africa. Comparable research studies have been carried out in Kenya

but not in Bomet county. Furthermore, most of the studies focus on diversification from cereal crops to horticultural crops but not within the food crops sub- sector.

Findings from this study may be useful in decision making and planning purposes by the Department of Agriculture, other relevant departments and stakeholder organizations in the county. In addition, information generated by this study could help in resource mobilization and allocation by the relevant actors that are involved either directly or indirectly in food security matters.

Research institutions like KALRO and Universities among others may also get valuable information from the findings. This study has also provided information upon which the existing agricultural policies could be reviewed.

Finally, the national and the county governments may also benefit from this findings hence helping in implementation of policies and strategies for the improvement of food security.

1.9 Scope the Study

The study was conducted in three selected Sub-counties of Bomet county in Kenya, namely Sotik, Bomet East and Chepalungu between August and September 2018. These sub-counties were selected for the study because they are the major producers of food crops in the county. The other two sub-counties were left out because they are cash crops (tea) producers. This study focused on the smallholder maize farmers in these sub-counties. The statistical inferences from the sample size taken are representative of the whole of Bomet county.

1.10 Limitations of the Study

A structured questionnaire and an interview schedule were used in data collection and it was anticipated that all the respondents gave truthful answers to the questions. This however may not

be true; some respondents might have given inaccurate information due to various reasons such as not understanding the questions clearly, prejudice and expectation of rewards.

1.11 Assumptions of the Study

The following assumptions formed the basis of this study.

i. All respondents would cooperate and provide reliable responses during the interview. The local language was used by the interviewer to ensure that the questions were clearly understood by the respondents; and

ii. All the respondents had crop production records on the crops of interest to the study. The majority of farmers however did not have crop production records hence information from the extension offices was sought.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter highlights an overview of the existing literature in the field of crop diversification among smallholder farmers. It contains a review of related literature, theoretical framework, conceptual framework and knowledge gap.

2.2 Review of Related Literature

This section will focus on crop diversification issues related to the objectives of the study. These include review on crop diversification, levels of diversification, importance of diversification, status of maize production, selected crops for diversification and determinants of diversification.

2.2.1 Crop diversification

The concept of crop diversification expresses different meaning to different people at different levels (Ojo, Ojo, Odine & Oganji, 2014). Ellis, (2011) in Ojo *et a*l, (2014), defines diversification of activities as the process whereby rural households build up a range of activities and several assets to exist and improve their living standards. Diversification of crops can be defined as reallocation of resources, especially cultivated land at the disposal of farmers to accommodate a more varied cropping pattern (Mandal & Bezbaruah, 2013). Evans & Ngau, (1991), in the same study identify two forms of diversification namely; farm diversification (crop diversification) and farm income diversification (diversification of activities). Farm diversification involves variation of agricultural activities located within the farm while diversification of activities involves income diversification generated from different activities carried out within and outside the farm. Crop diversification involves the production of different

types of crops of similar or different species in an area rotationally and or by intercropping (Makate, Wang', Makate & Mango, 2016). This study focused on establishing the significant determinants of diversification of selected food crops among smallholder maize farmers in Bomet county. The selected food crops were sorghum, finger millet, Irish potatoes and sweet potatoes. Allocation of land by smallholder maize farmers in Bomet county amongst these selected crops was established.

2.2.2 Levels of diversification

According to Golleti (1999), cited in Masoud A.,H. (2010), agricultural diversification occurs at three levels; micro, regional and macro levels. At the micro level, the individual household diversifies in order to strengthen their income sources. This level involves both horizontal diversification which is an expansion towards new agricultural commodities and vertical diversification into non-farm activities like marketing, storage and processing. At the regional level, regions undertake agricultural activities which they have comparative advantage. At the macro-level, diversification entails an organizational shift from agriculture into non-farm activities, either in rural or urban areas or in rural towns.

Diversification refers both to the number of economic activities an economic unit is involved in and the distribution of those activities' in the total economic unit (Kimenju & Tschirley, 2008). To this study, diversification was based on the micro-level (household) which is the individual smallholder maize farmer who practice diversification to enhance food security and increase income sources**.**

2.2.3. Importance of diversification

Recent evidence points out to climate change being one of the foremost threats to development in the African continent (Makate C., Wang R., Makate M., & Mango N., 2016). Climate change seriously affects agriculture among other sectors. Falling crop yields, increased risks in agricultural, dwindling soil fertility and degradation of the environment also continue to frustrate collective efforts to enhance food security, increase income and nutritional security particularly in smallholder farming. With these concerns, a real transformation of the agriculture sector is inevitable (Makate *et al*, 2016). A meaningful and acceptable transformation is required so as to improve livelihoods and decrease environmental degradation (Nyasimi, Amwata, Hove, Kinyangi & Wamukoya, 2014).

Climate-smart agriculture (CSA) has been recognized by climate change adaptation researchers in agriculture among the sustainable agricultural practices (SAPs) to help households manage the harmful impact of CC and inconsistency in farming systems by the smallholders (Makate *et al*, 2016). CSA operates under the following three principals: first is tackle climate related risks while enhancing food security, fostering economic empowerment as well as ensuring nutrition security. The CSA should also enhance productivity and livelihood improvement. Finally, the technology should be appropriate in the particular areas they are practiced.

Crop diversification through rotations and intercropping is one of such climate-smart techniques identified among others like minimum tillage, mulching, use of shade housing, water management among others. Although diversification of crop production is not a completely new practice, CC impact in agriculture has given it popularity. Adopting the technology could significantly bring down risks linked to agricultural production by improving productivity, income, food and nutritional security among smallholder farmers (Makate *et al*, 2016).

According to Joshi, (2005) in Makate *et al*, (2016), diversification is among the most ecologically viable, efficient and practical strategies of minimizing uncertainties in agriculture particularly among small scale farmers. In addition, crop diversification enhances resilience and boosts farm spatial and biodiversity (Makate *et al*, 2016). Lin, (2011) indicates that soil fertility is improved through crop diversification. It also enhances pests and diseases control, facilitates yield stability, improves human nutritional diversity and health. Crop diversification is also a dominant substitute to chemical use in soil fertility conservation and pests' control. Diversified cropping systems are generally, more agronomically stable and resilient due to decrease weed and insect, reduced requirement of nitrogen fertilizers (especially when leguminous crops are incorporated), reduced erosion due to cover crops use, increased and increased productivity (Lin, 2011; Makate *et al*, 2016). Moreover, Makate *et al*, (2016) indicate that crop diversified systems provide conducive environment for beneficial insects hence reducing the amount of pests by making the host crops less conspicuous for attack by pests. Crop diversification also contributes to local biodiversity more so when indigenous crop varieties are grow. Lin, (2011) also indicates that proper management of soils helps maximise use of water by plants thereby improving overall crop yields. Crop diversification therefore contributes in one way or another to all the three principles of CSA through improvement of productivity, livelihood, resilience of agricultural systems and reduction of carbon dioxide emission. This study considered diversification of the selected food crops (sorghum, finger millet, Irish potato, sweet potato and beans) among the smallholder maize farmers.

2.2.4. Status of maize production

Maize (*Zea mays*) is among the most significant cereal food crops in the world as human food and animal feeds, also an industrial raw material for other products. It is cultivated over an area of 142 million hectares becoming the world's leading crop with a production of 637 million tons

of grain annually. Maize is also the most significant staple food in Kenya. About 90% of Kenyan population depends on it directly or indirectly for food, employment and income. It is a food security crop in the country. In 2016, the maize area 2,337,586 Ha giving a yield of 38.8 million bags which is higher than 35.4 million bags in 2017 contributing of KES 26,786 and KES 14,200 million respectively directly to the economically. This decrease in yield was largely attributed to lower amounts of rainfall, exorbitantly high farm inputs cost and the lingering impact of Maize Lethal Necrosis Disease as well as Fawl Amyworm infestation (KNBS, 2018). According to the county department of Agriculture annual reports, 2017, the county's maize production in the same year stood at 30,940Ha with a yield of 590,672 bags, contributing KES 1,181 million to the economy.

Consumption of Maize in Bomet county is mainly as ugali (made from flour cooked in boiling water to a dough-like consistency) served with vegetables, stew, fresh or sour milk (Mursik) or boiling/roasting at green stage as a snack. This crop was the basis of the target population and selection of the research site since it is the staple food in the area.

2.2.5 Selected crops for diversification

This section looks at the selected crops for diversification to enhance food security by smallholder maize farmers in Bomet county. Apart from maize, other crops grown for food in the county include: Irish potato, sweet potato, finger millet, sorghum and beans.

2.2.5.1 Sorghum

Farmers of Africa and Asia arid and semi-arid lands (ASALs) grow sorghum, *Sorghum bicolo*r, for rural food security. According to Taylor, (2010), Sorghum is a traditional crop produced in several parts of the country for subsistence use. The crop has however been proven to be the

finest substitute to barley for brewing of beer hence increasingly becoming part of a successful food and beverage industry in Kenya (FAO, 2013).

Driven by the need to stabilize food security in the country, there is a new interest in revitalizing production of drought tolerant crops like sorghum (Chepng'etich, 2015). Sorghum was included as one of the crops promoted by the ministry of Agriculture under the orphaned crops programme. Its aim was to diversifying sources of food through promotion of indigenous crops that are drought tolerant (Karanja, 2015). In 2017, production of sorghum in Bomet county stood at 442ha yielding 490 tons. The crop is utilized by mixing with maize and ground to make floor for ugali or porridge (CGoB, 2017).

2.2.5.2 Finger millet

Farmers of the semi-arid tropics including the sub-tropics grow finger millet, *Eleusine coracana,* as one of their staple food crops for subsistence (Onyango A.O. 2016). The local farmers highly value it for its ability to produce in harsh agro-climatic environments where cereal crops like maize fail. Ecologically, it requires an annual rainfall of 500-1000mm that is well distributed and preferably well-drained fertile sandy to loamy soils at a pH of between 5 and 7. The crop is however adapted to a varied range of soil conditions (Onyango A. O., 2016).

Nutritionally, finger millet plays a vital role in the subsistence farmers' dietary requirements and habits. Important minerals and nutrients are obtained from foods cooked from the grain, particularly by expectant women, breast feeding mothers and children (Mitaru, Karugia & Munene, 1993). Finger millet is also superior to the commonly promoted rice and even wheat with 3-5 times protein, minerals and vitamins content (Bhohale, 2013). Finger millet is also drought tolerance, disease resistance, effective in suppressing weeds and has long shelf-life

(GoK, 2010). The grain can ensure food supply throughout the year even during crop failure as it can resist storage pests for even ten years longer than other cereals hence popularly known as 'famine crop' (Mgonja M. A., Lenne, J. M., Manyasa E., & Sreenivasaprasad S., 2007).

Millet is important for various securities such food, fodder, fibber, nutrition, health, environment and livelihood at very low costs making it an important guardian of agricultural security. This is one of the food crops grown in Bomet county and its production in 2017 was on 2185 Ha yielding 3108 tons. Its flour is usually utilized in for making ugali purely or mixing with maize flour and making porridge especially for children, nursing mothers or sick people.

2.2.5.3 Irish potatoes

Irish potato, *Solanum tuberosum*, is one of the world's most important food crops coming fourth after wheat, rice and maize. A record production of 320 million tons was attained in 2007. It is an significant source of food as well as employment and income in developing countries where production has almost doubled since 1991, with a equivalent increase in consumption (Menza, Girmay & Woldeyes, 2014). Potato, commonly referred to as Irish potato comes second in significance in Kenya following maize. It is also very significant to the country's economy. Nearly 1 million tons of tubers were produced by about 500,000 smallholder farmers from 100,000 ha of land. Kenya's production makes up 0.3% of the world's overall output and 6.5% of Africa's (MOA, 2010). The Kenyan government's major policy objective is to reduce poverty and Irish potato is eyed as one of the key sub-sectors to drive the agenda. Production of this crop in Kenya is expected to grow further and could replace maize as the number one food crop since the latter is threatened by climate change, pests and diseases such as FAW and MLND. In addition, Irish potato is fast maturing compared to maize hence can bridge the gap during shortage of the staple grain. According to KEPHIS, the crop has a high potential to address food

insecurity, unemployment and low farm incomes in Kenya due to its high productivity per unit area and its versatility in utilization. According to Agriculture department annual reports 2017, area under Irish potato production in 2017 was 2899 Ha producing 43,485MTs.

2.2.5.4 Sweet potatoes

Sweet potato, *Ipomea batatas*, has the third highest production level after cassava and yams. It is also among the most widely grown tuber crop among smallholder farmers in Sub-Sahara Africa (SSA) (Kaguongo, Ortmann, Wale, Dorroch & Low, 2010). Its importance as an attractive income generation is rising in Kenya (Odendo & Ndolo, 2002). According to Nungo, Ndolo, Kapinga & Agili (2017) in Odendo *et al*, (2002), its popularity in Kenya has increased since it is able to produce good yields even under hash climatic and soil conditions and minimal use of external inputs.

Sweet potato has more other advantages compared to maize. Furthermore, the flexibility of this crop in mixed farming systems enhances household food security therefore it is a significant livelihood strategy to the rural households (MOA & GTZ, 1998). Other than its fast maturity, Sweet potato is also drought resistant, flexible in harvesting time and it improves the yield of maize in a crop rotation compared to continuous maize production.

Sweet potato is consumed as a snack either boiled or roasted and a few instances in raw form (Nungo *et al*, 2017). Nutritionally, sweet potato is an excellent source of vitamin A, especially the orange fleshed varieties (Odendo *et al*, 2002). As per MOA and GTZ sweet potato yields more protein and calories per unit area than either maize or Irish Potatoes. The average yield is 10 tons per hectare (MOA & GTZ, 1998). According to the department of agriculture in Bomet county, production and productivity of the crop was boosted in 2014 by the sourcing 400,000

vines of the orange fleshed varieties (Kenspot 1, 3, 4 and 5, Vitaa and Kapode) from KALRO, Njoro. According to the department of agriculture in Bomet, the area under the crop in 2016 was 2300 hactares which yielded 2300MT. Sweet potatoes are generally an easy crop to farm due to their low capital intensity and applicability on small tracts of land.

2.2.5.5 Beans

Common bean, *Phaseolus vilgaris,* is extensively grown as a key staple food in both Eastern and Southern Africa (Birachi, Ochieng', Wozemba, Buraduma, Niyuhire & Ochieg', 2011). The crop can yield up to 10 bags from an acre of land (KARI, 2008). Beans are one of the key sources of plant proteins and are strategic in alleviation of malnutrition. It is largely grown for subsistence and mostly intercropped with maize during planting season. Unlike maize, they have a high potential to spur economic growth of a region since they fetch more income within a short period of time (Kariuki, 2014). Beans are also incorporated in intensive agricultural production system as a rotational crop due to their wide adaptability. They are tolerant to shades and fix nitrogen thereby improving soil nutrition (Kariuki, 2014).

In Bomet county, it is usually consumed as a stew with carbohydrates like rice, maize (ugali) or boiled with maize (githeri). Production area in the county stood at 31,857Ha with a yield of 238,668 bags in 2017, according to the department of agriculture in the county. The food crops trend is indicated in table 2.1.

Table 2.1

Food Crops Production Trend for Bomet County

	2017		2016		2015	
Crop	**Ha**	**Production (Tons)**	**Ha**	**Production (Tons)**	**Ha**	**Production (Tons)**
Maize	36,492	64,417	32,628	58,827	30,940	59,069
Beans	31,060	41,157	26,025	35,134	31,857	38,668
F. Millet	2,185	3,108	1,946	2502	922	1386
Sweet Potato	1,`077	17,980	2,977	28,613	2,333	24,397
Irish Potato	3639	34,097	2364	21,283	2899	26,091

Source: Directorate of Agriculture, Bomet county (2018)

This research sought to determine the extent to which the maize farmers have diversified into growing these alternative food crops in addition to maize. The research also pursued to establish the pattern of allocating land space amongst these crops throughout the year. A very good mix (diversification) of these crops annually would solve the vicious cycle of seasonal food insecurity.

2.2.6 Determinants of crop diversification

Determinants of people's decision on adoption of new technologies or practices like diversification have been studied by different scholars over time. The classic theory of diffusion of innovations considers the impact of social norms and values, individual characteristics, traits of the concerned technology as well as other external factors such as infrastructure and the policy environment. Ellis, (2000) also indicates that the decision to adopt an innovation is determined by a risk minimizing strategy as they are quite vulnerable to a risk arising out of natural and

anthropogenic uncertainties. Due to such uncertainties, farmers in developing countries are vulnerable to various risks that the severity leads to the eventual loss of assets and income.

A number of scholars have carried out studies on crop diversification in many places such as India, China, Pakistan and many African countries like Nigeria, Malawi, Zambia, Ethiopia, Zimbabwe and Kenya among others. While studying the status and determinants of crop diversification in Eastern India, Kumar, Kumar & sharma, (2012), analyzed age and education level of the household head, Agriculture as the main occupation, household size, credit access, farm assets, operated area, use of technology components, infrastructure and caste. Three stage and stratified sampling was used in this study where 2885 farmers were studied. They used Herfindahl Index to establish the extent of crop diversification and Tobit regression model for analyzing determinants of diversification towards vegetable cultivation in the study area. They established that the crop sector in the eastern region was moderately diversified. The study also showed that Education, size of the household, value of productive assets and the primary household head occupation had very significant influence on diversification. Age and gender however did not have a substantial effect on farmers' decision to diversify in favor of vegetables. While seeking to recognize factors which influence household decision to crop diversification in Ukhonul District, Manipur, Aheibam, Singh, Feroze & Singh, (2017) adopted Heckman's two-stage model to evaluate the determinants of household diversification decision and its intensity. The results showed that education level of the head of the household had a positive association with the level of crop diversification which is similar to Kumar *et al*, (2012), Mithiya, Mandal & Datta, (2018) and Shabzah *et al*, (2017). Other factors with positive influence are access to fertilizer, access to plough, availability of irrigation, exposure to farming information regularly, distance to the nearest market and experience of the farmer.

Mithiya *et a,l* (2018) while studying trends, pattern and determinants of crop diversification of smallholders in West Bengal used secondary data from different districts. Using Simpson Index (SI) which was also used by Aheibam, (2017), the results showed that every district in West Bengal and the whole state demonstrated higher crop diversification levels during new millennium compared to the nineties. The factors analyzed include level of literacy, urban population percentage of the district, comparative earnings from high value crops compared to cereals, regional market density, smallholders' percentage and area under high yielding food grain varieties. Education, land size, distance from the market as well as income from other sources had a significant influence. In addition, Huang, Jiang, Wang & Hou, (2014) did a study on crop diversification in coping with extreme weather events in China and used multiple stage sampling to obtain 3330 smallholder farmers. It was established that age had a negative effect on diversification where aged farmers were less expected to adopt crop diversification compared to younger farmers. Young farmers also have less experience hence more likely to adopt crop diversification as a means to avoid production risks. Young people are also more willing to try new things. This is in line with Aheibam *et al,* (2017), Dube, Numbwa & Guveya, (2016) and Ojo *et al,* (2014). Huang' however noted that farmers with lower education level are more vulnerable and are likely to use crop diversification as a tool to mitigate the effects of extreme weather event. In addition, Huang' found out that farmers with larger farms are more likely to diversify their crop types. A household with more land is expected to plant more crops since more arable land is available in big lands, better enabling them to plat more crops.

While studying determinants of crop diversification in mixed cropping zone of Punjab Pakistan, Shahbaz, Boz & Ul Haz, (2017) used multiple stage sampling to select 100 growers for the study. Herfindahl index was applied to calculate the farmer's diversification level which has

been used by many other scholars such as Kumar *et al,* (2012), Ojo *et al*, (2014) and Kanyua, Ithinji, Maluvi & Gido, (2013). Determinants of crop diversification were analysed using Tobit model which was also used by Kumar *et al,* (2012), Ojo *et al*, (2014) and Kanyua *et al*, (2013). It was established that level of education and farm size positively and significantly influence crop diversification. An educated farmer is more likely to understand the market condition and can act as a good tackler of the impact of the uncertain event. Similarly, ownership of farm machinery enhanced the levels of diversification in crop cultivation. The study however indicates a negative relationship between age and crop diversification. The reason could be that younger farmers are more innovative, risk takers and strong in physical activities at the farm compared to old people. The study also revealed that self - owned operated farms were less diversified in crop production than other tenures like renter or shareholder.

Sichoongwe, (2014) also studied the determinants and extent of crop diversification among smallholder farmers in Southern Province of Zambia. He analyzed gender, age, education level of the household head and household size, land holding size, number of fields or land plots, hired labour, tillage time, plough tillage, fertilizer quantity and distance from the market in 1,555 farmers. Determinants of crop diversification were analyzed using Tobit regression model while the extent of diversification was established using Crop Diversification Index (CDI). Sichoongwe established that crop diversification by smallholder farmers was relatively low. In his study, size of land holding, quantity of fertilizer, distance to the market, tillage time and tillage (plough) were established to determine crop diversification significantly.

While studying factors influencing smallholder crop diversification among 479 smallholder farmers in Manicaland and Masvingo provinces of Zambia, Dude, (2016) used Herfindahl Index to estimate diversification. He used Tobit regression model to evaluate factors associated with

diversification. This study showed that male headed households were slightly more diversified compared to female headed households. Tobit regression model also revealed that education, number of livestock units, access to irrigation, membership of a farmers' group, access to markets, farming experience, farms of flat terrain, farmer to farmer extension, agro-ecological zone and household income were the most significant factors in crop diversification.

Ojo *et al,* (2013) also studied determinants of crop diversification among small-scale food crop farmers in North Central Nigeria. Multiple stage sampling was used to obtain a sample of 300 respondents. Using Herfindahl Index, their study revealed that North central Nigrian smallholders were less diversified. The study also showed that experience, extension contacts as well as land size positive influenced diversification. Age and income from other sources however had no influence. In another study on determinants of food crop diversity and profitability in southeastern Nigeria, Rahman and Chima, (2015) used Multivariate Tobit approach. Their analysis revealed that farm size is the most dominant determinant of diversity compared to profitability. Other factors that vary in their influence include; proximity to the market and extension office, extension contact, training, agricultural credit, subsistence pressure and location. The study covered a total of 450 households.

Mesfin *et al,* (2011) while studying pattern, trend and determinants of crop diversification in Eastern Ethiopia among smallholder farmers interviewed 167 farm households. Tobit regression model was used to analyze covariates of crop diversification and its intensity. Among the determinants under scrutiny were; farm size, age of the household head, household size, distance to the market, number of extension contacts, farm machinery (tractor and water pump), off/non-farm income, number of farm plots, access to market information, irrigation intensity and sex of the household. They used modified Entropy Index to measure crop diversification. Mesfin,

established that farmers with more number of plots are more likely to diversify by growing different crops on each plot of land which is similar to the findings of Mussema *et al,* (2015) and Ogutu and Obare, (2015). It was also established that with access to market information, irrigation and ownership of machinery, farmers were likely to diversify. The findings however established that there was a negative relationship between number of extension services contacts and diversification since extension service providers were advocating for productivity and profitability which favors specialization at micro level and overlook the role of diversification in risk minimization.

In another study on determinants of crop diversification in Ethiopia, Oromia region, Mussema *et al,* (2015) used Margalef's Index (MI) to analyze determinants of crop diversification. The results suggest that asset ownership, soil quality, agricultural extension and level of infrastructure development are significant drivers of crop diversification. Three-stage sampling model was used to arrive at 382 households. The results revealed that land size affected crop diversification decision positively and significantly. Number of plots also had a significant and positive impact of diversification. In the same way, Extension services, market information and access to all-weather roads had positive and significant impact. Their findings on access to market were in line with those of Kumar *et al,* (2012), Aheibam *et al*, (2017), Mithiya *et al*, (2018), Sichoongwe *et al,* (2014), Dube *et al,* (2016) and Kanyua *et al,* (2013).

In another study on factors influencing diversification and intensification of horticultural production by smallholder tea farmers in Gatanga District, Kenya, Kanyua *et al,* (2013), analyzed participation in diversified cash crop farming, occupation, age and education level of the household head, tools, credit, distance from the market, contract among others. Heckman two-step model was used to analyze the determinants and it was found out that farm size and

value of farm tools to be the most significant in crop diversification. Heckman two stage model was also used by Aheibam *et al*, (2017). It was also established that the amount of land owned by a farmer has a very significant effect on the degree of diversification; with an increase in the farm size leading to an increase in the crop diversification index. From Kanyua's study, the amount of free land owned by the farmer had a very significant effect on diversification to horticulture however, other farmers with big lands had little crop diversity since more land had been allocated to tea. Gender was a very significant factor in diversification into horticulture by tea farmers; male headed households were more diversified than female headed households. This was similar with the findings of Dube *et al*, (2016) that male headed households were more diversified. Experience of the household head has a significant effect on degree of diversification possibly due to the learning curve effects.

Finally, Ogutu and Obare, (2015) did a study on crop choice and adoption of sustainable agricultural intensification practices on 532 randomly sampled smallholder households from Eastern and Western Kenya. They used stochastic production function model and established that gender played an important role in adoption of sustainable agricultural intensification (SAI) innovation and cropping choices. Female decision makers were seen to practice more intercrop on their plots. Land size and number of plots also had a positive influence. Education however did not have any influence on SAI practice and crop choice while income from other sources had a negative influence.

None of the above studies focused on diversification of food crops by smallholder farmers. This study therefore backs the knowledge gap on diversification of food crops by the smallholders.

2.3 Theoretical Framework.

A literature review indicates existence of three alternative economic theories to model farm household behavior. Each approach assumes that households have an objective function to maximize with a set of constraints. First is the Profit Maximization Theory, which has been criticized that it does not consider the aspects of consumption in the household decision processes. Second is the Utility Maximization Theory which incorporates both the production and consumption goals. In consideration of these two models, other economists have developed the Risk Aversion Theory which indicates that the objective function of a household is to secure and avoid risks (Mendola, 2007).

This study used Utility Maximization Theory. Utility maximization approach encompasses the dual character of households as both families and enterprises hence taking the consumption dimension of peasant decision making into consideration (Mendola, 2007). This is most commonly used when household consumption and production decisions are interdependent like in in rural areas (Lin, 2011). In the case of this study therefore, maize farmers are seen to diversify food crops not only for food security but also increase income hence livelihood improvement in general.

2.4 Conceptual Framework

This study focused on diversification of food crops; which in the case of this study are sorghum, finger millet, Irish potatoes, sweet potatoes and beans, by the smallholder maize farmers as the dependent variable (y_i). The independent variables, determinants of diversification, for the study are placed in three categories as follows: Socio-economic, market related factors and institutional factors.

Socio-economic factors

Under this category, the following seven socio-economic factors were analyzed; gender, age, education level of the household head, experience of the household head in farming, household size, land size and membership of the household head to a farmers' group.

Market related factors

The market related factors that were considered here are; distance from the household to the nearest commodity markets and perceived availability of markets. Cost of inputs and labour were dropped during the analysis phase since the producers did not keep records on these two aspects.

Institutional factors

Institutional factor under consideration for this study were extension services and access to credit.

The decision of the maize farmers to diversify or not to diversify their food production is influenced by these three categories of determinants the outcome of which is to enhance food security and increase income. This is depicted in the figure 2.1.

Pattern of food crop diversification

The pattern of diversification of food crops production along the cropping year has a great impact on food security. According to Wakibi et al, (2015), there is seasonality in food availability in Bomet county raising food insecurity to 23% between the months of January and April annually. This therefore necessitates the careful allocation of land resource to different types of food crops within the year to minimize such cases.

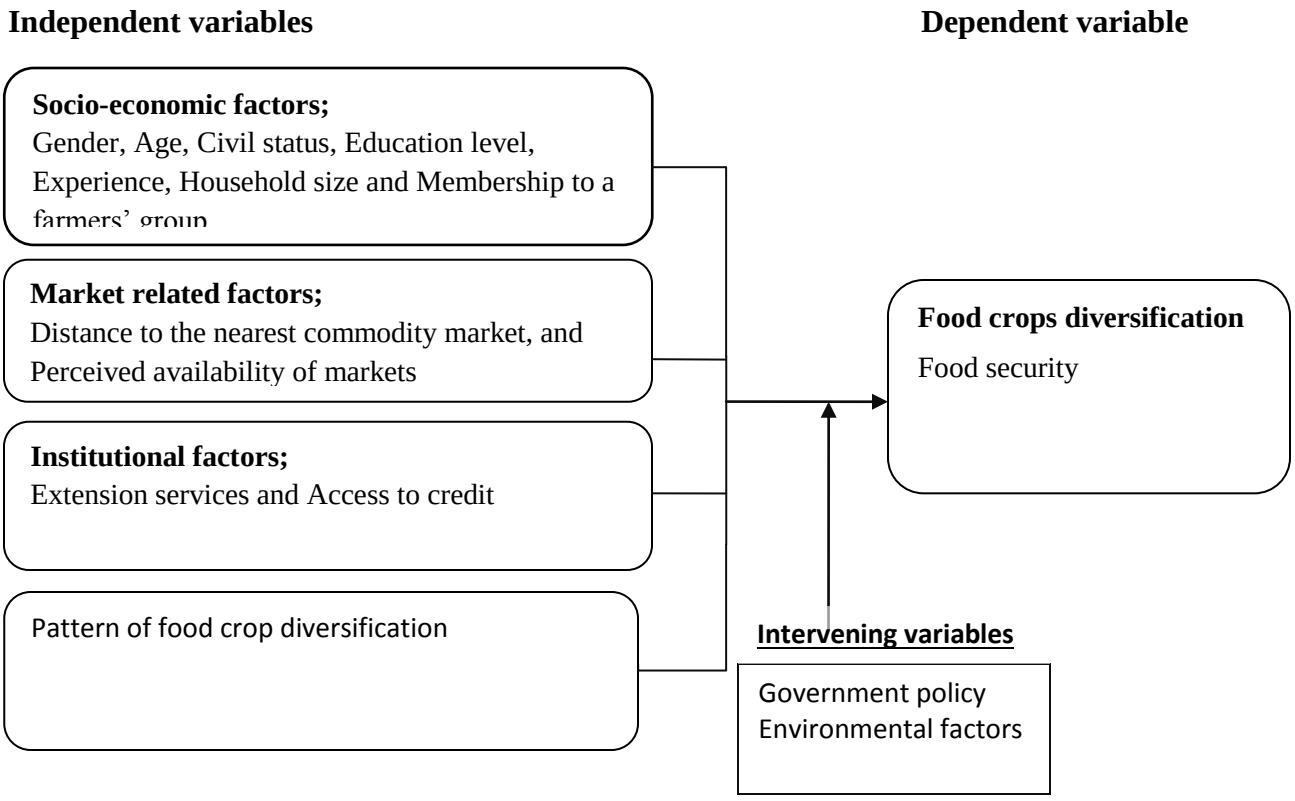


Figure 2.1: Conceptual framework of the determinants of diversification
Source: Author, (2019)

2.5 Identification of Knowledge Gap

From the reviewed literature, most of the studies focus on diversification in terms of movement from cereal crops or cash crops into horticultural crops which are normally referred to as High Value Crops (HVC). None of these studies focused specifically on diversification within the food crops sub-sector. Secondly, despite the scourge of MLND and infestation of FAW on Kenya's staple food and particularly in Bomet, there is no documented evidence of a research done to ascertain diversification of food crops in the county. Experts have also recommended and emphasized on diversification to aid in control of the disease and enhance food security yet no study has confirmed the extent of implementation. Moreover, with the reality of CC threatening food security, there was a serious need to ascertain the influencers of food crop diversification in

the county to enable proper planning of food security strategies. This study is therefore very relevant in filling these knowledge gaps.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the research methodology that was used for the study. The study area, research design, target population, the sample, sampling procedure and data collection are described. The chapter also describes validity and reliability of instruments, data collection procedure, data analysis and ethical considerations.

3.2 Research Design

This study adopted a cross-sectional survey and descriptive research designs to analyze the determinants of food crop diversification by the smallholder maize farmers in Bomet county. The two designs are more appropriate because they give a provision for comparison of the research findings. Furthermore, they are exploratory and allow the researchers to collect, sum up, evaluate, analyze, present and interpret the data in a simpler and more understandable manner (Kothari, 2008).

3.2. Location of Study

This research was conducted in Bomet county, one of the 47 counties in Kenya with her headquarters in Bomet town. The county borders four counties, which are Kericho to the North, Nyamira to the West, Narok to the East and South, and Nakuru to the North-east. It lies between latitudes 0º 29’ and 1º 03’ south and longitudes 35º 05’and 35º 35’ east, covering an area of 2037.4 Km^2. It has five sub-counties (constituencies) namely Konoin, Bomet Central, Bomet East, Sotik and Chepalungu, each with five wards. There are 67 locations and 176 sub-locations in the county (CGoB, 2013).

According to 2009 population and housing census, the population of Bomet county was

estimated at 723,813 (KNBS, 2009). The population was projected to be 782,531 in 2012, 846,012 in 2015 and 891,168 by 2017 at an estimated growth rate of 2.7%.

The county has three main agro-ecological zones, namely Lower Highland (LH), Upper Midland (UM) and Lower Midland (LM). The county is therefore suitable for farming of a variety of crops such as tea, pyrethrum, coffee, maize, Irish potatoes, beans, sorghum, finger millet, sweet potatoes, indigenous and exotic vegetables. Dairy farming is also important to the county's economy. The average farm size is estimated at 1.5 ha per household and most of it is utilized for agriculture and livestock production.

The rainfall ranges from 1000mm in the lower zones to 1400mm in the upper zones while the temperature ranges from 16^0C to 24^0C. The county borders a stretch of indigenous Mau forest where her rivers mainly originate (CGoB, 2013).

Bomet county was selected for this study because of her great potential in agricultural productivity given its varying range of favorable ecological conditions. This county has however experienced persistent food insecurity due to unpredictable rainfall patterns, crop pests and diseases (MLND and FAW) and high cost of farm inputs among others. According to African Women Study Centre (AWSC), food insecurity in the county stands at 15.8 % and 71.1% of the county residents derive their livelihood from sale of agricultural produce (AWSC, 2014). Seasonality in food availability is also still a big issue, January to April are the months with food scarcity (GoK, 2014). Furthermore, there is no documented research on the subject matter of study about the county.

The research was conducted in three of the five sub-counties between September and November 2018 on three forty one (341) smallholder maize farming households. The three Sub-counties, Sotik, Bomet East and Chepalungu, were selected because of their differing ecological zones,

crop production systems, food security status and history of MLND attack on maize. In addition these areas are a good representation of the whole county since the upper parts of Sotik and Bomet East are similar to Konoin sub-county ecologically. Bomet East and Konoin however are heavy tea growers. A larger part of Chepalungu however has its own unique ecological characteristics hence a little bit different crop production systems. The Poverty level in Chepalungu is also high compared to the other Sub-counties (KNBS, 2013). Finally, the three Sub-counties are major growers of maize in the County and were severely affected by MLND; in fact the disease was first reported in Kenya from Bomet East Sub-county, Longisa ward.

3.4 Target Population

This study targeted three thousand and ninety four (3094) smallholder maize farmers in Sotik, Bomet East and Chepalungu sub-counties of Bomet County (NCPB, 2017). This is the active population of youth and young adults at age 30 years to 65 years. The population between 15 to 65 years in the county constitute 50.3% of the total population and among this, age 15 to 29 constitute 28.7% of the total population. The average farm size of the target population is 1.5ha. Fifteen (15) agricultural extension staff from the wards were also targeted as the key informants for the study.

3.5 Sample Size and Sampling Procedure

3.5.1 Sample size

The sample size for this study was calculated using the following formula by Kothari, (2004):

$$n = \frac{Z^2 \, p.q. \, N}{e^2 \, (N-1) + Z^2 \, p.q}$$

Where: n = Sample size for a finite population

N = Size of population which is the number of households; 3094

P = the standard deviation of population and

e = Acceptable margin of error.

z = the standard variate at a given confidence level

Assuming 95% confidence level,

z =1.96, p=0.5 and a normal distribution of population p+q=1, then sample size (n) is:

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 3094}{(0.05)^2 \times (3094-1) + (1.96)^2 \times 0.5 \times 0.5}$$

=341 households. Research methodology, kothari

The key informants were purposively selected, one from each of the five wards in the selected sub-counties making a total of fifteen (15). All were picked because they are less than thirty.

3.5.2 Sampling procedures

Stratified random sampling was adopted in this study to select 341 maize farmers from 3094 registered maize farmers from the three sub-counties. This procedure is the most appropriate because it combines both stratified sampling which is essential in calculating the sample per sub-county and simple random sampling which is used when picking the particular farmers to be interviewed. The key informants were purposively picked, one from each of the five wards in the selected sub-counties making a total of fifteen. The sample size from each Sub-county and ward is shown in table 3.2

Table 3.2

Sample Size per Sub-county

Sub-county	Wards	Population (N)	% N	Sample Size (n)
Sotik	Chemagel	656	32	52
	Ndanai/Abosi	307	23	37
	Rongena/Manaret	200	13	20
	Kapletundo	153	18	28
	Kipsonoi	122	14	23
	Total	**1438**	**47**	**160**
Bomet East	Longisa	281	28	31
	Chemaner	241	24	26
	Merigi	230	23	25
	Kembu	160	16	17
	Kipreres	90	9	10
	Total	**1002**	**32**	**109**
Chepalungu	Siongiroi	144	22	16
	Nyongores	255	39	28
	Kongasis	111	17	12
	Sigor	92	14	10
	Chebunyo	52	8	6
		654	**21**	**72**
TOTAL		**3094**		**341**

Source; MOA, through NCPB farmers' data, (2018)

3.6 Data Collection Instruments

Two instruments, structured questionnaire and an interview schedule, were adopted by this study to collect primary data. An Interviews schedule was used to collection data from three hundred and forty one (341) smallholder maize farmers. This tool was divided into five sections in line

with the objectives of the study. Section A, Section (A) had introduction section and collected data on the socio-economic characteristics of the household. The second section (B) collected data on the extent of food crop diversification. The third section (C) had questions on institutional factors while the fourth section (D) contained questions on market related factors. Finally, the fifth section (E) collected information on the food crop types produced within the year. Section B captured data for objective 1, section A, C and D captured information for Objective 2, while D captured information for objective 3.

Structured questionnaires were used to collect data from the 15 selected extension staff in the area of study. The tool was divided into four areas covering information as per the study objectives; A for data on institutional factors, B for data on market related factors, C collecting data on market related factors and finally D to focused on pattern of diversification.

3.6.1 Validity of the research instrument

According to Kimberlin *et al*, (2008), validity is the extent to which a research tool measures what it is required to measure. It is the degree to which the outcomes of a test are acceptable. To ensure that the results obtained from, this study meet all the requirements of the scientific research, the instruments were be presented to two experts from the department of Agriculture and Bio systems and Economics at the University of Kabianga. The two experts have extensive experience in teaching and supervising postgraduate students.

3.6.2 Reliability of research instruments

According to Kothari, (2008), reliability refers to the degree to which scores obtained with an instrument are consistent measures. The reliability of the instrument was determined by pre-testing the instrument with a sample of 30 respondents in Bomet Central with similar

characteristics as the study sample but were not part of the study. Chronbach's alpha coefficient was used to calculate reliability coefficient. A coefficient of 0.7 was considered acceptable. In case this threshold was not achieved, the instrument was to be revised and pilot tested until an acceptable score was achieve.

3.7 Data Collection Procedures

The researcher obtained authority to undertake research from the National Commission for Science Technology and Innovation (NACOSTI) through an introductory letter from the Directorate of Graduate Studies, University of Kabianga. This was followed by a visit to the County Commissioner and the County Director of Agriculture in to brief them on the purpose of the research. Finally, the researcher proceeded to make appointments with the household heads through the Ward agricultural extension officers.

The researcher interviewed the heads or the authorized representative (spouse) of the household on the scheduled appointment time. Where both the household head and the authorized representative was absent, another appointment was scheduled. No household head or authorized representative was absent for the second scheduled appointment hence there was no replacement of any of the initially picked smallholder maize farmers.

3.8 Data Analysis and Presentation

This section presents information on data analysis and presentation.

3.8.1 Data analysis

Data collected from the interview schedule and questionnaires were collated, cleaned and coded for electronic entry and analysis. The Microsoft excel, STATA version 14.2 and Statistical Package for Social Science (SPSS) version 20 were used to process data for analysis. Inferential

analysis, descriptive statistics and econometrics were used to analyse the determinants of food crop diversification as well as the extent of crop diversification. The was then organized and analyzed using frequencies with percentages and presented in tables.

3.8.1.1 Measuring extent of diversification

The extent of food crop diversification by the smallholder maize farmers was determined using Crop Diversification Index (CDI) otherwise known as Transformed Herfindahl Index (THI). The CDI is calculated by subtracting the Herfindahl Index from one.

Herfindahl Index is calculated by taking sum of squares of acreage proportion of each crop in the total cropped area (Ojo *et al*, 2014). Mathematically, the index is given as follows;

$$HI = \sum_{i=1}^{N} P_i^2$$

This is an index of concentration with a direct relationship to diversification where its zero value shows specialization while a movement towards one indicates a rising level of diversification. Crop Diversification Index (CDI) is therefore indicated mathematically as;

$$CDI = 1 - \sum_{i=1}^{N} P_i^2$$

Where:

N = the total number of crops, in this case five (5).

Pi = area proportion of the i^{th} crop in total cropped area; in this study is the area proportion of the crops investigated for diversification by smallholder maize farmers.

3.8.1.2 Measuring of determinants of diversification

Tobit regression model, also known as censored regression model, was used to evaluate the statistical relationship between the independent variables that were anticipated to influence crop diversification. The dependent variable can be either left-censored or right-censored (above and/ or below). The Crop Diversification Index, which indicates the level of diversification, was the dependent variable in the model (censored between 0 and 1). Tobit model allows censoring of the dependent variable from below and /or above, also called left and/right censoring and is mainly appropriate for regression analysis of crop diversification index. This model therefore is the most appropriate because standard linear regression models like ordinary least square assessment would give biased and inconsistent results. (Mesfin et al., 2011).

The general form of the model is indicated as follows;

$y_i = ß_o + ß_iX_i \ldots\ldots\ldots\ldots ßX_n + \mu_i$

Where:

y_i = observed latent variable, the observed censored variable. In this case it is Crop Diversification Index (dependent variable) which is between zero (0) and one (1)

$ß_o$ = Constant or intercept

$ß_i$ = Probability of crop diversification due to X_i or coefficient

X_i = Factor affecting crop diversification (Independent variable of explanatory variable) which are either socio-economic, market related factors or extension

μ_i = Error term

This is simply indicated as follows;

$CDI = ß_{o+} ß_1 HH\mathit{Age} + ß_2 HH\mathit{Gender} \ldots\ldots\ldots ß9 DIST\mathit{farm}_{+} \mu_i$

All the three categories of the independent variables were analysed using this model in STATA version 14.2.

3.8.1.3 Establishing the pattern of diversification

Inferential statistics were used to analyze the pattern of diversification of the alternative food crops by the smallholder maize famers. Pattern here means the nature of mix of food crops grown by the smallholder maize farmers. This was established through the recorded types of crops

grown through two consecutive cropping seasons within the last one year inclusive of the current season.

3.9 Definition of Variables for the Study

X_1 = Gender of Household Head (GEND) – Male =1, Female = 0)

X_2 = Age of Household Head (AGEHH) in years

X_3 = Civil Status of household Head (MSTATS) – Married =1, Otherwise=0)

X_4 = Education level of Household Head (EDNLHH) - Number of years of formal education

X_5 = Experience of the Household head in farming (EXPHH) – Number of years in farming

X_6 = Household size (HHSZ)

X_7 = Land size (LNDSZ) in acres

X_8 = Membership to a farmers' group (MFGRP)

X_9= Agriculture as primary occupation of the household head (APOCHH)

X_{10} = Distance to the nearest commodity market (DNCM) – In kilometres

X_{11} = Perceived availability of commodity markets (CMRKT) – Formal or informal

X_{12} = Extension services (EXT) – Number of contacts

X_{13} = Access to credit (ACRDT)

Table 3.3

Summary of the Variables for Study

Variable	Type	Description	Expected sign
Gender	Dummy	Gender of Household Head (GEND) – Male =1, Female = 0	+
Age	Continuous	Age of Household Head (AGEHH) in years	+
Civil Status	Dummy	Civil Status of household Head (MSTATS) – Married =1, Otherwise=0)	+/-
Education level	Dummy	Education level of Household Head (EDNLHH) - Number of years of formal education	+
Experience	Continuous	Experience of the Household head in farming (EXPHH) – Number of years in farming	+
Household size	Continuous	Household size (HHSZ)	+/-
Land size	Continuous	Land size (LNDSZ) in acres	+
Group membership	Dummy	Membership of the household head to a farmers' group (MFGRP)	+/-
Primary occupation	Dummy	Agriculture as primary occupation of the household head (APOCHH)	+/-
Distance	Continuous	Distance to the nearest commodity market (DNCM) – In kilometres	+
Market		Perceived availability of commodity markets (CMRKT)	+
Extension		Government extension services (EXT) – Number of contacts	+
Credit access		Access to credit (ACRDT)	+

3.10 Ethical Considerations

The following ethical principles were taken into consideration while carrying out data collection, analysis and reporting.

Honesty: there was sincerity in collecting and reporting of data, results, methods and procedures. The permit from NACOSTI was used to inform respondents on the purpose of the study.

Objectivity: there was no bias during data collection, analysis or reporting.

Integrity: consistency of thought and action was displayed while undertaking this research. Intellectual property rights were respected and efforts were made to ensure that no plagiarism occurred during the study.

Confidentiality: there was maintenance of high professional and ethical conduct to ensure respondents' privacy and confidentiality during the study

Non-discrimination: all people who were involved in this study were treated courteously. No respondents were discriminated against on any basis, be it gender, race, ethnicity or any other factor unrelated to scientific aspects or integrity.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is a presentation of the thesis results in four major sections as per the objectives of the study. The first section deals with the extent of diversification of food crops by smallholder maize farmers presented as Crop Diversification Index. The second part presents descriptive analysis of the sample size. Results of the Tobit model are presented in the third section where the major determinants of food crop diversification by smallholder maize farmers is presented covering the second and the third objective. Lastly, the fourth section presents the pattern of food crop diversification by smallholder maize farmers.

4.2 Presentation of Results

This section is a presentation of the results of the study in three sections according to the objective; the first section is on the extent of food crops diversification, second section on determinants of food crops diversification and the third section is on the pattern of food crops diversification. The diagnostic analysis is also presented here.

4.2.1 Extent of food crops diversification

The extent of food crop diversification among smallholder maize farmers in Bomet County was established using Crop Diversification Index (CDI). This is an index of concentration with a direct relationship to diversification whereby its zero value shows specialization while an incline towards one indicates an intensifying level of diversification. The total number of farmers who did not diversify were 26, with a CDI of zero (0) making up 7.6% of the total sample. These are

the farmers who produced maize alone as a food crop throughout the year. 92.4% (315 in number) of the smallholder maize farmers diversified on food crop production at different levels with a CDI of between 0.1 and 0.78. The farmers who practiced low diversification at a CDI of 0.1 to 0.44 were 20.5%. These farmers majorly grew maize in the first season and beans in the second season with very sparse production of the other food crops along the range. Those at 0.45 to 0.5 were 15.5% and they grew maize and beans in the first and the second season and had a moderate distribution of the other food crops within the two cropping seasons. The highly diversified group with a CDI of between 0.51 and 0.78 were the highest at 42.3% with a good distribution of the various food crops under study throughout the cropping seasons. The mean CDI was 0.4974, which implies that the smallholder maize farmers in Bomet county were low to moderately diversified. Other researchers on extent of crop diversification like Sichoongwe, (2014) established that diversification of smallholder farmers in Zambia was low. The results of the extent of food crop diversification is presented in Table 4.2

Table 4.1

Extent of Food crop Diversification by Smallholder Maize Farmers in Bomet

Category	Level of CDI	Number of farmers	Percentage of farmers
None diversifiers	0	26	7.6
Low diversifiers	0.17 – 0.44	70	20.5
Moderate diversifiers	0.45 - 0.50	101	29.6
High diversifiers	0.51 -0.78	144	42.3

Source; Study Data, (2018)

4.2.2 Determinants of food crop diversification

a) Socio-economic determinants

The determinants of food crop diversification were analysed using Tobit regression model. The results of Tobit regression models on table 4.3 indicate that food crop diversification among smallholder maize farmers in Bomet County was determined by civil status of the household head, age, experience in farming and size of land. This study also reveals that gender, education level of the household head, size of the household, agriculture as a primary occupation of the household head and membership of the household head to a farmers' group does not positively influence diversification of food crops among the smallholder farmers in Bomet County.

Tobit regression results on socio-economic determinants are presented in Table 4.3

Table 4.2

Tobit Regression for Determinants of Food Crop Diversification by Smallholder Maize Farmers

Number of obs = 341					LR chi2(9) =	7.34
					Prob > chi2 =	0.6014
Log likelihood = 22.562582					Pseudo R2 =	-0.1944
CDI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GENDER	-.0100764	.0280627	-0.36	0.720	-.0652795	.0451266
CIVSTAT	.0127907	.0170085	0.75	0.453	-.0206674	.0462488
AGE	.0158567	.0121018	1.31	0.191	-.0079491	.0396625
HHSZE	-.0085991	.0187891	-0.46	0.647	-.0455598	.0283616
EXP	.0037622	.0164984	0.23	0.820	-.0286924	.0362167
EDUCTN	-.0147186	.0127419	-1.16	0.249	-.0397836	.0103463
APROC	-.000217	.0123653	-0.02	0.986	-.0245413	.0241072
LNDSZE	.0017559	.0116098	0.15	0.880	-.0210822	.0245939
MBFGRP	-.0297971	.0226117	-1.32	0.188	-.0742774	.0146832
cons	.5284161	.0844516	6.26	0.000	.3622883	.6945439
sigma	.1984814	.008141			.1824669	.214496

Obs. summary: 26 left-censored observations at CDI<=0
315 uncensored observations
0 right-censored observations

Source; Study Data, 2018

NB: CDI as the Dependent Variable

The positive determinants are discussed as follows;

i) Civil status

The majority of the respondents, 78.6 %, were married while the single, divorced and separated were 21.4 %. Civil status of the smallholder maize farmer had a positive influence on food crop diversification. A married man or woman probably has more resources due to extra contribution by the spouse. Ideas, skills and labour contribution to food crop production for married farmers are better than their counterpart single farmers. Preferences of the types of food crops to be grown are also diverse hence high chances of diversifying. In addition, since a larger number of these maize farmers (77.1%) have agriculture as their primary occupation, both spouses are available for farming activities and focus on it since it is their main source of income hence high diversity on food crops produced. This factor has a possible effect of 1.2% improvement on food crop diversification *ceteris paribus*.

ii) Age

The average age of the respondents was between 36 and 45 years. Age of the household head had a positive influence on diversification of food crops contrary to findings of Kumar *et al,* 2012, Huang *et al,* 2014, Shabhaz *et al,* 2017and Ojo *et al,* 2013 that age negatively influences diversification. According to this study, older farmers are usually patient with food crops that have longer growing periods like maize, millet and sorghum. The young farmers prefer quicker food crops such as Irish potatoes and beans. In addition, older farmers are more skilled in

producing traditional food crops more than the young people. Furthermore, older people have a high preference for the traditional food crops such as finger millet, sorghum and sweet potatoes other than maize compared to the young people. This was the greatest socio-economic determinant indicating 1.5 % increase in food crop diversification 1 increase in age *ceteris paribus* effect food crops diversification

iii) **Experience**

The average experienced of the maize farmers in agriculture was over 10 years at 67%. This determinant also had a positive influence on food crop diversification by smallholder maize farmers. This is in line with the explanation on age that older people have more skills in producing the selected food crops especially maize and the traditional food crops than the younger people. This factor has minimal effects on food crop diversification at 0.3%, other factors held constant. This is in line with the findings of Aheibam 2017, Dube 2016, Ojo *et al,* 2013 and Kanyua *et al,* 2013.

iv) Land size

The average land size for maize farmers was between 1.8 arcres (0.7ha) with a range of between 1 to 5 acres (0.4 – 2 Ha). The size of land had a positive influence on diversification of food crop production among the maize farmers in the County with a minimal effect of 0.17%. Bigger land space makes it possible for a farmer to produce more food crops other than maize hence diversify. These findings on the effect of land size on diversification are similar to the findings of

Mithiya *et al*, 2018, Huang *et al*, 2014, Shabhaz *et al*, 2017, Ojo *et al*, 2013, Rahman & Chima, 2015, Mussema *et al*, 2013, Sichoongwe, (2014), and Kanyua *et al*, 2013.

This study however reveals that gender of the household head did not positively influence the diversification of food crops by farmers similar to the findings of Kumar *et al*, 2012, but against Kanyua *et al*, 2013. Household size also had no positive influence on diversification which is against Kumar *et al*, 2012. Majority of larger households' composition could be children who are in school and could not be participating in farming activities. Education level likewise did not have positive influence on diversification, against findings of Kumar *et al*, 2012, Aheibam, 2017, Mithiya *et al* 2018, Shabhaz *et al* 2017 and Dube 2016 but similar to findings of Huang *et al*, 2014 and Ogutu & Obare, 2015. In this study, the more the number of years spent in education the more the likelihood that a person is formally employed and does not fully rely on farming as a source of food or income. More learned farmers could also prefer growing the horticultural crops rather than the traditional food crops. Agriculture as a primary occupation also did not positively influence food crop diversification which is against the findings of Kumar *et al*, 2012. Equally, membership to a farmers' group does not positively influence diversification of food crops among the smallholder farmers in Bomet County which is against the findings of Dube, 2016.

Summary of household characteristics

The household characteristics of the sample size is summarised in table 4.4

Table 4.3

Household Characteristics of the Sampled Smallholder Maize Farmers in Bomet County

Variable	Wards	Frequency	Percentage
Gender	Male	250	73
	Female	91	27
Civil status	Married	268	78.6
	Single	35	10.3
	Widowed	34	10.0
	Divorced	2	0.6
	Separated	2	0.6
Age (Years)	18 to 35	93	27.3
	36 to 45	115	33.7
	46 to 60	82	24.0
	Over 60	51	15.0
Size of the Household	Less than 6	171	50.1
	6 to 10	146	42.9
	Over 10	24	7.0
Education level	Primary	131	38.4
	Secondary	112	32.8
	College	77	22.6
	University	21	6.2
Primary Occupation	Farming	266	78
	Formal Employment	36	10.6
	Informal employment	13	3.8
	Business	26	7.6

Source; Study Data, 2018

b) Market related factors

The market related factors that were consideration for the study are; Distance from the nearest market and perceived availability of market for each of the selected food crops. Their results are presented as follows;

i) Distance to the nearest market

The market related factors under investigation were distance to the nearest commodity market, perceived availability of markets, access to loan, cost of inputs and labour. Analysis of the cost of inputs and labour was however dropped since farmers did not have records on these two aspects of production.

Tobit analysis revealed that access to credit (loan) positively determined diversification of food crops among maize farmers in Bomet County. This factor had 18% effect on diversification of food crops in Bomet county; a 1% increase in credit acquired by a farmer results in 18% improvement in diversification, *ceteris paribus*.

ii) Perceived availability of market

Perceived availability of market for each of the selected crops was analysed as a determinant to production of the food crops. This revealed that the perceived availability of market for Irish potato positively determines the decision by smallholder maize farmers to produce it or not. This is probably because the crop is mainly produced for commercial purposes rather than subsistence. Its effect is however very minimal at only 0.19%. This could be attributed to the influence of the informal market since the results also indicated a great influence from brockers.

Notably, availability of market for other food crops did not positively impact on diversification. This can be explained by the fact that the scale of production of the selected food crops among

smallholder maize farmers is small and is usually mobbed up by the middlemen, which is the major marketing system by most of the farmers.

Tobit analysed results for the market related factors is presented in Table 4.4

Table 4.4

Tobit Regression for Market Related Factors

Number of obs = 340				LR chi2(8)	=	29.01
				Prob > chi2	=	0.0003
Log likelihood = 32.909305				Pseudo R2	=	-0.7879
CDI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DNCM	.0000889	.000082	1.08	0.279	-.0000724	.0002501
MAVMZE	-.0187905	.0137456	-1.37	0.173	-.04583	.008249
MAVFMT	-.0152285	.014929	-1.02	0.308	-.0445959	.0141389
MAVSGM	-.0225611	.0152061	-1.48	0.139	-.0524734	.0073513
MAVIPTO	.0019213	.0126873	0.15	0.880	-.0230364	.026879
MAVSPTO	-.0079392	.0150141	-0.53	0.597	-.0374739	.0215955
MAVBNS	-.0255751	.0097956	-2.61	0.009	-.0448443	-.0063059
cons	.6169537	.0544007	11.34	0.000	.5099401	.7239674
sigma	.1928533	.0079141			.1772852	.2084213
Obs. summary:			26 left-censored observations at CDI<=0			
			314 uncensored observations			
			0 right-censored observations			

Source; Study data, 2018

NB: CDI as the dependent variable

c) Institutional Factors

This section is a presentation of extension services and access to credit which were the selected institutional factors that under investigation in this study as determinants of food crops diversification.

i) Extension services

Tobit regression analysis of number of contacts by different extension service providers revealed that extension services from public and private service providers had a positive influence on crop diversification. Extension service provision by the government had a higher influence at an effect of 0.3% on diversification of food crops. This is in line with the findings of Dube, (2016), Ojo *et al*, (2013) and Mussema *et al*, (2015). This is because of the direct physical contacts with the farmers particularly right in their farm fields. Findings on farmer to farmer extension as well as extension through the media had a negative impact. This is similar to findings of Mesfin, (2011) who also established that extension had a negative effect on crop diversification indicating that extension focused more on profitability therefore encouraging specialization.

ii) Access credit

Access to credit is the access to financial services which include; loans – monetary or in kind, insurance and other risk management services. This factor was the highest contributor towards crop diversification since its coefficient is positive with an effect of 18%, that is, a 1% increase in credit access leads to 18% increase in food crop diversification. This is similar to Mesfin's findings in Ethiopia. Regression on extension services and credit access by different providers is presented in Table 4.6.

Table 4.5

Tobit Regression for Number of Extension Contacts by Provider

Number of obs = 341				LR chi2(8)	=	4.04
				Prob > chi2	=	0.4009
Log likelihood = 14.216955				Pseudo R2	=	-0.1655
CDI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GEXT	.0031374	.0084368	0.37	0.710	-.0134581	.0197329
PEXT	.0016577	.010873	0.15	0.879	-.0197298	.0230452
MEDEXT	-.0122359	.0082556	-1.48	0.139	-.0284749	.004003
FRFEXT	-.011476	.0113836	-1.01	0.314	-.0338679	.0109159
ACRED	.0186897	.0116352	1.61	0.109	-.0041982	.0415777
cons	.5970071	.0706525	8.45	0.000	.4580317	.7359824
sigma	.2010962	.0083091			.1847519	.2174405
Obs. summary:		26 left-censored observations at CDI<=0				
		315 uncensored observations				
		0 right-censored observations				

Source; Study data, 2018

NB: CDI as the dependent variable

4.2.4 Pattern of food crops diversification

This section describes the pattern of food crops diversification within the year of production and relates to food security in Bomet county.

i) Pattern of food crops diversification

This study revealed that the production of maize in Bomet county is bimodal following the rainfall pattern. 70% of the annual maize production is done in the first season which is the long rains season while the remaining 30% is done in the short rains season. Finger millet and Sorghum is also done majorly in the first season while 20% of the beans are produced in the long rains season intercropped with maize. The remaining 80% is produced in the short rains season majorly as a pure stand. Food crop production pattern in the county is bi-modal with the long

rains season beginning end of February to early March while short rains begin July/August. This pattern is for Maize, sorghum, millet and beans while Irish and sweet potatoes are grown throughout the year.

ii) Food crops diversification pattern and food security

The CDI results indicates a low to moderate diversification however the intensity of the diversified food crops is very low. Further investigation to the level of production of the alternative food crops under the study prints a very disturbing picture in relation to food security in the county. This study reveals that despite the devastating impact of MLND on maize, the smallholder farmers still allocate bigger junks of land to maize leaving very negligible peace to the alternative food crops. Maize and beans were produced on average land of 1.7 and 1 acres respectively leaving 0.57 acres for the rest of the food crops. This is partly why there is a vicious cycle of seasonal food shortage between the months of between the months of January to April as documented by Wakibi *et al*, (2015). Table 4.7 is a summary of land allocation amongst the food crops by smallholder maize farmers in Bomet county.

Table 4.6

Level of Food Crops Production Amongst Smallholder Maize Farmers in Bomet

Crop	Average acreage	Percentage of farmers growing
Maize	1.7	100
Beans	1	89.4
Finger millet	0.2	34
Sorghum	0.1	28.4
Irish potato	0.14	27
Sweet potato	0.13	28.7

4.3 Diagnostic Tests

This section describes the diagnostic tests concerning the reliability of the research instruments and multicollinearity tests of the determinants.

4.3.1 Reliability of research instrument

A statistical coefficient – Cronbach's alpha (α) was used as a measure of internal reliability (Cronbach, 1971). Reliability coefficient of 0.7 or more indicates high reliability of the data. Cronbach's alpha reliability coefficient ranges between 0 and 1 (Mugenda, 2003). Based on the feedback from the pilot test, the questionnaire was modified and a final one developed.

Tables 4.1 shows that all the scales were significant, having an alpha above the prescribed threshold of 0.7. Extension Services had the highest reliability (α=0.825) followed by Food crop pattern (α=0.767); then crop diversification (α=0.731); while economic factors was (α=0.714), this showed that the data collection instrument was reliable and hence was used for collecting data for the study.

Table 4.7

Reliability Coefficients Scale

Variables	Cronbach Alpha	Number of Items
Food crop diversification	0.731	10
Market related factors	0.714	11
Institutional Services	0.825	12
Socio-Economic Factors	0.767	8

Source: Research data (2018)

4.3.2 Multicollinearity tests

After Tobit model regression analysis, the independent variables were checked for multicollinearity, which is a condition of high correlation amongst explanatory variables. Their independent effects on the dependent variable can therefore not be separated out hence no confidence in the policy prescription concerning the particular variables (Sichoongwe *et al*, 2014) Standard errors may be overestimated and t-values depressed. This phenomena is detected by examining the correlation matrix of regressors also by carrying out auxiliary regression amongst the regressors (Wang G. C. S.,1996) as presented in table 4.8.

The results indicated multicollinearity in some variables therefore those variables should not be considered separately in policy formulations towards food security.

Table 4.8

Multicollinearity Test on Socio-economic Variables

	GEN	CIVST	AGEHH	HSZE	EXP	EDLHH	APROC	MBFGRP
GEN	1.0000							
CIVSTAT	0.4686	1.0000						
AGEHH	0.0199	0.0717	1.0000					
HSZE	0.1382	-0.1532	0.2049	1.0000				
EXP	0.0107	0.0248	0.4561	0.3071	1.0000			
EDLHH	-0.1271	-0.0462	-0.2238	-0.1371	-0.2471	1.0000		
APROC	0.0609	0.0968	-0.1474	-0.1360	-0.2036	0.1879	1.0000	
MBFGRP	0. 0108	0.0397	-0.0417	-0.0884	-0.1509	-0.1351	0.0143	1.0000

Multicollinearity test indicates a positive correlation between some of the factors hence there is no confidence in their consideration in policy matters to do with food security. Those without multicollinearity effect however should be highly considered since their individual effect on the dependent variable can easily be isolated.

CHAPTER FIVE

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings, conclusions and recommendations of the study based on the objectives as well as suggestions for further research.

5.2 Summary

This section is presented in four sections according to the different objectives of the study.

a) Extent of food crop diversification

The mean CDI was 0.4974, meaning that the smallholder maize farmers in Bomet county had low in food crops diversification. The farmers were placed in four categories, namely none-diversifiers, low, moderate and high diversifiers.

b) Determinants of food crop diversification

i. Socio-economic determinants

The results of Tobit regression models indicate that food crop diversification among smallholder maize farmers in Bomet County was determined by civil status of the household head, age of the household head, experience in farming and size of land owned by the household. This study however revealed that gender of the household head, household size, education level, agriculture as a primary occupation and membership to a farmers' group does not positively influence diversification of food crops among the smallholder farmers in Bomet County.

On market related factors, Tobit analysis revealed that access to loan positively determined diversification of food crops among maize farmers in Bomet County. Perceived availability of market for the food crops however did not positively impact on diversification except for

Potatoes. Perceived market availability for the crop positively determined its inclusion production by the smallholder maize farmers probably because the crop is mainly produced for commercial purposes rather than for subsistence.

i. Market related determinants

Perceived availability of market for Irish potato was a determinant to its production by smallholder maize farmer.

ii. Institutional determinants

Extension by public and private providers had a positive influence on crop diversification probably due to direct physical contacts with the farmers right in their farms. Number of extension contacts through the media and with other farmers did not have an influence on diversification of food crops.

c) Pattern of food crop diversification

This study revealed that the production of maize in Bomet county is bimodal following the rainfall pattern. 70% of the annual maize production is done in the first season which is the long rains season while the remaining 30% is done in the short rains season. Finger millet and Sorghum is also done majorly in the first season while 20% of the beans is produced in the long rains season intercropped with maize. The remaining 80% is produced in the short rains season majorly as a pure stand. The other two crops; Irish and sweet potatoes are grown throughout the year.

Alternative food crops are allocated minimal land space by smallholder maize farmers unlike maize and beans.

5.3 Conclusions

This study was carried out with the specific objectives to; determine the extent of diversification of food crops production by smallholder maize farmers, identify the socio-economic factors influencing food crop diversification, establish the effect of extension services and market related factors on food crop diversification and determine the pattern of food crop diversification by the smallholder maize farmers.

1. From analysis of the field data, the results show that the smallholder maize farmers in Bomet county are low in food crop diversification since the mean CDI is less than 0.5.

2. The results indicate that civil status, age, experience and land size had an influence on the farmers' decision to diversify on food crops production. In addition, access to credit was a great market related determinant of food crop diversification.

3. Furthermore, extension services from the public and private extension service providers influenced diversification of food crops production.

4. Perceived access to market for Irish potatoes influenced its production positively unlike the other food crops under the study.

5. The study also established a bi-modal pattern of food crops production following the bi-modal rainfall pattern. This is especially for sorghum, finger millet and beans but Sweet potato and Irish potato are grown continuously throughout the year.

6. From data collection, it was established that food crops producers do not keep adequate records which led to dropping of the aspect of input cost as a determinant of diversification during analysis stage.

7. These factors should therefore be streamlined into policies and strategies on food security. This would better harness the good climatic conditions for food crops production and enhance sustainability of food security.

8. Very little land is allocated to the alternative food crops hence food security is not guaranteed.

5.4 Recommendations

In view of the above conclusion, this study recommends that there should be a critical consideration of the factors influencing diversification whenever food security strategies are put in place. This will foster sustainability in food security due to proper use of the land harnessing the good climatic conditions for food crop production throughout the year.

Specific recommendations are;

1. Promote the food crops production among the young and educated. This will increase productivity of the crops since young farmers are energetic and with higher education levels, they understand the extension messages well and can implement them correctly. This would therefore improve the level of diversification hence food security enhanced.
2. Improve access and control of land use. The results from the study indicate that land plays a big role in influencing food crops diversification positively. The government and other relevant stakeholders should formulate policies that enable food crops producers to access and control land use hence investing more on food crops production to sustain food security.

3. The government and private sector stakeholders should enhance extension service provision and foster public private partnership (PPP) to enhance diversification of food crop production and improve productivity therefore enhancing food security.
4. The stakeholders to provide farmer friendly credit products. As indicated from the research findings, access to credit influence diversification of food crop production throughout the year and its access will always enhance food crops production.
5. Avail quality food crops production inputs; agro-input stakeholders should avail quality food crops production inputs on time in line with the pattern of food crops production.
6. The stakeholders should facilitate the farmers' groups on establishing market linkages and other forms of collective marketing to improve their income. This will also encourage production of the food crops hence sustainable food security within the county and beyond.
7. The extension providers should train farmers on record keeping and follow up on its implementation. This will facilitate measurement of efficiency in production of the food crops and easy access of credit hence sustainable food crops diversification and food security
8. Food security policies should provide guidelines on resource allocation to production of food crops especially hardy crops; resistant or tolerant to pests and diseases.

5.5 Suggestions for Further Research

This study analysed the determinants of food crops diversification among maize farmers in Bomet County focusing on socio-economic factors, market related factors and extension. This study therefore proposes further research on efficiency in food crops diversification. In addition, this study proposes further research on impact of food crop diversification on household income and food security in Bomet County.

REFERENCES

African Women Studies Centre (AWSC), (2014). Status report on Kenya National Food Security. *Filling the granary*: *Zero tolerance to hunger, Nairobi: University of Nairobi Press*

AGRA, (2014). African agriculture status report 2014. Retrieved 29th January 2018 from https://reliefweb.int/sites/reliefweb.int/.../agra-africa-agriculture-status-report-2014.pdf *online*

Aheibam, M., Singh, R., Feroze, S. M., Singh, N. U., Singh, R. J., & Singh, A. K. (2017). Identifying the determinants and extent of crop diversification at household level: *An evidence from Ukhrul District, Manipur. Economic Affairs, 62(1): 89.*

Alliance for a Green Revolution (AGRA). (2014). Africa agriculture status report: *Climate change and smallholder agriculture in Sub-Sahara Africa. Nairobi, Kenya*

Bhohale, R. S. (2013). Decline in traditional millet farming in tribal trace areas of Mahabaleshwar Taluka a hazard to ecosystem. *International Journal of Science and Engineering*, *1*(2): 69-70.

Birachi, E. A., Ochieng, J., Wozemba, D., Ruraduma, C., Niyuhire, M. C., & Ochieng, D. (2011). Factors influencing smallholder farmers' bean production and supply to market in Burundi. *African Crop Science Journal*, *19*(4): 335-342.

Chepng'etich, E., Nyamwaro, S. O., Bett, E. K., & Kizito, K. (2015). Factors that influence technical efficiency of sorghum production: *A case of small holder sorghum producers in Lower Eastern Kenya. Retrieved 30th January 2018 from* https://www.hindawi.com/journals/aag/2015/861919/

CGoB, (2017) Agriculture department annual reports, 2017; as secondary data.

CGoB, (2013), Bomet county integrated development plan, County Government. Retrieved 3rd February 2018 from *cog.go.ke/39-main-menu/304-cidp,* Online

Dube, L., Numbwa, R., & Guveya, E. (2016). Determinants of crop diversification amongst agricultural co-operators in Dundwa agricultural camp, Choma district, Zambia. *Asian Journal of Agriculture and Rural Development*, *6*(1): 1.

Ellis, F. (2011). The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics*, *51*(2), 289-302.

Evans, H. E., & Ngau, P. (1991). Rural- urban relations, household income diversification and agricultural productivity. *Development and change*, 22(3), 519-545.

FAO, (2017), The future of food and agriculture, trends and challenges. Retrieved 4th January 2018 from www.fao.org/3/a-i6583e.pdf

FAO, (2016a), Climate change and food security, risks and responses. Retrieved 4th January 2018 from www.fao.org/3/a-i5188e.pdf

FAO, (2016b), The state of food insecurity in the world 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. *Food and Agriculture Organization Publications, Rome*.

FAO, (2015), Economic lives of smallholder farmers, an analysis based on household data from the nine countries. Retrieved 4th January 2018 from www.fao.org/3/a-i5188e.pdf

FAO, (2013), Analysis of insentives and disinsentives for sorghum in Kenya. Retrieved 4th June 2018 from www.fao.org/mafap

FAO, (2009), World summit on food security, Declaration of world summit on food security. Retrieved 5th January 2018 from www.fao.org

FAO, (2001), World food summit; *Five years later*. Retrieved 4th January 2018 from www.fao.org

FAO, (1995), Lessons from the green revolution; Towards a new green revolution. Retrieved 4th January 2018 from www.fao.org

FAO, IFAD and WFP, (2015). The state of food insecurity in the world, 2015. *Meeting the 2015 international hunger targets: taking stock of uneven progress*. Retrieved 29th January 2018 from www.fao.org/3/a-i4646e.pdf

FAO, IFAD, UNICEF, WFP and WHO, (2017). The state of food security and nutrition in the world 2017. *Building resilience for peace and security.* Rome, FAO. Retrieved 29th January 2018 from www.fao.org/3/a-1765e.pdf

Fitzgerald-Moore, P., & Parai, B. J. (1996). The green revolution. *University of Calgary*.

GoK (2017), National food and nutrition security policy implementation framework 2017 – 2022. Retrieved 29th January 2018 from www.kenyagreece.com

GoK, (2014), Household Baseline Survey. Bomet County, Ministry of Agriculture Livestock and Fisheries. Nairobi

GoK (2010), Agricultural sector development strategy *2010 – 2020.* Retrieved 29th January 2018 from www.kenyagreece.com .

Goletti, F. (1999). *Agricultural diversification and rural industrialization as a strategy for rural income growth and poverty reduction in Indochina and Myanmar* (No. 596-2016-40031).

Masoud All, H. (2010). *Agricultural diversification determinants and contribution to small holder farmers' incomes* (Doctoral dissertation, Sokoine University of Agriculture).

Huang, J. K., Jiang, J., Wang, J. X., & Hou, L. L. (2014), Crop diversification in coping with extreme weather events in China. *Journal of Integrative Agriculture, 13*(4):677-686.

In, J., & Lee, S. (2017). Statistical data presentation. *Korean journal of anesthesiology, 70*(3): 267-276.

Kaguongo, W., Ortmann, G., Wale, E., Darroch, M., & Low, J. W. (2012). Factors influencing adoption and intensity of adoption of orange flesh sweet potato varieties: *Evidence from an extension intervention in Nyanza and Western provinces, Kenya.*

Kanyua, M. J., Ithinji, G. K., Muluvi, A. S., Gido, O. E., & Waluse, S. K. (2013). Factors influencing diversification and intensification of horticultural production by smallholder tea farmers in Gatanga District, Kenya. *Current Research Journal of Social Sciences, 5*(4), 103-111.

Karanja, L., Malinga, J., Ndung'u, J., Gichangi, A., Lelgut, D., Kamundia, J., & Gethi, M. (2015). Development and Evaluation of New Sweetpotato Varieties through Farmer Participatory Breeding for High Altitudes in Kenya. *Potato and Sweetpotato in Africa: Transforming the Value Chains for Food and Nutrition Security*, 88-97.

KARI, (2008). Growing improved beans for food and income. Retrieved 12th January 2018 from www.kalro.org/fileadmin/publications/brochuresII/Grow_improved_beans.

Kariuki M. T., (2014), Quality status of farm saved bean seed in Maragua Sub-county and management of seed borne diseases by seed treatment. *erepository.uonbi.ac.ke/bitstream/handle/.../Muthii_i%20submission%20draft.*

Kenya Agriculture and Livestock Research Organization (2017), Fall Armywarm. Retrieved 14th December 2017*www.kalro.org/sites/default/files/Fall-Army-Worm-brochure-april-2017.*

Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health-System Pharmacy, 65*(23): 2276-2284.

Kimenju, S. C., & Tschirley, D. L. (2008). *Agriculture and livelihood diversification in Kenyan rural households* (No. 680-2016-46739).

KIPPRA, (2016). Kenya economic report 2016. *Fiscal decentralization in support of development*, Nairobi Kenya.

KNBS & SID, (2013). Exploring Kenya's inequality, pulling apart or pooling together. Bomet county, Nairobi, Kenya. Retrieved 20th April 2018 from statistics.knbs.or.ke

KNBS, (2009). 2009 Kenya population and housing census. Retrieved 20th April 2018 from statistics.knbs.or.ke

KNBS, (2018). Economic survey 2018. Retrieved 19th April 2018 from statistics.knbs.or.ke

Kothari, C. R. (2004). *Research methodology: Methods and techniques, 2nd edition*. New age International Publishers (P) Ltd., New Delhi, India.

Kumar, A., Kumar, P., & Sharma, A. N. (2012). Crop diversification in Eastern India: Status and determinants. *Indian Journal of Agricultural Economics, 67*(4), 600-616.

Lin, B. B. (2011). Resilience in agriculture through crop diversification: adaptive management for environmental change. *BioScience, 61*(3), 183-193.

Makate, C., Wang, R., Makate, M., & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. *SpringerPlus, 5*(1): 1135.

Mandal, R., & Bezbaruah, M. P. (2013). Diversification of cropping pattern: Its determinants and role in flood affected agriculture of Assam Plains. *Indian Journal of Agricultural Economics*, *68*(2): 170-181.

Masoud Ali, H. (2010). *Agricultural diversification determinants and contribution to small holder farmers' incomes* (Doctoral dissertation, Sokoine University of Agriculture).

Mendola, M. (2007). Farm Household Production Theories: A Review of``Institutional"and``Behavioral"Responses. *Asian Development Review*, *24*(1), 49.

Menza, M., Girmay, G., & Woldeyes, F. (2014). Enhancing household food security through Irish potato production in Gamo Highlands of Southern Ethiopia. *Scholarly Journal of Agricultural Science*, *4*(7), 410-419.

Mesfin, W., Fufa, B., & Haji, J. (2011). Pattern, trend and determinants of crop diversification: empirical evidence from smallholders in eastern Ethiopia. *Journal of Economics and Sustainable Development*, *2*(8): 78-89.

Mgonja, M. A., Lenne, J. M., Manyasa, E., & Sreenivasaprasad, S. (2007). Finger millet blast management in East Africa Creating opportunities for improving production and utilization of finger millet.

Mitaru, B. N., Karugia, J. T., & Munene, C. (1993). Finger millet production and utilization in Kenya. Mohan Primlani for Oxford & IBH Publishing Co..

Mithiya, D., Mandal, K., & Datta, L. (2018). Trend, pattern and determinants of crop diversification of small holders in West Bengal: A district-wise panel data analysis. *Journal of Development and Agricultural Economics*, *10*(4): 110-119.

Mugenda O. M, Mugenda A. G, (2003), Research Methods*: Quantitative and Qualitative Approaches.* Acts Press, Nairobi

Mussema, R., Kassa, B., Alemu, D., & Shahidur, R. (2015). Determinants of crop diversification in Ethiopia: Evidence from Oromia region. *Ethiopian Journal of Agricultural Sciences*, *25*(2): 65-76.

National Cereals and Produce Board - NCPB, (2017). Bomet county farmers' register. Retrieved 24th April 2018 from www.ncpb.co.ke/.../FARMERS/BOMET%20COUNTY

NEPAD, (2015). Climate change and adaptation and resilience in Africa. Recommendations for policy makers. Network of African Science Academies (NASAL), Nairobi, Kenya.

Nungo, R. A., Ndolo, P. J., Kapinga, R., & Agili, S. (2007). Development and promotion of sweet potato products in Western Kenya. In *Proceedings of the 13th ISTRC Symposium* (pp. 90-794).

Nyasimi, M., Amwata, D., Hove, L., Kinyangi, J., & Wamukoya, G. (2014). Evidence of impact: Climate-smart agriculture in Africa.

Odendo, M., Ndolo, P. J., & Kapinga, R. (2002). Impact of improved sweet potato varieties in Western Kenya: Farmers Perspective. KARI-Regional Centre, Kakamaga, Kenya. Draft Report. 23pp.

Ogutu, W. N., & Obare, G. A. (2015). Crop choice and adoption of sustainable agricultural intensification practices in kenya. *Adoption Pathways project discussion paper*, *10*.

Ojo, M. A., Ojo, A. O., Odine, A. I., & Ogaji, A. (2014). Determinants of crop diversification among small–scale food crop farmers in north central, Nigeria. *Production Agriculture and Technology Journal*, *10*(2): 1-11.

Onyango, A. O. (2016). Finger millet: food security crop in the arid and semi-arid lands (ASALs) of Kenya. *World Environment*, *6*(2): 62-70.

Rahman, S., & Chima, C. D. (2016). Determinants of food crop diversity and profitability in southeastern Nigeria: *a multivariate tobit approach*. Agriculture, 6(2), 14.

Sabila, S. C. (2014). Factors that influence food security in rural households of mount Elgon sub county, Kenya (Doctoral dissertation, University of Nairobi).

Sebby, K. (2010). The green revolution of the 1960's and its impact on small farmers in India.

Shahbaz, P., Boz, I., & ul Haq, S. (2017). Determinants of Crop Diversification in Mixed Cropping Zone of Punjab Pakistan.

Sichoongwe, K., Mapemba, L., Ng'ong'ola, D., & Tembo, G. (2014). The determinants and extent of crop diversification among smallholder farmers: A case study of Southern Province, Zambia (Vol. 5). Intl Food Policy Res Inst.

Taylor, J., & Taylor, J. (2010). Simple Sorghum Grain Quality Evaluation Procedures. *Presented at the Sorghum Food Enterprise and Technology Development in southern Africa workshop in Lusaka, Zambia*, December 6-9: 2010.

Onyango, A. O. (2016). Finger millet: food security crop in the arid and semi-arid lands (ASALs) of Kenya. *World Environment*, *6*(2), 62-70.

UNDP, (2015a). Millenium Development Goals. Retrieved 10th January 2018 from *www.undp.org/content/undp/en/home/sdgoverview/mdg_goals.html*

UNDP, (2015b). Goal 1: No poverty. Retrieved 7th Feb 2018 from www.undp.org/content/undp/en/.../sustainable-development.../goal-1-no-poverty.

Wakibi, S., Gichuhi, W., & Kabira, W. M. (2015). Food Security Score for Kenya., Retrieved 7th Feb 2018 from www.awdflibrary.org

Wang G. c., s., (1996), How to handle multicollinearity in regression modeling; *Journal of Business Forecasting methods and Systems* 15, 23-27.

Wawa, B. (2015). Maize lethal necrosis: a serious threat to food security in eastern Africa and beyond. Retrieved 30th January 2018 from https://www.cimmyt.org

World Agroforestry Centre (WAC) & NEPAD (2015). African crops consortium 2015 progress report, *africanorphancrops.org*

APPENDICES

APPENDIX 1: INTERVIEW SCHEDULE

TOPIC: DETERMINANTS OF FOOD CROP DIVERSIFICATION AMONG SMALLHOLDER FARMERS IN BOMET COUNTY, KENYA

Introduction

Iam Everlyne Cherotich Mwangangi undertaking a master degree course on Agricultural Economics at University of Kabianga. This questionnaire is meant to collect information on the above stated topic for a research project. The information collected will be treated with confidentiality and used for academic purpose only. Kindly give your time to answer all questions as accurately as possible.

Serial No: _____

Date of data collection: …… Location (ward) …….

Sub-county: …… village: ……

SECTION A: DEMOGRAPHIC CHARACTERISTICS

Q1. Has this household grown maize in the last one year? 1. Yes 2. No

Note: If yes above, proceed with the interview, if No, discontinue and move to another farmer

Q2. Who is the head of this household?

1. Self 2. Spouse

Q3. Gender of the household head

1. Male 2. Female

Q4. Civil status of the household head

1. Married 2. Single 3. Widowed/widower.

Q5. Age of the household:

1. Less than 36 Year 2. Thirty six (36) –to- 60 Year 3. More than 60 Years

Q6. On average, how many people live in this house presently?

1. Less than 6 2. 6 to 10 3. Over 10

Q7. How many of the members who live in this household are able to engage in active family farm labor?

1. Less than 5 2. 6 to 10 3. Over 10

Q8. For how long has the head of this household practiced farming?

1. Less than 6 years 2. 6 to 10 years 3. Over 10 years

Q9. What is the highest level of education attained by the household head:

1. Primary 2. Secondary 3. Post-secondary

Q10. What is the main source of livelihood for this household?

1. Farming 2. Formal employment 3. Informal employment 4. Business

Q11. How much land does this family own (in acres)? …….

Q12. Does the household head belong to any farmers' group?

1. Yes 2. No

Q13 (a) If Yes, what is the name of the Organization: _____

Q13 (b) What benefits do you derive from being a farmers' group member?

1. Extension services 2.Better output prices 3. Easy access to credit

SECTION B: EXTENT AND PATTERN OF DIVERSIFICATION

This section deals with the amount of crop grown per type

Q14. What is the size of your farm under the following crops in the last two cropping seasons?

S/No.	Crop type	Acreage under the crop in the last two cropping seasons	
		Season 1	Season 2
1.	Maize		
2.	Finger millet		
3.	Sorghum		
4.	Irish potatoes		
5.	Sweet potatoes		
6.	Beans		

Q15. Do you practice any kind of intercropping of these food crops?

1. Yes 2. No

Q16. Which combination of these food crops do you intercrop during the growing season?

S/No.	Intercrop combination			
	Season 1	Acreage	Season 2	Acreage
1.				

2.				

SECTION C: MARKET RELATED FACTORS

Q17. Do you use the following inputs in producing your food crops?

1. Improved seeds 2.Fertilizers 3.Pesticides 4.Insecticides 5. Labor

Q18. What was the cost of input used on each crop per acre?

(a). Maize

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Hired labor			
Agro-chemicals			
Transport			
Fuel and oil			
TOTAL COST			

(b). Finger millet

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Repairs			
Hired labor			
Agro-chemicals			
Transport			
Fuel and oil			
TOTAL COST			

c).Sorghum

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Repairs			
Hired labor			
Agro-chemicals			

Transport			
Fuel and oil			
TOTAL COST			

(d). Irish Potato

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Repairs			
Hired labor			
Agro-chemicals			
Transport			
Fuel and oil			
TOTAL COST			

e) Sweet potato

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Repairs			
Hired labor			
Agro-chemicals			
Transport			
Fuel and oil			
TOTAL COST			

(f). Beans

Input	No. of Units	Cost per unit	Total cost
Seed			
Fertilizer			
Repairs			
Hired labor			
Agro-chemicals			
Transport			
Fuel and oil			

TOTAL COST	

Q19. Distance from the household residence to the nearest commodity market (Km)……

Q20. Commodity marketing systems (for column 3&4, tick where applicable)

Commodity	Marketing system		
	Market available 1-Y 2-N	Group marketing (Contract farming)	Middlemen
Maize			
Finger			
Sorghum			
Irish potato			
Sweet potato			
Beans			

SECTION D: INSTITUTIONAL SUPPORT

Q21. In the past two production seasons, did you seek the services of any agricultural extension officer? 1. Yes 2. No

Q22. Did any extension office visit you in the past two production season without your invitation? 1. Yes 2. No

Q23. If yes (in 23 above), fill in the table below.

Source Extension service	No. of contacts in the last 12 months	Did you pay for the services? 1=YES 0=N0	Cost per each visit 1. Free, 2. <200 3. 200-500, 4 >500
Government extension worker			
Private extension provider			
Media (Radio, TV)			
Other farmers			

Q24. What Extension messages were received by the household?

1. Farm management 2. Entrepreneurship
3. Production technology 4. Pest and disease control

Q25. Has the household had any experience with Maize Lethal Necrosis Disease (MLND) and or Fawl Armywarm (FAW) in his/her farm in the last one year?

S/No.	Pest and Disease	Experience 1. Yes 2. No	Approximate crop loss. Between 1. 0 - 25% 2. 26 - 50% 3. 51 - 75% 4. 76 - 100%

1.	MLND		
2.	FAW		

Q26. What do you do to manage and control the disease/pest (Tick where applicable) and what is the effectiveness of the methods used? (Between 1 and 10)

S/No.	Control method	MLND control	Effectiveness	FAW control	Effectiveness
1	Diversification - rotation				
2	Chemical control				
3	Growing of resistant varieties				
4	Nothing				
5	Traditional methods (specify				

Q27. What is the source of capital used to run food crop production in your farm?

1. Proceed from previous crop 2.Bank loans
3.Loan from farmers' group/cooperative 4. Salary /wages from off farm employment

Q28. Did you try to access loan within the last one year?

1. Yes 2. No

Q29. If yes in 23 above, did you get the loan?

1. Yes 2. No

Q30. If no in 23 above, what was the reason?

1. Do not know how to access credit services 2. Do not know where to access credit services
3. Do not have enough collateral 4. High interest rates

APPENDIX 4: KEY INFORMANT INTERVIEW

TOPIC: DETERMINANTS OF FOOD CROP DIVERSIFICATION AMONG SMALLHOLDER FARMERS IN BOMET COUNTY, KENYA

Introduction

Iam Everlyne Cherotich Mwangangi undertaking a master degree course on Agricultural Economics at University of Kabianga. This questionnaire is meant to collect information on the above stated topic for a research project. The information collected will be treated with confidentiality and used for academic purpose only. Kindly give your time to answer all questions as accurately as possible.

NB: Tick the appropriate answer or fill in the black spaces where applicable

Serial No: _____

Date……Ward……Sub-county……Gender:……

Deployment……Number of years in Extension……

SECTION A: DEMOGRAPHIC CHARACTERISTICS

Q1. What is the average household size of the smallholder maize farmers in your ward?

1. Less than 6 2. 6 to 10 Over 10

Q2. On average how many of the household members are able to and actualy engage in active family farm labor?

1. Less than 5 2. 6 to 10 3. Over 10

Q3. What is the average experience of the smallholder maize farming household heads in faming?

1. Less than 6 years 2. 6 to 10 years 3. Over 10 years

Q4. What is the highest level of education attained by the smallholder maize farming household heads?

1. Primary 2. Secondary 3. Post-secondary

Q5. What is the main source of livelihood for the majority of the smallholder maize farmer households?

1. 1Farming 2. Formal employment 3. Informal employment 4. Business

Q6. What is the average land size among the smallholder maize farming households (in hectares)? …….

Q7. a) Are there maize farmers' groups or cooperatives in this ward?

1. Yes 2. No

b) If Yes in Q7 (a), what is the average percentage of maize farmers who are members in those groups? ……..

1. Less than 25% 2. 26-50% 3. 51-75% 4. 76-100%

c).What are the motivating reason for smallholder maize farmers to coming together in a group? List in order of priority by numbering besides it (1,2,3,4,5)

1. Easy access to extension services 2. Easy access to market

3. Ease of access to inputs 4. Ease of access to credit 5. For social benefits

SECTION B: EXTENT AND PATTERN OF DIVERSIFICATION

This section deals with the amount of crop grown per type

Q8. What was the area under the following crops in the last three cropping seasons (1 year) in this ward?

S/No.	Crop type	Area under the crop in the last three cropping seasons (1 year) in acres
1.	Maize	
2.	Finger millet	
3.	Sorghum	
4.	Irish potatos	
5.	Sweet potatoes	
6.	Beans	

Q9. a) Do the smallholder maize farmers practice any kind of intercropping of these food crops?

1. Yes 2. No

b). Which combination of the food crops listed in Q8, do the smallholder farmers in this ward intercrop in the growing season?

S/No.	Common intercrop combination			
	Season 1	Acreage	Season 2	Acreage
1.				
2.				

Q10. a) Do the smallholder maize farmers practice any kind of rotational cropping among the food crops listed above? 1. Yes 2. No

b). If yes, indicate the most common crop rotation schedule on the table below

Crop rotation schedule	
Season 1	Season 2

SECTION C: MARKET RELATED FACTORS

Q11. a) What is the average usage in percentage of the following inputs in production of these food crops by smallholder maize farmers in your ward? **see code below the table**.

Inputs	Maize	Finger millet	Sorghum	Irish potatos	Sweet potatoes	Beans
1. Improved seeds						
2. Fertilizers						
3. Pesticides						
4. Insecticides						
5. Hired labor						
6. Machinery						

Code

1. Less than 25% 2. 26-50% 3. 51-75% 4. 76-100%

Q12. What is the average cost of input used by the smallholder farmers in your ward per acre?

(a). Maize

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

(b). Finger millet

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

(c).Sorghum

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

(d). Irish Potato

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

(e)Sweet potato

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

(f). Beans

Input	Unit	Cost per unit	Total cost
Seed			
Fertilizer			
Machinery			
Labor			
Chemicals			

Q13. Commodity marketing systems

Commodity	Marketing system		
	Market available 1-Yes 2-No	Group marketing (Contract farming)	Middlemen
Maize			
Finger			
Sorghum			
Irish potato			
Sweet potato			
Beans			

SECTION D: INSTITUTIONAL SUPPORT

Q14. What is the average number of smallholder maize farmers who sought for agricultural extension services from your office?

1. Less than 25% 2. 26-50% 3. 51-75% 4. 76-100%

Q15. Do you reach out to smallholder maize farmers in your ward? 1=YES 2=NO

Q16. If yes, how often do you reach the same farmer and through which means?

Means	Percentage of farmers reached (see code Bellow)	Frequency (See code below)
Office information desk		
Farm visits		
Field days		
Barazas		
Workshops		

Code:

Percentage

1. Less than 20% 2. 21-40% 3. 41-60% 4. 61-80% 5. over 80%

Frequency

1. Once a month 2. once in 3 months 4.Once in 6 months 5.once in 12 months

Q17. Which other sources do the smallholder maize farmers get extension messages from and on average what percentage?

Extension service source	Percentage of smallholder maize farmers reached
Government extension worker	
Private extension provider	
Media (Radio, TV)	
Other farmers	

1. Less than 25% 2. 26-50% 3. 51-75% 4. 76-100%

Q18. What proportions of Extension messages are passes to the smallholder maize farmers by type?

Extension service type	Proportion (see code bellow table)
1. Farm management	
2. Entrepreneurship	
3. Production technology	
4. Pest and disease control	

1. 0 - 25% 2. 26 - 50% 3. 51 - 75% 4. 76 - 100%

Q19. Have you had any experience with Maize Lethal Necrosis Disease (MLND) and or Fawl army warm (FAW) in your ward in the last two cropping seasons? What was the extent of yield loss associated with the pest and the disease?

S/No.	Pest and Disease	Experience 1. Yes 2. No	Approximate crop loss. Between 1. 0 - 25% 2. 26 - 50% 3. 51 - 75% 4. 76 - 100%
1.	MLND		
2.	FAW		

Q20. What do you advice farmers on the control and manage of the disease (Tick where applicable) and what is the effectiveness of the methods used? (Rate between 1 and 10)

S/No.	Control method	MLND control	Effectiveness	FAW control	Effectiveness
1	Diversification - rotation				
2	Chemical control				
3	Growing of resistant varieties				
4	Nothing				
5	Traditional methods (specify				

Q21. What is the main source of capital used by maize farmers to run food crop production enterprises?

1. Proceed from previous crop
2. Loan from farmers' group/cooperative
3. Bank loans
4. Salary /wages from off farm employment

Q22. Within the last two cropping seasons did the smallholder maize farmers seek for your help in applying for bank loans to run food production enterprises?

1. Yes 2. No

Q23. If yes in 22 above, what percentage applied and what percentage actually got the loan?

Loan application	Proportion of farmers
Applied	
Got the loan	

1. 0 - 25% 2. 26 - 50% 3. 51 - 75% 4. 76 - 100%

Q24. What were the reasons for the unsuccessful applications?

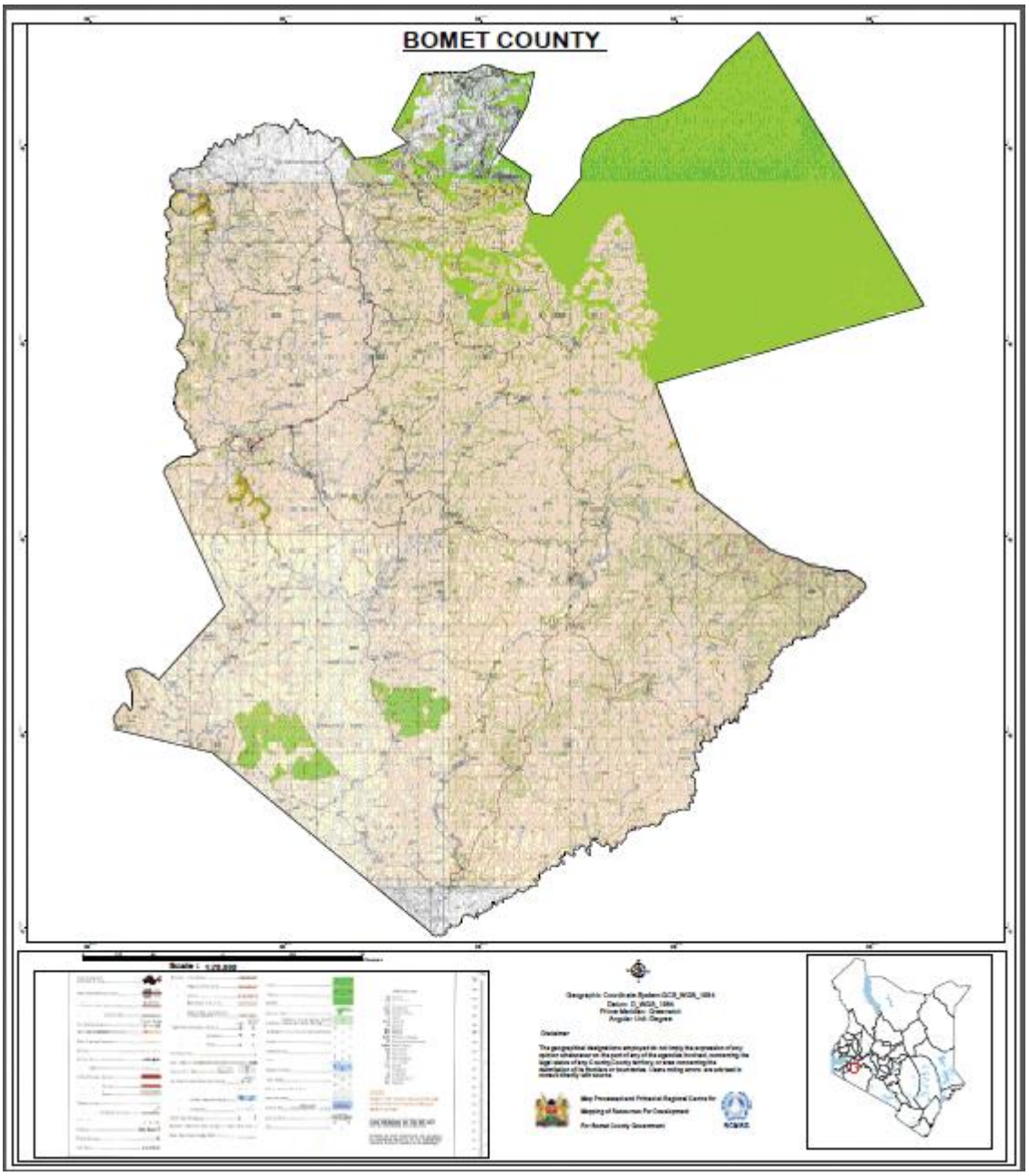
1. Lack of collaterals
2. Lack of credit product on food crop production
3. An improperly done proposal
4. Past default cases

Q25 In your own view, what are some of the reasons other farmers don't go for loans for the purpose of food crop production? (Indicate in order of priority – number beside the reason)

1. Do not need credit services -
2. Do not know how to access credit services -
3. Do not know where to access credit services -
4. Do not have enough collateral -
5. Has no good plan on how to repay the loan -
6. High interest rates -

Thank you

APPENDIX 5: MAP OF BOMET COUNTY



Map of Bomet County, Source: GoK (2013)

APPENDIX 6 EXPLORATORY VARIABLES

In this study the explanatory variables used in the model are:

X_1 = Gender of Household Head (GEND) – Male =1, Female = 0)

X_2 = Age of Household Head (AGEHH) in years

X_3 = Civil Status of household Head (MSTATS) – Married =1, Otherwise=0)

X_4 = Education level of Household Head (EDNLHH) - Number of years of formal education

X_5 = Experience of the Household head in farming (EXPHH) – Number of years in farming

X_6 = Household size (HHSZ)

X_7 = Land size (LNDSZ) in acres

X_8 = Membership to a farmers' group (MFGRP)

X_9= Agriculture as primary occupation of the household head (APOCHH)

X10 = Distance to the nearest commodity market (DNCM) – In kilometres

X11 = Availability of commodity markets (CMRKT) – Formal or informal

X12 = Government extension services (EXT) – Number of contacts

X13 = Private extension services (PEXT) – Number of contacts

X14 = Extension services from the media (MEDEXT) – Number of contacts

X15 = Farmer to farmer extension services (FRFEXT) – Number of contacts

X15 = Access to credit (ACRDT)