INFLUENCE OF CROP DIVERSIFICATION ON THE RESILIENCE OF SMALLHOLDER FARMERS IN BUNGOMA SOUTH SUB- COUNTY, KENYA

BY

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DECLARATION

Declaration by candidate

I hereby declare that this Thesis is my original work and that it has never been presented for award of any degree in any other University.

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DEDICATION

To my parents Chrispus Juma Lukingi and Florah Makokha who sacrificed to invest in me.

My academic endeavours are a consequence of the foundation they laid for me.

ABSTRACT

Recognition that many agriculture-based economies have few other livelihood strategies has generated the desire to build resilience among smallholder farmers. Globally, due to rapid population growth and continual urban sprawl, average arable land per household is shrinking and hence crop diversification is gaining increased importance in the quest for solutions to the perennial food security problems in most of Sub-Saharan countries. Crop diversification is seen as the most viable strategy that should be embraced by the global poor farmers. However, the relationship between crop diversification and farmers 'resilience is unclear, hence the need for further research. The purpose of this study was to assess the influence of crop diversification on the resilience of smallholder farmers in Bungoma South Sub County. The objectives of this study were to: examine the influence of crop diversity on food crop yield among the smallholder farmers; assess the influence of crop diversity on food affordability among the smallholder farmers; and examine the influence of crop diversity on costs of farming among the farmers. A cross-sectional descriptive research design was adopted for the study. The study population comprised of all smallholder farmers, agricultural service providers, Sub-county agricultural officer and local administration chiefs in Bungoma South Sub County, from which a representative sample of 384 participants was drawn from the accessible 3,895 subjects to participate in the study using proportionate sampling technique. Primary data were collected through: Questionnaires, key informant interviews and observation. The data were analysed using descriptive statistics: percentages, means and standard deviation.Inferential statistics:chi-square and simple linear regression analysis were used to analyse the data and test the hypotheses. All the tests of significance were conducted at $\alpha = 0.05$. The results showed that 61% (r^2=0.609), 60.9% (r^2=0.609) and 66.8 (r^2=0.668) of variation of food crop yield, food affordability index and cost of farming respectively were explained by crop diversification index.About 39%, 39.1% and 33% ofvariation of food crop yield, food affordability index and cost of farming respectively were accounted for with factors not considered in this study. The results demonstrated crop diversification as a dominant ecologically feasible, cost effective factor that significantly enhanced crop productivity and consequently farmer's resilience in the rural smallholder farming systems. Therefore, the study recommended wider adoption of diversified cropping systems among smallholder farmers notably those currently less diversified to make them resilient.

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LIST OF ABBREVIATIONS AND ACRONYMS

SSA	-	Sub-Saharan Africa
FAO	-	Food and Agriculture Organization
CDA	-	County Director of Agriculture
GNP	-	Gross National Product
GOK	-	Government of Kenya
MDG	-	Millennium Development Goal
CIMMYT	-	International Maize and Wheat Improvement Centre
USAID	-	United States Agency for International Development
MOA	-	Ministry of Agriculture
ASTGS	-	Agricultural Sector Transformation and Growth Strategy
ASDS	-	Agricultural Sector Development Strategy
ASDSP	-	Agricultural Sector Development Support Programme
IFPRI	-	International Food Policy Research Institute
CDI	-	Crop Diversity Index
FAI	-	Food Affordability Index
GDP	-	Gross Domestic Product
IPCC	-	Intergovernmental Panel on Climate

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WORKING DEFINITION TERMS

Crop Diversification: Cultivating more than one crop variety in the form of rotations and or intercropping. Crops diversified herein refer to food crops- Maize, beans, sweet potatoes and finger millet.
Crop Diversification was measured using Crop Diversity Index (CDI)

Resilience: Capacity for a given system to overcome the changes caused by disturbing elements.

Resilient small holder farmer: One who can continue to provide a quality life for themselves and their family after facing a shock that increases their costs of farming and reduces their household income and crop yield substantially.

Small holder farmer: This is a farmer who owns or rents land equal to or less than 4 acres.

Food crops: Crops planted and referred to by the majority as food. They include Maize, Beans, Sweet Potatoes and Finger Millet.

Food crop yield: The total yield for all the food crops a smallholder farmer gets per harvesting season

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Living among hazards does not necessarily mean damage and vulnerability, but the lack of resilience and the amount of knowledge and perception of a population independent of the degree of the type and the risk of causing damage (Javadinejad, 2019). It is for this reason that world-class changes in risk perceptions are evolving so that the dominant approach has been to reconstruct and reduce vulnerability to increased resilience to disasters (Kachergis, 2014).Our climate is changing and all over the world we are experiencing more unpredictable and uncertain whether than in the past. Those depending on the weather for their daily bread – farmers and farm workers – are feeling, and will continue to feel, climate change more intensively than everyone else(IPCC, 2014).Therefore, reducing the vulnerability of rural farmers by increasing the resilience plan and improving the resilience to the adverse effects of climate change can be one of the special tasks of management and agricultural development planning by identifying the exact factors influencing the strengthening of the resilience (Field, 2014).Fortunately, there are ecological farming practices that will increase farmers' capacity to adjust to climate change, which is crop diversification. These practices will help farmers and their communities cope with, and recover from, climate shocks hence become resilient. However, the influence of crop diversification on smallholder farmers' resilience is not clear.

Worldover, the agriculture sector, contributes 15 percent of Gross Domestic Product (GDP) on average, and accounts for almost 60 percent of employment (FAO 2017). Most farming households are poor smallholders who account for approximately 80 percent of all farms

(World Bank 2018). Therefore,the resilience of a smallholder farmer cannot be overlooked. On the one hand, farming households largely rely on own production to meet their dietary needs. On the other, the produce they sell often provides the main source of household income.Despite this, agriculture is highly sensitive to climate change and variability, and rain-fed agriculture systems, are especially susceptible to unpredictable weather(Mango, et al 2018). This makes smallholder farmers destabilized resulting in an increase in poverty and food insecurity.Therefore, as the population continues to grow, countries need to invest more in developing resilient agricultural systems that are able to maintain, or even increase, agricultural productivity and food security in the face of the adverse effects of climate change to make farmers resilient (World Bank, 2018).However, the existing national strategies and interventions such as the Agricultural Sector Development Strategy (ASDS) have not adequately mainstreamed building farmers' resilience in the agricultural sector.

In Sub-Saharan Africa (SSA), food crop production, the primary income generating enterprise in rural areas, is inadequate to enhance the well-being of smallholder farmers. Its contribution to rural livelihoods is hampered by high cost of production (Gautam & Andersen, 2016).Farmers in Sub-Saharan African are vulnerable to market risks, weather-related risks and shocks. Decisions on whether to diversify or to specialize production impact on farmers' resilience, and thus their capacity to cope with and adapt to these risks (FAO, 2016). The exposure to these risks is exacerbated by the fact that national agri-food systems in SSA in general, and of individual communities, are not sufficiently diversified and hence highly reliant on just one or a few staple crops. Therefore, this low productive diversification, alongside a frequent lack of assets to buffer against risks, exposes farmers to risks of income variability, crop failure, and resulting malnutrition, among others which makes the resilience of small holder farmers wanting.Worse of,researchfocusing on the contribution of crop

diversification on the crop yield harvested by small holder farmers which was sought by this study is not clear.

In Kenya, the poverty rate is 52 percent and 70 percent of the labor force depends on agricultural production for its livelihood (World Bank,2010).In addition to that, majority of the Kenya's food insecure population lives in rural areas in the country and are subsistence producers who may not grow enough to meet their families' needs (Tutwiler, 2016). This can also be considered as a low level of resilience, which can broadly be described as the inability of households to recover from disturbance in a timely manner and without compromising essential system structures and functions; (Tanner, et al. 2015). Partly, discussions of food security in Kenya usually revolve around maize, since the country's food security is overwhelmingly dependent on it, despite a continued structural deficit in maize production that has resulted in an increase in food prices. Overall, vulnerability to increase in food prices in the country is exacerbated by the absence of substantive diversification in food production and consumption(FAO, 2013). However, the potential influence of crop diversification on food affordability remains unclear.

In Bungoma County, the economy is predominately based on agriculture; 70% of its arable land is under food crop production and about 29.9% of which is under cash crop production (GOK, 2013).Agriculture in Bungoma County faces many challenges including increasing population, land fragmentation, unsustainable farming practices and climate variability, as outlined in the Bungoma County Integrated Development Plan (BCIDP) 2013-2017.Therefore, with the evidence of these challenges considered to be unequivocal even at community level, crop diversification action is considered a prudent insurance in the Sub-County (Oloo, 2013)to make small-holder farmers resilient. This is attributed to the fact that, Bungoma South Sub-County's cropland is diversified into various food crops namely, maize, beans, finger millet, sweet potatoes, bananas, Irish potatoes and assorted vegetable, while

sugar cane, cotton, palm oil, coffee, sun flower and tobacco are the main cash crops(Chenge, 2015). However, the potential effects of this crop diversification on farmers' resilience in the region is not clear.

1.2 Statement of the problem

Most governments are faced with the dilemma of achieving food security and reducing poverty in the face of increasing population. However, our climate is changing in ways that are unpredictable and most smallholder farmers use unsustainable farming practices. This situation makes everyone more vulnerable, and it is particularly risky for people who grow food for a living and depend on the weather for their daily business. Fortunately, there are ways to make the life of millions of farmers and their families less vulnerable to climate change, increased food prices and costs of farming. The way to do this is by building the capacity to deal with change, and recover after it, starting with their own small farms. This capacity is called resilience and our future, and that of millions of farmers in Africa and across the world, depends on it for survival in the presence of various shocks. Worth noting is that many farmers and organizations are already investing significant effort into building resilience in Kenyan rural areas through crop diversification. However, the extent to which there are synergies between the two variables is not clear. Therefore, the purpose of this study was to establish the influence of crop diversification on the resilience of smallholder farmers in Bungoma South Sub- County.

1.3 Objective of the Study

The overall objective of this study was to find out the influence of crop diversification on the resilience of smallholder farmers in Bungoma South Sub- County.

Specific Objectives.

1. To establish the influence of crop diversity on food crop yield among smallholder farmers in Bungoma South Sub- County.
2. To determine the influence of crop diversity on food affordability among smallholder farmers in Bungoma South Sub- County
3. To establish the influence of crop diversity on costs of farming among smallholder farmers in Bungoma South Sub- County.

1.3 Hypotheses of the study

The following null hypotheses were statistically tested:

1. Crop diversity has no significant effect on food crop yield among small holder farmers.
2. Crop diversity has no significant effect on food affordability among the smallholder farmers.
3. Crop diversity has no significant effect on costs of farming among the small- holder farmers.

1.5 Significance of the study

The findings of this study will help in pointing out to the development planners the need to develop a policy on crop diversification for enhancing resilience of smallholder farmers for different agro- ecological zones in Kenya.

Secondly, the findings will encourage smallholder farmers to embrace crop diversification as an important strategy geared towards improving their food crop yields, improve food affordability and reduce costs of farming to make them resilient.

Thirdly, the findings of this study will form a basis upon which extension officers would create awareness to farmers on the importance of embracing crop diversification to make them resilient.

Finally,the findings will add to the existing conceptual and empirical evidence that crop diversification influences resilience of agricultural land production.

1.6 Scope and Limitations of the Study

The study was carried out in Bungoma South Sub-County in the larger Bungoma County, Kenya. The study evaluated the crop diversity indices against the indicators of farmers' resilience in the region. The study targeted all smallholder farmers in the Sub- County.

The study was limited to farming of the following major food crops grown in the study area: maize, beans, sweet potatoes and finger millet because they are purely rain fed commonly grown crops in the region.

The study did not dwell on livestock farming because the study purposed to establish farmers' resilience derived from cultivation of food crops only.Only smallholder farmers who plant food crops were involved in the study.

Finally, data was collected at a period especially after the harvest, which could not cater for what happened after data had already been collected because it was a cross sectional study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section discussed the various literature related to crop diversification visa-viz resilience of food crop yield which was analysed according to the objectives of the study.

2.2 Crop diversification and food crop yield

Many experts agree that the best way to build resilience is through sustainable agricultural practices compatible with ecological farming (Cowger et al, 2008). Crop diversification is one of the strategies that provides a wider choice to farmers in production of a variety of crops in a given area and this helps farmers avoid risks and uncertainties due to climatic and biological vagaries so as to expand production on various crops (Heal, 2000). Thus, a resilient farmer continues to provide a vital service such as food production if challenged by unpredictable environmental conditions (Mugendi, 2013). It is therefore implied that in agricultural systems, crop diversity provides the link between stress and resilience because a diversity of organisms is required for ecosystems to function and provide services (Heal, 2000). This is attributed to the fact that Crop diversity is central to food security because it underpins today's production in the face of a rapidly changing world. (FAO, 2016). However, adoption of increased diversification has been slow among many farmers. Therefore, there is need forfarmers to know how to manage vulnerability and resilience on their farms by dynamically adjusting the practices they use and the crops they plant that was carried out by this study.

In Sub Saharan Africa (SSA), many communities depend largely on agricultural products (food, fodder, fuel) for their livelihoods (Altieri, 1999). These farmers are more vulnerable to the overall effects of climate change since they have limited resources to invest in expensive coping strategies (Brenda, 2011). The majority of farmers here are smallholders own less than 5 acres (2 hectares) of land (which is likely to be further reduced due to current land fragmentation and unregulated urban center expansion) and practicing "low-resource" agriculture (Altieri et al, 2012). Crop diversification is seen as one of the most ecologically feasible, cost-effective, and rational ways of reducing uncertainties in agriculture especially among small-scale farmers (Brenda, 2011). However, adoption has been very slow. Therefore, there is need to understand how crop diversification makes small holder farmer resilient through improved food crop yieldto hasten the adoption that is provided by this study.

Presently, there is renewed global interest in the area of crop diversification, mainly ascribed to the present rising concerns about loss of biodiversity, and human and environmental health. (Yatich,*et al* 2007). This indicates that more scientific expertise is desirable to identify which aspects of crop diversification could provide alternative and more viable tactics for crop productionto make smallholder farmers resilient. Moreover, the potential of genetic diversification at the crop species level for improving production, resilience, and yield stability in low-input systems needs to be critically examined (GoK, 2009). This makes this research very relevant in addressing the relationship between crop diversity and food crop yield.

In 2008, the government launched Kenya Vision 2030 as the overall national long-term development blueprint that aims to transform the country into a newly industrializing, middle income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment (GOK, 2009). In Vision 2030, agriculture was identified as a key sector

in achieving the envisaged annual economic growth rate of 10%. This would be achieved through transformation of smallholder agriculture from subsistence to an innovative, commercially oriented and modern agricultural sector (GOK, 2009). In response to entrenching the aspirations of Vision 2030, the Agricultural Sector Development Strategy (ASDS) was developed and has been the overall national policy document for the rural sector ministries (ASDS, 2009). Three anchors were articulated herewith: increasing small-scale farmer incomes, increasing agricultural output and value-add, and boosting household food resilience (GOK, 2013). However, the vision 2030 emphasized resilience of agricultural land production unlike this study that is out to emphasize smallholder farmers' resilience.

Bungoma County constitutes a specific ecological zone having specific problems and possibilities. Most smallholder farmers are poor, face high cost of certified seeds and natural calamities such as unreliable rainfall and hailstones. Chronic food insecurity where maize monoculture is the norm among the Sub-County's many smallholder farmers is largely due to the fact that 85-90 per cent of agriculture is rain-fed and accounts for 35 percent of the region's gross national product(CIMMYT, 2016).While Maize is viewed as the anchor of the County's food security, lack of policy focus on diversification of food availability at household level leaves many households vulnerable to the effects of unstable weather and unreliable marketing systems (Birch, 2018). Studies in the study area reveal that the county does not have a policy guidelines on crop diversification and the county's food security is depended on maize whose yields are dwindling to levels where they cannot sustain the population's food requirements(Simiyu, 2014). This makes this research relevant in addressing the role of crop diversity in improving crop yield.

2.3 Crop diversification and food affordability

Food affordability is based on the ability to procure food (FA0, 2012). This may be impeded on both sides of the consumption process, with high food prices or lack of financial capital to acquire goods. Worth noting is that 75% of the hungry population are found in the less developed countries, especially in the rural areas (FAO, 2010). While a large proportion of the African population relies primarily upon subsistence agriculture, markets have long been important as a secondary source of food (Ingram,*et al* 2005). However, those who derive their livelihood from natural resources will additionally suffer increased food insecurity, based on smaller crop yields limiting availability of food for both personal consumption and a source of capital(FAO, 2012). Therefore, growing a greater diversity of crops is essential to working towards 100% food security and also increasing profitability for farmers, through production of higher- value crops (FAO,2018).The above studies acknowledge that most people in Africa are food insecure, mostly rely on markets as a secondary source of food and crop diversity can help improve food security. However, these studies do not further justify how crop diversity can help farmers become resilient, unlike this study that has justified the relationship between crop diversification and food affordability.

With rain-fed agriculture and pastoralist being the primary livelihood options in Sub-Saharan Africa, there are a great many people who are vulnerable, and who could see their financial capital seriously limited (Aggarwal,*et al* 2008). Limited financial means, combined with expectations of high food prices, will thus seriously affect accessibility, and serve as an additional source for potential food insecurity in the face of climate variability (Heather, 2010).

However, those who derive their livelihood from natural resources will additionally suffer increased food insecurity, based on smaller crop yields limiting availability of food for both personal consumption and as a source of capita (FAO, 2012). Investment in crop diversification will help cushion smallholder farmers from food insecurity due to the likely general increase in yields as reported by several previous studies (Lin, 2011). While there has been extensive research on how different capacities such as farm size, education and access to resources influence the commercial behavior of smallholder farmers, there is less understanding on how to make the small holder farmers resilient after a disturbance.

In Kenya, making nutritious food affordable and available to all is a central goal of any agricultural transformation (GOK,2009). The ASTGS is grounded in the belief that achieving 100% food security – a goal of the Big Four -- requires a vibrant, commercial and modern agricultural sector development (ASDS,2009). In the first five of ASTGS, the flagships will not only lay the ground for the longer 10-year transformation of the sector, but these flagships will contribute significantly to the Big Four agenda by improving the availability of food for all (GOK, 2013). On average, approximately 30% of households in Kenya regularly lack enough money for food, with households in Western Kenya ranging as high as 45% (GOK,2005). In addition to that, among the crop farmers, 58% of small-scale farming land is allocated to the production of maize, followed by 17% beans and only 1% to 5% of any other commodity (CIMMYT, 2016). This limited diversity has significant implications for crop rotation, soil health, disease and insect pressure management, and dietary nutrition. More so, it exposes Kenya to the potentially severe consequences of a major crop disease or crop failure (FAO, 2018). Growing a greater diversity of crops is not only essential to improving national nutrition and working towards 100% food security, but also to increasing profitability for farmers, through production of higher-value crops (FAO, 2018).However, it

is not known to what extent this cropdiversification can make a smallholder farmer resilient unlike this study that is out to find out the relationship between crop diversity and food crop yield among the smallholder farmers.

Properly diagnosing the barriers to building resilience requires an assessment of three elements at the household level, including: outcome indicators, food system performance and risks. (Holling, 1996). Currently, approximately 40% of Kenya's population is poor and, on average, 25% suffer from chronic food insecurity and poor nutrition. Food consumption currently accounts for 45% of Kenyan household expenditure (GOK, 2013). However, the proportion of Kenyans reporting that they sometimes or often go without food dropped from approximately 60% in 2013 to 42% in 2016 (FAO, 2012). Furthermore, when it comes to nutrition, around 90% of households have an acceptable level of dietary diversity and frequency; however, this varies by region, with more than 25% of Turkana and Baringo households having poor or borderline dietary diversity. Secondly, Risk such as climate and environmental risks, political and geopolitical risks, and global and regional price volatility pose challenges to farmers (ASDSP, 2011) and any changes in rainfall could significantly impact Kenya's food resilience as 98% of crops in Kenya are rain-fed with 50% of land experiencing rainfall variation of more than 20% (GOK, 2013). Fall armyworm infestation damage has been increasing, affecting around 2 million acres of maize in 2016, and rising temperatures are expected to reduce maize yields further (FAO, 2018). One of the long-term strategies to ease the strain of food price inflation is diversification of the crop base with a focus on nutritious and versatile staple foods which are not susceptible to the vagaries of international commodity markets.However, the influence of crop diversification on the food affordability among the smallholder farmers is not clear.

In Bungoma County, generally, there has often been a famine season from June to August, when crop yields do not meet demands, and food must largely be bought from markets (Oloo, 2013). However, there is concern in the literature that this hungry season will become longer amidst increasingly poor crop productivity and food prices. Similarly, consumption of purchased food also increases during a dry spell and as the dried season and low crop productivity become increasingly common, reliance upon these purchased foods is expected to increase (GOK,2005). This makes smallholder farmers vulnerable in terms of food affordability thus threatening their resilience.

In terms of food affordability, the primary adaptive strategy to minimize vulnerability of agricultural productivity, and thus improve market access when subsistence crops are not plentiful enough to provide food affordability, is crop diversification (Altieri, 1999). The theory behind this is that profit with specialization in a single crop will be greater, but two or more products may be produced to reduce the risk of very low incomes in some years (Mugendi, 2013). In Kenya, making food affordable and available to all is a central goal of any agricultural transformation. The ASTGS is grounded in the belief that achieving 100% food security – a goal of the Big Four Agenda-- requires a vibrant, commercial and modern agricultural sector development (GOK, 2013). However, while these studiespoint towards the obvious value of adopting crop diversification to improve food affordability, adoption has been slow because little information still exists on effects of crop diversity on food affordability among smallholder farmers in Sub- County.

2.4 Crop diversification and costs of farming.

Crop diversification may improve the economic picture of the farm by reducing production costs and increasing gross income. For example, the inclusion of legumes into rotation

reduces spending on nitrogen fertilizer or adding crops (two or more) into the rotation, resulting in fewer pest problems, reducing expenditures on pesticides(Walia, 2019). In another study, Sare,2017 postulated that even if the profit from a new crop is negligible – or negative – you can still benefit economically from an expanded rotation. This is attributed to the fact that the cultivation of certain crops requires less labour and machinery compared to others. This helps to distribute the workload and resources used throughout the year for which the cost of production of the crops decreases to a certain extent (Makate, et al 2016). On the other hand, a comparative study was done on the relationship between diversified and monocrop farms and this were the findings: That for farm households with few resources, crop diversification is likely to be an important strategy for managing production and price risk. However, for larger, better capitalized farms, diversification may not be welfare enhancing, because returns to specialization may be higher for these households (FAO, 2017). All the above studies recognized crop diversification as one of the most feasible, cost-effective, and rational ways of developing a resilient agricultural cropping system. However, the influence of crop diversification on costs of farming is not evident

2.5 Theoretical framework

This study was based on Resilience theory which was first described by Holling (1973), who studied how populations function within ecological systems, particularly after some sort of ecological stress. Resilience theory emphasizes change, uncertainty, and the capacity of systems to adapt (Folke*et al*., 2002). Frameworks to analyze resilience therefore go beyond frameworks assessing sustainability, as the latter are comprehensive regarding environmental, economic, and social performance (Wabwoba, 2018). In relation to this study, today's smallholder farmers face a broad range of environmental, economic, social and institutional challenges. Therefore, the ability of the smallholder farmer to cope with these challenges can

be conceptualized as resilience. This makes the theory fit for this topic of study because without clearly referencing the theoretical literature on resilience thinking, it would beuncertain to know if this crop diversification couldeffectively make smallholder farmers resilient.

2.6 Conceptual framework

The main variables investigated in the study were cropdiversification, food crop yield, food affordability and costs of farming. The number of crops farmers diversify in,influence their food crop yield, food affordability and costs of farming which determines the resilience of individual smallholder farmers.In this study therefore, crop diversification was the independent variable while crop yield, food affordability and costs of farming were dependent variables as shown in Figure 1 below.

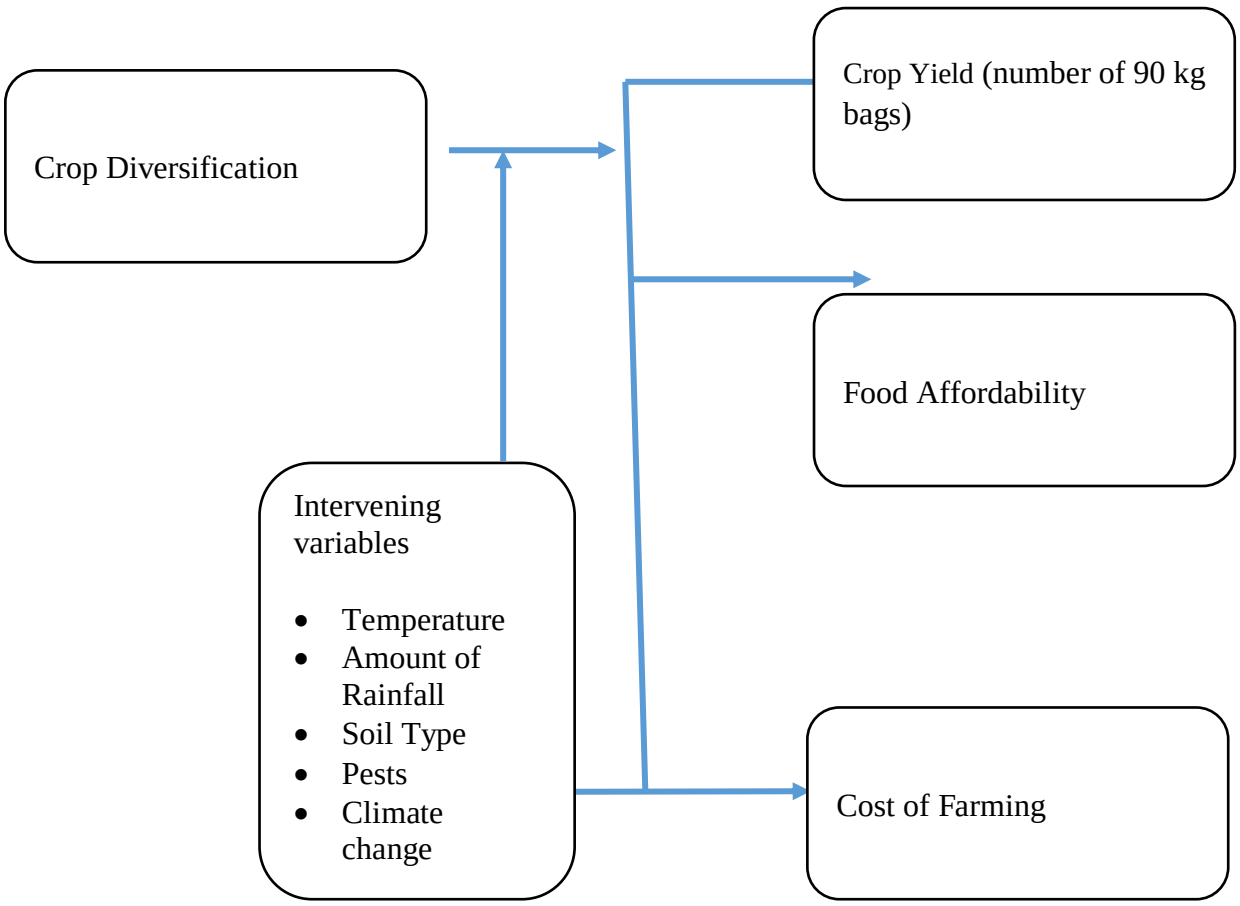


Figure 1: Conceptual Framework

From the figure, at the center of this framework are the number of crops the smallholder farmers diversified in, measured in terms of the number of crop patches per plot and on which individual smallholder farmers' draw to build their resilience. The number of crop patches farmers diversified were influenced by the vulnerabilities of individual smallholder farmers. The number of crop patches adopted by individual smallholder farmers in response to these vulnerabilities produced outcomes that were assessed in terms of the indicators of farmers' resilience such us food cropyield, food affordability and costs of farming. However, there were other factors that influence farmers' resilience that could be controlled by adopting crop diversification. These included, temperature, amount of rainfall, climate change soil types and pests.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter offers details of the methodology that was used to investigate the problem in question. The overview of the study area, researchdesign, sampling procedures, sources of data, data collection methods, data analysis and presentation and ethical considerations.

3.2 Study Area

This study was carried out in Bungoma South Sub-county. This is one of the ten Sub-Counties in BungomaCounty, namely Tongaren, Bungoma South, Webuye East, Webuye West, Kabuchai, Cheptais, Kopsiro, Kimilili, Bumula, Bungoma West, as shown on figure 2. It is situated on longitude 34’30E and lies between latitude 00’ 28 and latitude 10’ 30 north. It borders Bumula Sub- County to the West; Webuye West Sub- County to the East and Kabuchai Sub- County to the North. It covers a total area of 329 sq. km; it is divided into 8 administrative wards and 10 locations. The region is served by the following rivers that have permanent tributaries: Kuywa, Nzoia, Sio and Chwele. (GOK, 2005).

MAP OF BUNGOMA SOUTH SUB- COUNTY

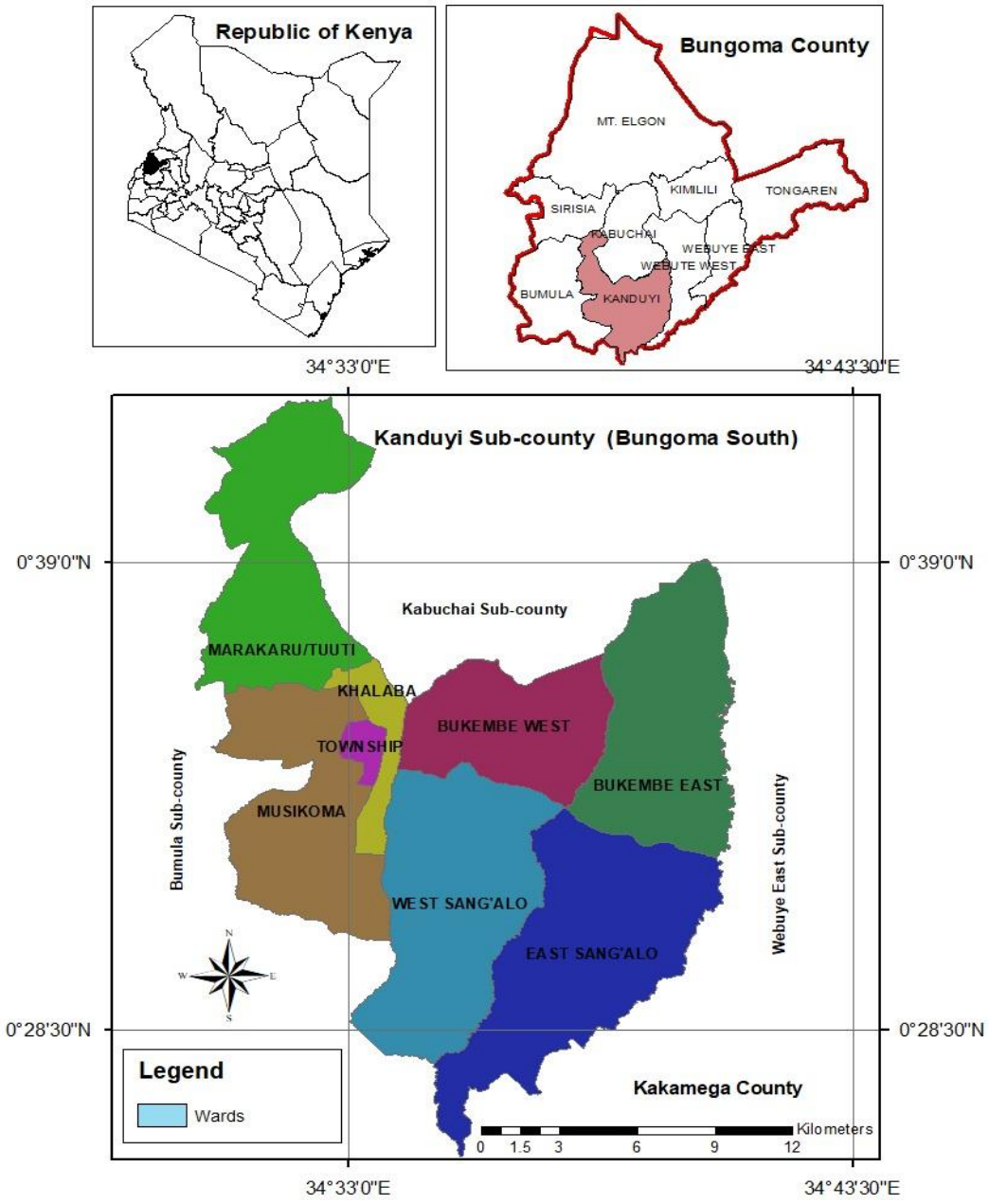


Figure 2: Map of Bungoma South Sub- County

3.2.1 Climate

Bungoma South receives reliable annual rainfall that ranges from 1000mm and 1500 mm and is a bimodal rainfall pattern; the long rains (March–July) and the short rains (August-October). The month of December, January and February are generally characterized by low rainfall. The Sub- County is within the Lake Victoria Basin, with an altitude range of 1200 and 1500 meters above Sea Level (A.S.L) and temperature ranges from 21-25°C during the year (GOK, 2013).The rainfall figures were sufficient for farming and this also justified why agriculture in the County was rain fed and smallholder farmers were bound to suffer during failed orexcess rains threatening farmers' resilience

3.2.2 Population Density

According to the Bungoma County Development Plan 2013-2017, the Sub-County had a population of 298584 (145078 Males and 153506 Females). Based on the area of 392 sq. km, the Sub-County has an average population density of 721 persons per sq. km. The sub - county had a total number of 48361 households with 26617 farm holdings(GOK, 2013). Of the 10 Sub- Counties, Bungoma South- Sub County had the highest population. This indicated that the highest population in the Sub- County posedfood challenges to smallholder farmers. Thisthreatened farmers 'resilience.

3.2.3 Crop Production

The main crops grown in Bungoma South were classified into three categories: namely food, industrial crops and horticultural crops. The main food crops grown were maize, beans, sweet potatoes and Finger Millet. Major industrial crop in the region was Sugar cane. Sugarcane was produced by farmers both under contract with sugar companies which account for 80% and privately. Horticultural crops included vegetables (tomatoes, kales, onions, cabbages and indigenous vegetables) and Fruits (bananas, pineapple, passion fruits and watermelon). All these crops were mainly rain fed and dependent on the bimodal rainfall in the region (GOK, 2013).The fore mentioned crop production showed that the cropland in Bungoma County was diversified. However, the influence of the crop diversification on farmers resilience was not clear hence the essence of the study.

3.3 Research Design

This research adopted a cross-sectional descriptive research design. This was considered appropriate method for this study since data were collected only once after the 2017 crop harvest. This was in line with Mugenda & Mugenda, 2003 who argued that descriptive research involves a one-time interaction with groups of people. Therefore, the researcher interacted with the participants through interviews to collect the necessary information on crop diversification, crop yield and costs of farming to determine the status of resilience of farmers. Households were the sampling units while unit of analysis were the household heads involved in smallholder crop farming in the region.

3.4 Study Population and Sampling

3.4.1 Study Population and Sample Size

The target population of the study consisted of 26,617 small holder farmers in Bungoma South Sub-County. Moreover, 8 local chiefs, 8 agricultural service providers in each location and 1 Sub-County agricultural officer were also considered. The list of small holder farmers was obtained from Bungoma South Sub-County Agricultural office. From this target population a total of 3,895 small holder farmers were accessible for the study (see Table5.4 Appendix 1).

3.4.2 Sample Size Calculation

Generally, a sample size depends on several factors: number of variables in the study, type of research design, methods of data analysis and the size of accessible population. However, according to Mugenda& and Mugenda,2003, atleast 10-30% of the accessible population is viable and representative enough to yield acceptable and reliable results for a generalization. This study therefore used 10 % of 3,895 that gave a sample of 390 small holder farmers.

However, from the lower number of responses from the respondents and to maintain a 95% confident level, a total of 384 households who were smallholder farmers were interviewed. The study targeted respondents who were household heads that is both adult men and women in the study area. They provided information on crop diversification, crop yield, food affordability in the region and costs incurred during farming.

3.4.3 Sampling Procedure

Proportionate random sampling technique was employed to select proportionate number of small holder farmers from the 10 locations in the Sub-County (Table 5.4, appendix1 and Figure 3). This technique was considered appropriate because it ensured that all smallholder farmers had an equal chance of being included in the study sample because the number of

smallholder farmers in each location also differed. However key informants were selected purposively from the region.

Purposive sampling was also used to select the 17 key informants who included 8 local chiefs, 8 agricultural service providers and 1 Sub-County agricultural officer. Mugenda& Mugenda (2003), asserted that purposive sampling technique helps the researcher to interview a group of people believed to be experts in their field. Key informants therefore provided information on food crop yield, food affordability and costs of farming incurred by smallholder farmers.

3.5 Data Collection Methods

3.5.1 Tools of Data Collection

Questionnaires, interviews, observation schedules were used to collect primary data on social demographic characteristics of the respondents, crop diversity indices, crop yield, food affordability and costs of farming incurred by smallholder farmers in Bungoma South Sub-County.

3.5.1.1 Questionnaire

Structured questionnaires with both open and closed ended questions was administered to 384 household heads who adult male and female small holder farmers in the region were. The questionnaires were self-administered by the researcher with the help of the enumerators to give respondents clarification on questions that they could not properly understand. Use of questionnaires was advantageous because it was administered to respondents in their own private settings. Information collected through questionnaires included; demographic features of the respondents such as gender, occupation, source of livelihood, land ownership

and cropping patterns, crop diversification elements such as, number of crops grown per season ns ,crop yield, food affordability parameters such as prices of food items on the market and costs of farming.

3.5.1.2 Interview Schedule

In order to collect the necessary qualitative data about the influence of crop diversification on the resilience of agricultural land production, an interview guide was used to interview the local chiefs and agricultural service providers. They were interviewed owing to their experience in their various work stations which made them knowledgeable on the type of crops smallholder farmers diversify in, shocks that affect the smallholder farmers, information on crop yield, some of the costs incurred by farmers and general resilience of farmers in the region. This method helped give in-depth information that established the reliability of the responses provided from the other tools.

3.5.1.3 Observation Schedule

The researcher also used an observation checklist to establish the diversification methods used by farmers in the area at the farm level. This involved direct visits to the farms in person and recording the average number of crops farmers diversify in per farm holding, food crops that farmers grow and average size of the farms under crops. The information gathered through observation was helped complement responses provided from the other tools.

3.5.2 Sources of Data

3.5.2.1 Primary Sources

Primary data on social demographic characteristics of the respondents, crop diversity indices, crop yield, food affordability and costs of farming incurred by smallholder farmers in Bungoma South Sub-County was collected from the field by surveying household heads who practiced smallholder farming and key informants. Key informants' interviews were

administered to elicit data which served to confirm some information collected from household interviews.

3.5.2.2 Secondary Sources

Relevant literature on the idea of resilience and crop diversification and the relationship between the two was sought from both published and unpublished sources. These were obtained from relevant journals, textbooks, magazines, newspapers and government reports (published and unpublished reports) accessed from libraries at MasenoUniversity, Bungoma Sub-County Agricultural Office, and Bungoma Weather Meteorological Department.

3.6 Validity and Reliability of Research Instruments

To check the validity and reliability of the questionnaires in gathering the data required for the purposes of the study, pilot testing and expert opinion were used. Mugenda& Mugenda (2003) argue that the pretest sample should be between 1% and 10% depending on the size of the sample, the larger the sample, the smaller the percentage. In this study, the questionnaire was therefore, pilot tested on 10% of the sample to ensure that the instrument was relevant and reliable. The questionnaire was tested on forty (40) small holder farmers in the region, who were not involved in the main study. The responses from the 40 respondents were used to determine the existence of ambiguities in the items and to establish whether they could elicit the type of responses sought. The items that were not clearly understood and that evoked unanticipated responses were subsequently modified to improve their clarity.

To ensure content validity, the questionnaire was subjected to thorough examination by two independent resource persons (supervisors), from the School of Arts and Social Sciences of Maseno University. They evaluated the statements in the questionnaire and confirmed them relevant, meaningful and clear. However, for the purpose of construct validity, the

questionnaire was divided into several sections to ensure that each section assesses information for a specific objective and ensure that the same is closely tied to conceptual framework of the study.

3.7 Data Analysis and Results Presentation

Both qualitative and quantitative data analysis were used to get results of this study. Qualitative data collected from open ended questionnaires was analyzed and organized according to themes, sub- themes, categories and sub- categories that emerged. Notes from the field that comprised of direct observed variables and responses not captured by questionnaires were grouped into themes and discussed. Regression analysis of related variables in the objectives 1, 2, 3 was run by use of statistical package for social science (SPSS) version 23. To test for the research hypothesis, the study used simple linear regression at α=0.05. The simple linear regression model adopted was:

$$Y = \beta_1 + \beta_i x_i$$

Where;

Y= CDI Index

β_1= Constant

β_i = Regression coefficient for the x_i

x_i = Crop yield or FAI or Costs of farming.

To determine the Food Affordability Index (FAI), the study adopted the formula by (Lele et al, 2016)

$$FAI = \frac{Price\ of\ the\ foods\ (crop\ yield)}{Wages}$$

If the wages remained constant, an increase in the price of the food indicated that it became difficult to afford food and if the price went down then it was cheaper to afford food. Therefore, a higher FAI meant that the food items were relatively expensive while low FAI implied that the food items on the market werecheaper.From the FAI scale by (Lele*et al*. 2016), FAIof more than 0.75 indicated that the foods were relatively expensive and difficult to afford.

With reference to the data collected, FAI for Bungoma South Sub- County region was calculated and it was found to be 0.3743 (Mean FAI = 0.3743, Std. Dev.= 0.01159) as shown in Table 5.0 in appendix 1. From the FAI scale by (Lele*et al*. 2016), ourFAI of 0.3743 was found to be less than 0.75, which was ratedlow,indicatingfood was accessible/affordable in the region.

Similarly, Crop Diversification Index (CDI), was calculated using Dipak *et al*(2016) that is:

$$CDI = \frac{Percent\ of\ the\ total\ harvested\ area\ under\ k\ crops}{Number\ of\ k\ crops}$$

Where k crops were those crops that individually occupied 10 per cent or more than 10 per cent of the total cropped area in the study region. This formula was inversely related with the magnitude of diversification. Here, the higher was the value of the index, the lower would be the degree of diversification and vice versa. CDI scale by Dipak *et al* (2016) indicated that CDI value of less than 0.20 meant very high diversification practice, at least 0.20 to less than 0.4 indicated high diversification practice, and 0.40 to 0.5 indicated low diversification practice and more than 0.5 indicated very low diversification practice.

Basing on the data collected, the CDI for Bungoma South Sub- County was calculated and it was found to be 0.2277 (Mean CDI = 0.2277, Std. Dev. = 0.1231) as shown in appendix 1(Table 4.9) This value of 0.2277 fell within the [0.2, 0.3] interval, hence indicated high practice of crop diversification as per Dipak et al (2016), who states that CDI value between 0.2 and 0.3 meant that crop diversification washigh. Therefore, we concluded that there was high practice of crop diversification by small holder farmers in Bungoma South Sub-County.

Crop yield was measured in terms of the number 90kg bags for all the crops under study. Total Crop yield was calculated using the following formulae:

$$Total\ Yield = Maize\ TY + Beans\ TY + Millet\ TY + Potatoe\ TY$$

Where:

Maize TY= Maize Total Yield

Beans TY= Beans Total Yield

Finger Millet TY= Millet Total Yield

Sweet Potatoes TY= Potatoes Total Yield

Costs of farming was calculated using the following formula:

$$Total\ Cost\ Incurred = Maize\ TT + Beans\ TT + Millet\ TT + Potatoe\ TT$$

Where:

Maize TT= Maize Total Cost Incurred

Beans TT= Beans Total Cost Incurred

Finger Millet TT= Millet Total Cost Incurred

Sweet Potatoes TT= Potatoes Total Cost Incurred

Total Revenues from crop production for farmers in Bungoma County was calculated using the following formula:

$$Total\ Revenues = Maize\ TT\ Rev + Beans\ TT\ Rev + Millet\ TT\ Rev + Potatoe\ TT\ Rev$$

Where:

Maize TT Rev= Maize Total Revenue

Beans TT Rev=Beans Total Revenue

Finger Millet TT Rev= Finger Millet Total Revenue

Sweet Potatoes TT Rev=Sweet Potatoes Total Revenue

3.8 Research Ethics

The study was carried out at the farm level hence there was need for the researcher to observe ethical issues as far as data collection was concerned. The researcher had to seek permission from the local administration and the Sub-County Agricultural Officer to carry out research in their area of jurisdiction. In addition to that, the researcher also had to seek the consent of farmer respondents. The respondents were informed about the purpose of the study and the benefits of this research to the community. In part, the researcher informed the respondents about the procedures of the study which they had to participate in and the expected duration of participation. The researcher also assured the respondents of privacy and confidentiality for any information collected from them. Numbers were used for identification to maintain anonymity of the respondents.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents an analysis of the results and also discusses the study findings according to the objectives of the study as per the following sub- headings; socio-economic and demographic characteristics of the respondents, crop diversification and food crop yield, crop diversification and food affordability and crop diversification and costs of farming.

4.2 Return Rate

A total of 390 questionnaires were given to the 390 smallholder farmers for purposes of data collection. However, only 384 questionnaires were received back. This meant that there was a return rate of 96.45%.

4.3 Socio-economic and Demographic Characteristics of Respondents

4.3.1 Gender

A total of 394 households were interviewed. Table 4.1 shows the valid responses across gender that were used to identify the frequencies and percentages for the respondents who were involved in the study.

Table 4.1: Valid response across gender

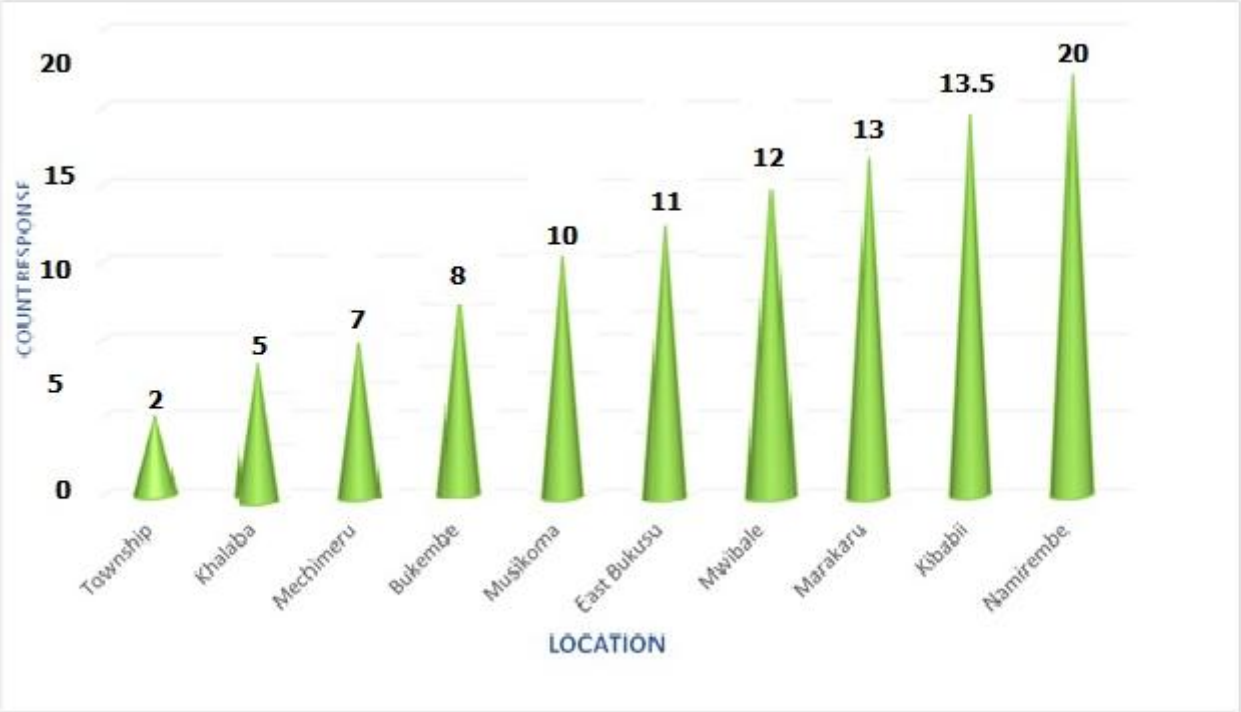
Sex	Count	Column N %

Male	208	54.0%
Female	176	46.0%
Total	384	100%

From Table 4.1, majority of the respondents involved in small holder farming were male (54%) compared to female (46%). This meant that the unit of analysis used in the study were household heads who comprised of either male or female respectively.

4.3.2. Location (Region) of the Respondents

The study covered ten locations within the Bungoma South Sub-County. Participants were



asked to indicate their location and the response wereas in the Figure 3

Figure 3. Distribution of response across location

The findings (Figure 3) showed that majority of the respondents (20%) were from Namirembe Sub-location while Township location had the least number of respondents (2%) who participated in the study. This was attributed to the fact that the number of smallholder farmers differed from one location to another (Table 5.4, appendix1.)

4.3.3. Occupations of Respondents

Though all the participants in the study were small holder farmers, respondents were asked to state their main occupation in their lives and their responses were as shown in Table 4.2

Table 4.2: Response across Main Occupations

Main occupation	Count	Column N %
Farming	347	91.3%
Others	14	2.9%
No response	23	5.8%
Total	384	100.0%

From Table 4.2; it is evident that majority of the respondents (91.3%) practiced farming as their main occupation in life while only 2.9% had other main occupations apart from farming which concurs with the responses given by key informants who said that majority of people in the Sub- County are farmers. Oloo, (2013) confirmed the findings of this study that most people in Bungoma County are smallholder farmers and agriculture accounts for 35 percent of the regions Gross National Product. This justified the viability of looking at the resilience of smallholder farmers because it touches on their livelihoods.

4.3.4. Land Ownership

Land ownership and the size of the land did matter a great deal in the proceeds from farm produce. Respondents were asked to state whether the land they put under farming is their own or they were leased. Their responses were as shown in Figure 4.

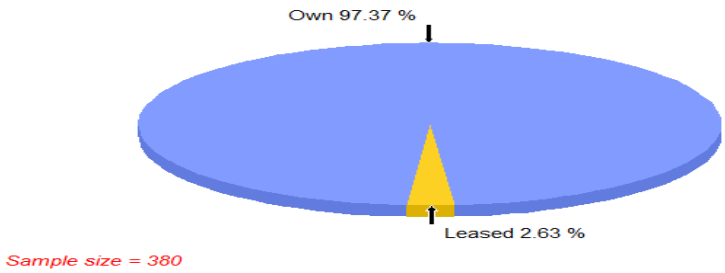


Figure 4: Land ownership

The findings from Figure 4 shows that majority of the farmers in the region own the land they had under farming as indicated by 97.37% of the respondents who suggested that they owned the land on which they did farming. This was a justification that most respondents were smallholder farmers from which they draw their source of livelihoods in order to make them resilient.

4.3.5 Crop Diversification

Farmers were asked to state the number of and list the crops they plant on their farms every season and the response was as shown in Figure 5.

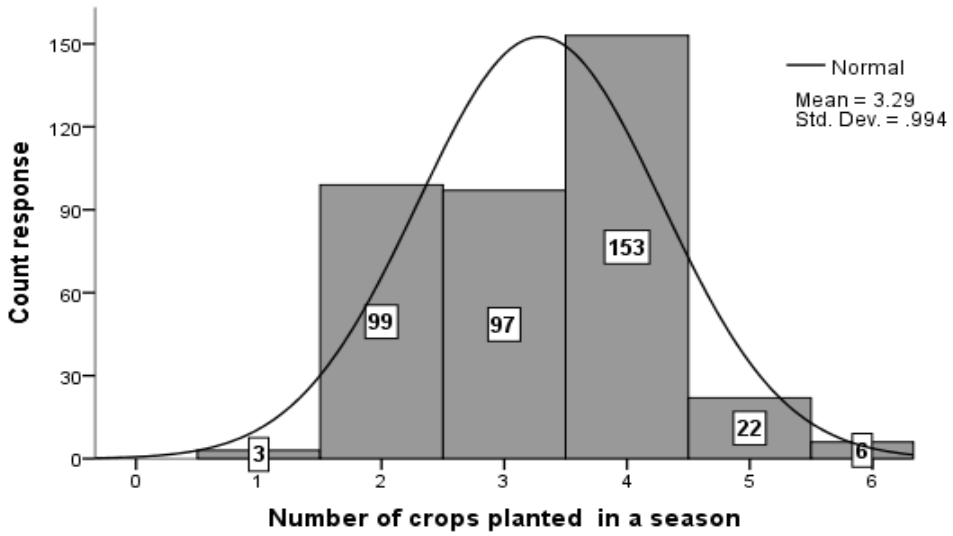


Figure 5. Number of crops planted by farmers per season

From the findings, it was evident that 99.2% (377) of the respondents reported that a farmer in the region (Bungoma South Sub-County) planted approximately four (4) crops every season as shown in Figure 5. Similarly, interview session with Agricultural service providers and local chiefs also revealed that farmers in the region planted more than one crop. This concurred with Wachira, (2013) who postulated that Bungoma South Sub County's cropland was diversified into four major food crops namely maize, beans, sweet potatoes and finger millet. Therefore, this was an indication that majority of the respondents practice crop diversification on their farms that enabled them to bounce back after a disturbance hence resilient.

4.3.6. Food Crop Yield

The respondents were asked to state the yield in bags for all the diversified crops produced in the last season in one acre and the responses were as shown in Table 4.3.

Table 4.3: Average yield in bags

Crop	Valid N	Mean	Std. Deviation	Skewness

		Statistic				
	Statistic	(bags)	Std. Error	Statistic	Statistic	Std. Error
Finger millet	55	3.0	.39000	3.55304	2.886	.264
Beans	354	3.99	.183	3.4444	3.039	.130
Maize	369	13.75	.430	8.268	0.688	.127
Sweet Potatoes	167	18.16	.682	8.815	-.570	.188

Note that one bag is equivalent to 90 kilograms.

The study revealed that (Table 4.3) the yield for beans and finger millet among the smallholder farmers were homogeneous (indicated by a lower standard deviation), while the yield for maize and sweet potatoes were not homogeneous (indicated by a higher standard deviation).Similarly, beans, finger millet and maize were positively skewed meaning that they were mostly grown by most smallholder farmers in the Sub- County. However, sweet potatoes were negativelyskewed probably because most farmers did not plant the crop every other season even though it had the highest mean, an indication that the crop was equally marketable. In addition to that, from Table 4.3, the study revealed that a Finger millet farmer in Bungoma South Sub-County produced approximately three 3bags every season, beans farmers produced approximately four 4bags, maize farmers produced approximately fourteen 14 bags and sweet potatoes farmers produced approximately eighteen 18 bags every season (Table 4.3). These findings suggested that in each season, a farmer who planted more than one crop was able to spread the economic risks and could not miss out on yields completely per given season. This made the small holder farmers resilient because they were able to withstand environmental and market shocks as a result of spreading the risks. To some extent,

these results are consistent with Oloo (2013), who postulated that while monoculture farming in the Sub- County has advantages in terms of efficiency and have ease of management, however, the loss of the crop in any one given year could put a farm out of business and/or seriously disrupt the stability of a community dependent on that crop.

4.3.7: Food Affordability

The respondents were asked whether they do experience a hunger season and the responses are presented in Table 4.4.

4.4: Experience of afamine season

Do you experience a hunger season?		Yes	No	Total	**Chi-square test for homogeneity**		
					Statistic	Df	p-value
Response	Count	157	221	378	10.836	1	0.001<0.05
	% Count	42%	58%	100%			

The study findings (Table 4.4) Shows that 42% of the respondents were experienced famine seasons while 58% claimed they were not; the chi-square results ($x_1^2 = 10.836$, $\rho = 0.001 < 0.05$) indicate that the proportion of the farmers experiencing famine was significantly different from those not experiencing famine, an implication that some of the farmers in Bungoma South Sub-county were experiencing a famine season. The key informants agreed to the fact that people in the region experienced a famine season especially from February to June and that during this period there was usually a shortage in supply of the food items on the market. This was an indication that smallholder farmers were vulnerable to increased

price levels on the market as a result of the shortage of food items on the market. This compromised the resilience of the smallholder farmers.

4.3.8 Prices of Food items on the Market

Information on the average price of various food items was also sought from the small holder farmers and the findings were presented in Table 4.5 below.

Table 4.5 Average price per kilogram of food items in Bungoma South Sub-County

Crop	N	Mean (Ksh)			Skewness	
		Statistic	Std. Error	Std. Deviation	Statistic	Std. Error
Beans	379	80.37	0.18585	3.61811	1.530	0.125
Finger millet	329	89.53	0.67524	12.24769	-4.068	0.134
sweet potatoes	334	19.89	1.03069	18.83649	1.737	0.133
Maize	380	41.08	.15936	3.1066	3.467	0.125

The study revealed (Table 4.5) that the prices of beans and maize on the market were homogeneous (indicated by a lower standard deviation), while the prices of finger millet and sweet potatoes were not homogeneous (indicated by a higher standard deviation).Similarly, beans, sweet potatoes and maize were positively skewed meaning that they were still marketable in the market. However, finger millet was negatively skewed probably because it took longer for it to be sold on the market even though it has the highest mean. In addition to that, (Table4.5) also shows that one (1) kilogram of beans costs approximately Ksh. 80.00

(mean = 80.37≈ 80.00), one (1) kilogram of finger millet costs approximately Ksh. 90.00 (mean= 89.53≈ 90.00), one (1) kilogram (bunch) of sweet potatoes costs approximately Ksh. 20.00 (mean = 19.89 ≈ 20.00) and one (1) kilogram of maize costs approximately Ksh. 41.00 (mean = 41.08 ≈ 41.00). This price levels indicated that food items in the market were expensive. The high price levels made some food items unaffordable which posed a threat on farmers' resilience. However, the prices of minor crops such as finger millet and sweet potatoes helped stabilize the prices of maize and beans making them relatively affordable (Table 4.5). On the other hand, the high price levels helped smallholder farmers who diversified in the very crops realize an improvement in their levels of income hence improved farmers' resilience.

4.3.9 Farming Costs

The study reveals that farmers in Bungoma South Sub-County either use family labor or hired labor as shown in figure 6 below.

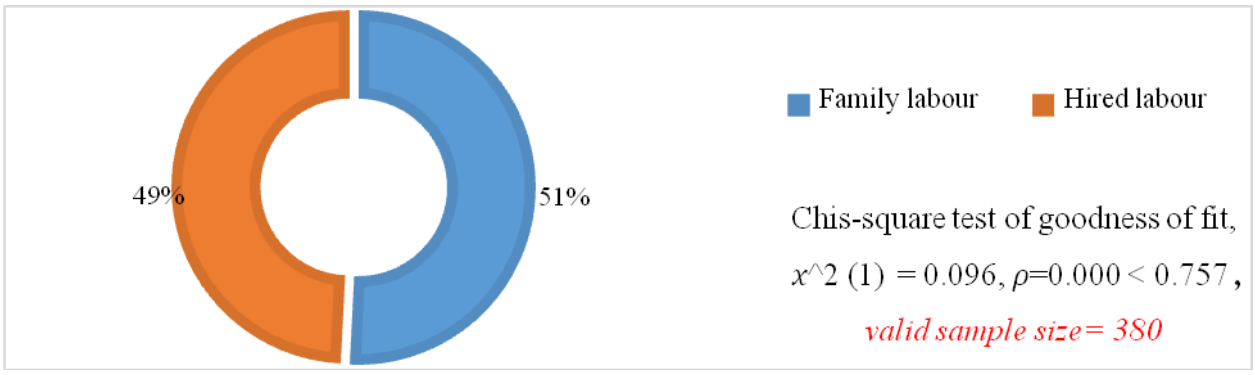


Figure 6: Type of labor used by famers in the region

The findings of figure 6 shows that 51% of the respondents were using family labour while 49% were using Hired labour on crop farming. A Chi-square test, x_1^2 =51.608[a], ρ =0.000 <

0.05, indicates that there was no significant difference between farmers using hired labour and those using family labour in the region as shown in figure 6.

4.4 The Influence of CDIon Food Crop Yield.

To begin with, the CDI for Bungoma South Sub- County was calculated and it was found to be 0.2277 (Mean CDI = 0.2277, Std. Dev. = 0.1231) as shown in appendix 1(Table 4.9) This value of 0.2277 falls within the [0.2, 0.3] interval, indicating high practice of crop diversification as per Dipak*et al* (2016), who states that CDI value between 0.2 and 0.3 indicates that crop diversification is high. However, to show the influence of crop diversification on the food crop yield in Bungoma South Sub-County, simple linear regression model was used to get the best line of fit (figure 7).

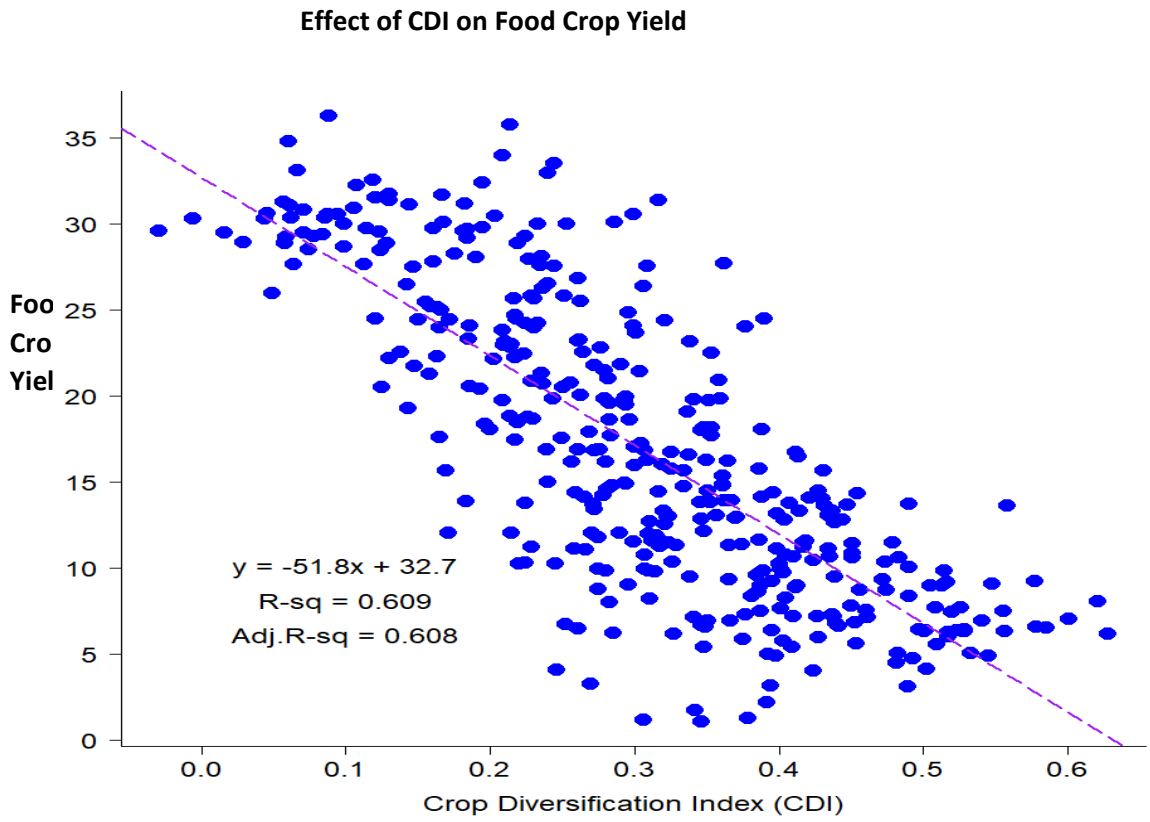


Figure7, Scatterplot between Crop Diversification Index (CDI) on food crop Yield.

Agricultural Yield (90 kg bags) = 34.787 - 35.309 CDI, r^2=0.609.

Figure 7 shows that 61% (r^2=0.609) variation of food crop yield was explained by crop diversification index. This implied that only 39 % variation of food crop yield was attributed to other factors not considered in this study. The scatter plot showed an inverse relationship between the CDI and food crop yield. This indicated that, a unit change in the CDI resulted to a decrease in the food crop yield in Bungoma South Sub-County. Since the CDI was in the inverse of the situation of crop diversification, such that lower CDI indicated increased crop diversification (Dipak *et al.*, 2016), thus increased cropdiversification led toincreased crop yield in Bungoma South Sub-County and vice versa. Hence, we reject the null hypothesis and conclude that Crop Diversity Index (CDI)has a significant influence on agricultural yield in Bungoma South Sub-County.

Similarly, from the ANOVA results shown in table 4.6, it is evident that the regression model well fitted the data set [F (1, 379) = 21.240, P = 0.000< 0.05].

Table 4.6: Simple Linear Regression of Crop Diversity Index on the Food Crop Yield

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.243[a]	.609	.608	17.17532

a. Predictors: (Constant), Crop Diversity Index

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16873	1	16873	21.240	.000
	Residual	10816	379	29		
	Total	27689	380			

a. Dependent Variable: Food Crop Yield

b. Predictors: (Constant), Crop Diversity Index

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		β	Std. Error	Beta	*T*	Sig.
1	(Constant)	34.787	1.963		17.724	.000
	Crop Diversity Index (CDI)	-35.309	7.661	-.243	-4.609	.000

a. Dependent Variable: Food Crop Yield

From Table 4.6, CDIhad a statistically significant contribution in the prediction of the agricultural yield in Bungoma South Sub-County, (β = -35.309, t = -4.609, $p=0.000<0.05$). CDI had a negative standardized beta coefficient = -0.243 in the coefficients results of table 4.6; an indication that a unit change in the CDI results to a decrease in the food crop yield in Bungoma South Sub-County by 24.3%. Since the CDI is the inverse of the situation of crop diversification, such that lower CDI indicates increased crop diversification (Dipak *et al.*, 2016), thus that an increase in crop diversification indicated by a negative standardized beta coefficient = -0.243 in the coefficients results of table 4.6 lead to increased crop yield in Bungoma South Sub-County and vice versa. Therefore, our regression results implied that increase in the magnitude of crop diversification (decrease in CDI) by one unit resulted to an increase in the crop yield by 24.3%. The linear regression model that predicted agricultural yield in Bungoma South Sub-County given Crop Diversity Index (CDI) was as follows:

Agricultural Yield (bags) = 34.787 - 35.309 CDI

With reference to the above findings, studies across continents showed mixed reactions on the relationships between crop diversity and output. Brenda (2011) postulated that not all studies carried out showed that greater diversity lead to increased production yield. In one study, bio diverse rotational systems of three or six species produced 25% lower yield versus integratedmonocrop grain systems, but the grain was of higher quality (Snapp et al. 2010).However, in another study of examining the effect of species diversity on crop and weed biomass in perennial herbaceous polycultures, biomass increased log linearly with species richness and polycultures out yielded monocultures by an average of 73% (Picasso*et al.* 2008). Similarly, a growth in production was also seen in field experiments manipulating diversity in crop rotations (crops, cover crops and chemical inputs), showing significantly greater corn grain yields with increased diversification over time (Smith*et al.* 2008). Such results demonstrated that diverse polycultures could have higher and more stable yields that

led toincreased economic benefits for farmers aswell.Therefore, this mixed reactions on the relationships between crop diversity and output, was cleared by the findings of this study that showed that crop diversification increased food crop yield.

In the Kenyan context, majority of the Kenya's food insecure population lives in rural areas in the country and many are subsistence producers who may not grow enough to meet their families' needs (Tutwiler 2016). In addition to that, discussions of food security usually revolve around maize, since the country's food security is overwhelmingly dependent on it, despite a continued structural deficit in maize production that has resulted in an increase in food prices (FAO, 2013).This puts farmers' resilience at risk. While monoculture farming in Bungoma South Sub- County has advantages in terms of efficiency and ease of management, the loss of the crop in any one year puts a farm out of business and/or seriously disrupt the stability of a community dependent on that crop (Oloo, 2013).Therefore, the findings of this study are in line with Oloo (2013) because they showed that planting a variety of crops helped smallholder farmers realize an increase in food crop yields because farmers did not miss out on harvest from any of the crops they diversified in as result of external vagaries. This improved their resilience.

4.5 The influence of CDI on Food Affordability

To begin with, FAI for Bungoma South Sub- County region was calculated and it was found to be 0.3743 (Mean FAI = 0.3743, Std. Dev. = 0.01159) as shown in table 4.9 in appendix 1. From the FAI scale by (Lele*et al*. 2016), ourFAI of 0.3743 was found to be less than 0.75, which was ratedlow,indicatingfood was accessible/affordable in the region.

To determine the relationship between crop diversification and the food affordability in Bungoma South Sub-County, simple linear regression was used to get the best line of fit (Figure 8).

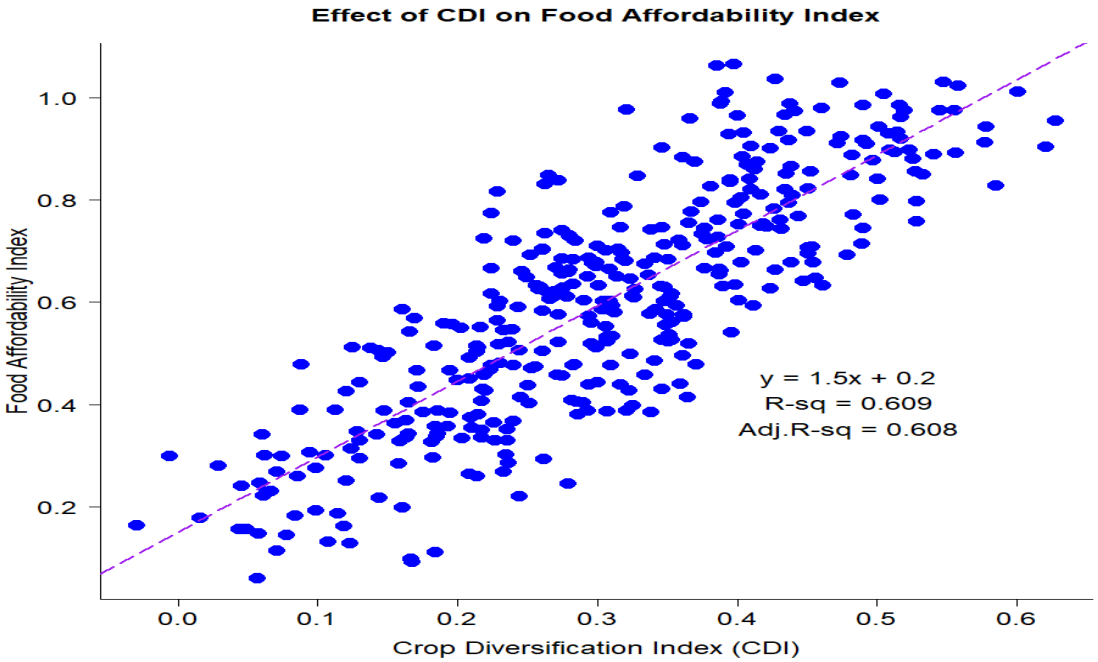


Figure 8: Scatterplot between Crop Diversification Index (CDI) and the Food Affordability Index (FAI).FAI = 0.297 + 0.609CDI, r^2=0.609.

Figure 8 showed that60.9% (r^2=0.609) variation of food affordability index was explained by crop diversification index. This meant thatonly 38.1% variation of food affordability index could be explained by factors not considered in this study. Therefore, based on these findings the null hypothesis was rejected and we concluded that Crop Diversification had a significant influence on food affordability in Bungoma South Sub-County. The scatter plot showed a linear relationship between CDI and FAI.This meant that Unit increase in the CDI led to an increase in FAI. However, Since the CDI was in the inverse of the situation of crop diversification, such that lower CDI indicated increased crop diversification (Dipak *et al.*,

2016), hence a unit increase in crop diversification (decrease in CDI) led to increased chances of easy food affordability by smallholder farmers in Bungoma South Sub-County.

Similarly, From the ANOVA results as shown in table 4.7, it was evident that the regression model well fitted the dataset [F (1, 378) = 11.506, P = 0.001< 0.05]

Table 4.7: Simple Linear Regression of CDI on the Food Affordability Index (FAI)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.180[a]	.609	.608	.22293
a. Predictors: (Constant), Crop Diversity Index				
ANOVA[a]				
Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	15.335	1	15.34	11.506	.001[b]
Residual	7.468	378	.020		
Total	22.803	379			
a. Dependent Variable: Food Affordability Index (FAI)					
b. Predictors: (Constant), Crop Diversity Index					
Coefficients[a]					

Model		Unstandardized Coefficients		Standardized Coefficients		
		β	Std. Error	Beta	*T*	Sig.
1	(Constant)	.297	.025		11.752	.000
	Crop Diversification Index (CDI)	.332	.098	.180	3.392	.001
a. Dependent Variable: Food Affordability Index (FAI)						

From Table 4.7, (CDI)had a statistically significantly contribution in the prediction of the food affordability in Bungoma South Sub-County, (β =0.332, t = 3.392, $p=0.001 < 0.05$).CDI had a positive standardized beta coefficient = 0.180 in the coefficients results of Table 4.8, which indicated that a Unit increase in the CDI led to an increase in the FAI by 18.0%. Since the CDI was in the inverse of the situation of crop diversification, such that lower CDI indicated increased crop diversification (Dipak *et al.*, 2016), hence a unit increase in crop diversification (decrease in CDI) increased smallholder farmers' ability to purchase the food items on the market by 18% in Bungoma South Sub-County.Therefore, the linear regression model that predicted Food Affordability Index (FAI) in Bungoma South Sub-County given Crop Diversity Index (CDI) was as follows:

Food Affordability Index (FAI) = 0.297 + 0.609 CDI

These findingsagreed with otherresearch done across the world. Holling, (1996) who asserted that, proper diagnose of the barriers to building resilience requires an assessment of food affordability, at the household level. In Kenya and even Bungoma South, making nutritious

food affordable and available to all is a central goal of any agricultural transformation (GOK, 2009). However, on average, approximately 30% of households in Kenya regularly lack enough money for food, with households in Western Kenya ranging as high as 45% (GOK, 2013). Investment in crop diversification helped cushion smallholders from increased prices of the major food items in the market from the above findings. This was attributed to the fact that, minor food crops like finger millet and sweet potatoes helped stabilize the prices of major food items on the market such as maize and beans (Table4.5). This helped improve farmer's resilience.

4.6. Influence of CDI on Costs of Farming

Costs of farming were incurred in terms of labor costs (hired labor) and other input variable costs (cost of buying seeds and fertilizers). Input variables included the inputs bought from farm input retail shops. In this study seeds and fertilizers were included as the basic input variables used by smallholder farmers in the region. This was summarized in table 5.1 (Appendix 1). From the Table, a farmer who practice crop diversification (planted maize, beans sweet potatoes and finger millet) in the region incurred a total variable cost of approximately Ksh18, 562.50 on approximately 1.5-acre piece of land. However, it should be noted that a farmer who practiced potato farming in the region didn't incur any variable cost since farmers neither bought the planting stems nor applied fertilizers. Labor costs were incurred during land preparation, weeding and harvesting of the crops. In addition to that, for those small holder farmers who use family labor, there wereno additionalcosts incurred apart from costs of buying seeds and fertilizers. However, for the farmers who use hired labour, they incurred both labour costs and costs of buying seeds and fertilizers. This was summarized in table 5.2 (Appendix 1)However, to get the gross margin that a small holder

farmer earned out of the crop farming, the costs were subtracted from the revenue as indicated in table 5.3 (Appendix 1)

Keeping other factors constant, the study revealed that majority of the smallholder farmers used a total cost of Ksh.41, 400.00 (mean = 41,438.71 ≈ 41, 400.00) in growing crops in a season and gained a profit of approximately Ksh.51900.00 (mean = 51851.42 ≈ 51900.00) out of the yields as detailed in table 5.3 (appendix 1). Note that every farmer incurred input variable costs but only those who use hired labor did incur labor costs.

To determine the relationship between crop diversification and the costs of farming in Bungoma South Sub-County, a simple linear regression model was used to get the line of best fit showing the relationship between Crop Diversification and the cost of farming (Figure 9).

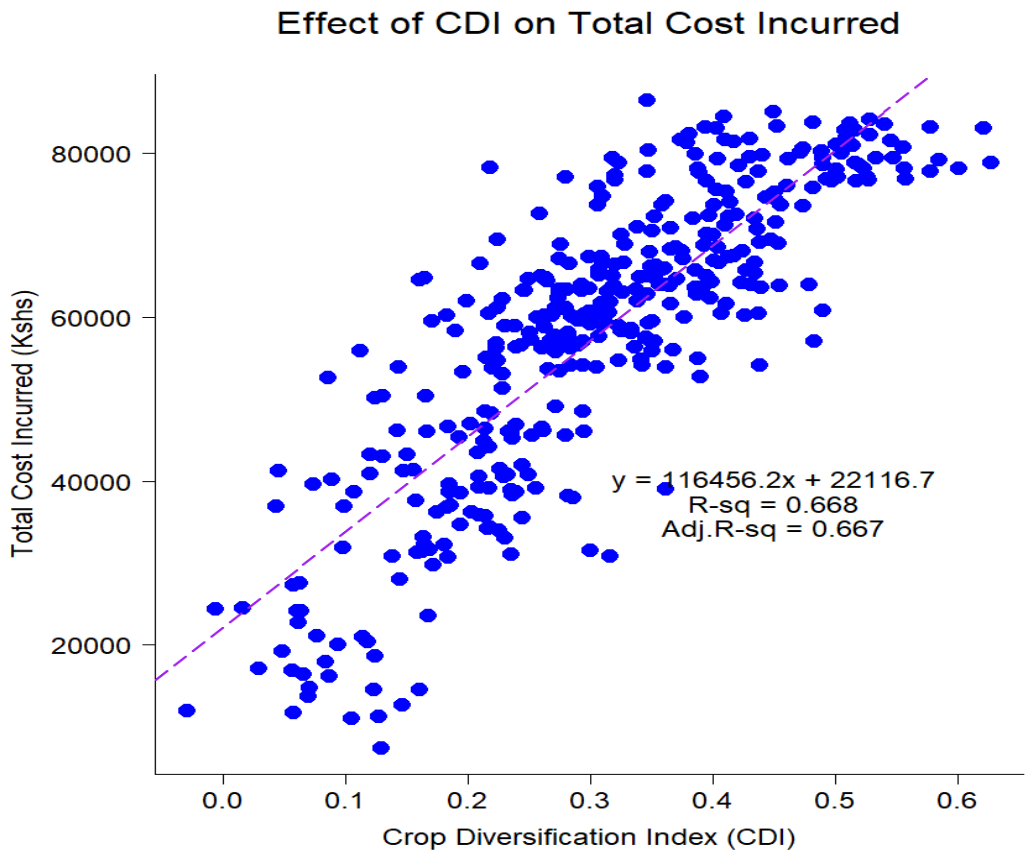


Figure 9: Scatterplot between Crop Diversification and the cost of farming,

Cost of Farming = 23275.312 + 36705.875CDI, r^2=0.668.

Figure 9 shows that 66.8% (r^2=0.668) variation of cost of farming was explained by crop diversification index. This showedthat only 32.2% variation of cost of farming could be explained by factors not considered in this study. Therefore, based on these findings, we rejected the null hypothesis and concluded that CDIhad a significant influence on cost of farming in Bungoma South Sub-County. The scatter plot showed a linear relationship between CDI and Cost of farming. This meant that Unit increase in the CDI led to an increase in the Cost of farming. However, Since the CDI was in the inverse of the situation of crop diversification, such that lower CDI indicated increased crop diversification (Dipak *et al.*, 2016), hence a unit increase in crop diversification (decrease in CDI) led to increased Costs of farming incurred by smallholder farmers in Bungoma South Sub-County.

From the ANOVA results shown in table 4.8, the regression model well fitted the dataset [F (1,342) = 759.8, P = 0.000< 0.05].

Table 4.8: Simple Linear Regression of CDI on the cost of farming

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.229[a]	.688	.667	19197.69924

a. Predictors: (Constant), Crop Diversification Index

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8.150e+10	1	8.150e+10	759.8	.000[b]
	Residual	4.055e+10	378	1.073e+08		
	Total	12.205e+10	379			

a. Dependent Variable: Cost of farming

b. Predictors: (Constant), Crop Diversification Index

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		β	Std. Error	Beta	T	Sig.
1	(Constant)	23275.312	2179.056		10.681	.000
	Crop Diversification Index (CDI)	36705.875	8420.344	.229	4.359	.000

a. Dependent Variable: Cost of farming

The results of coefficients in Table 4.8 showed that CDIhad a statistically significantly influence in the cost of farming in Bungoma South Sub-County, (β = 36705.875, *t* = 4.359, *p=0.000<0.05*). CDI had a positive standardized beta coefficient = 0.229 in the coefficients results of table 4.8. This indicated that a Unit change in the CDI increasedthe cost of farming incurred by smallholder farmers in Bungoma South Sub-County by 22.9%. Since the CDI was the inverse of the situation of crop diversification, such that lower CDI indicated

increased crop diversification (Dipak *et al.*, 2016), thus a decrease in crop diversification indicated by (a positive standardized beta coefficient = 0.229 in the coefficients results of table 4.8)led toincreased costs of farming in Bungoma South Sub-County. The linear regression model that was used to predict cost of farming in Bungoma South Sub-Countygiven the CDIwas as follows:Cost of Farming = 23275.312 + 36705.875CDI.

From these findings,cropdiversification was one of the most ecologicallyfeasible, cost-effective, and rational ways ofreducing uncertainties in agriculture especiallyamong small-scale farmers hence improved their resilience.This findings concurs with the research carried out by Sare (2011), who argued that even if the profit from a new crop would be negligible – or negative – one would still benefit economically from an expanded rotation because Labor and equipment are distributed more smoothly through the year, thereby increasing operational efficiency and decreasing payroll costs.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the study findings and conclusions based on the findings in chapter four. The conclusions were derived by relating the findings to the achievement of the three objectives of the study as well as the hypotheses that had been formulated for the study. Finally, the chapter highlights recommendations and suggestions for future research.

5.2. Summary of findings

The first objective of the study was to assess the influence crop diversification and crop yield among the smallholder farmers. The findings were as follows: Firstly, the scatter plot showed an inverse relationship between CDI and food crop yield.Secondly, 61% (r^2=0.609) variation of food crop yield was explained by CDI and lastly, the results of regression analysis indicated that crop diversification index (CDI) had a significant influence in the crop yield among the farmers [F (1, 51) = 9.080, P = 0.004< 0.05; (β = -35.309, *t* =- 4.609, *p=0.000<0.05*].Hence an increase in the crop diversification indicated by a lower CDI led to an increase in the crop yield by 24.3%.

The second objective of the study was to establish the influence of crop diversificationfood affordability. The findings were as follows: Firstly, the scatter plot showed a linear relationship between CDI and FAI. Secondly, 60.9% (r^2=0.609) variation of FAI was

explained by CDI and finally, the results of regression analysis indicated that crop diversification index (CDI) had a significant influence in the food affordability among the farmers [F (1, 342) = 11.506, P = 0.001< 0.05; β = 0.333, *t* = 3.392, *p=0.001 < 0.05*]. That is, an increase in CDI by a unit led to an increase in FAI by 18%

The third objective of the study was to establish the influence of crop diversificationon thecost of crop farming among the smallholder farmers. The findings were as follows: To begin with, the scatter plot showed a linear relationship between CDI and FAI, secondly, 66.8% (r^2=0.668) variation of FAI was explained by CDI and thirdly, the results of regression analysis indicated that crop diversification index (CDI) had a significant influence in the total cost of farming among the farmers [F (1, 20) = 16.484, P = 0.001< 0.05; (β = 192715.955, *t* = 4.060, *p=0.001<0.05*]. An increase in the crop diversification index by a unit led to an increase in the total cost of farming by 22.9%.

5.3 Conclusion

From the findings outlined so far, several conclusions are draw

- Crop diversification increased food crop yield among the smallholder farmers.
- Crop diversification help reduce the prices of major food items on the market. Crop diversification helped stabilize the prices of the main food items in the study region hence making them affordable by the smallholder farmers.
- Increased diversification of subsistence food crops increased total variable costs but lead to reduced labour costs. This is attributed to the fact that most small holder

farmers used family labour and did intercropping as well. In addition to that, those that used hired labour and practiced crop diversification didminimize onlabour especially when weeding and fertilizer costs because they did the weeding and fertilizer application at once for all the intercropped plants. This reduced the costs incurred in farming altogether by smallholder farmers.

- Improved crop yield, stability of prices of the main food items on the market and the reduction in farming costs improved the resilience of smallholder farmers who had done crop diversification.

5.4 Recommendations

The findings of this study recommend the following.

- The small- holder farmers in the Sub- County and beyond should widely embrace crop diversificationto make them resilient because it helps in improving the crop yields, makes the main food crops affordable and reduces costs of farming.
- The County Government of Bungoma to intensify greater implementation of diversified cropping systems especially those currently less diversified as policy direction due to food insecurity and malnutrition in this era of climate variability that possess extra burden to farmers

5.5. Areas for Further Study

The areas that require further research include the following:

- Evaluation on the affordability of a resilient agricultural system among small holder farmer.

- Effects of crop diversification on the resilience of agricultural land production among the smallholder.
- Effects of cash crop farming on farmers' resilience among the smallholder farmers.

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APPENDICES

APPENDIX I: DATA ON THE MAIN VARIABLES

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
1	24300	20250	0.5	3.5	0.83	75400
2	44500	19710	0.5	3.5	0.44	75400
3	28800	19620	0.17	26	0.68	65300
4	28800	19620	0.17	26	0.68	65300
5	28800	20700	0.13	26	0.72	65300
6	28800	20700	0.13	26	0.72	64800
7	28800	10800	0.5	7.5	0.38	59500
8	28800	19800	0.13	6.5	0.69	59500
9	28800	19800	0.13	6.5	0.69	59400
10	22800	24750	0.25	6	0.57	58300

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
11	24400	20250	0.17	6	0.83	57500
12	60700	18450	0.17	6	0.3	57400
13	24400	12150	0.08	6	0.5	56200
14	32000	19800	0.5	8	0.62	55400
15	24400	11070	0.08	6	0.45	55400
16	22400	22950	0.17	6	0.25	54900
17	22400	19800	0.19	7	0.88	54500
18	22400	19800	0.19	7	0.88	54500
19	22400	19800	0.19	7	0.88	54500
20	40800	19800	0.25	14	0.49	54000
21	40800	20700	0.25	14	0.51	54000
22	40800	19260	0.25	14	0.47	54000
23	35000	20700	0.13	25.5	0.59	54000
24	35000	23400	0.13	25.5	0.67	54000
25	38000	11070	0.25	8.5	0.29	53500
26	54799	24300	0.23	11.5	0.44	52000
27	54799	19800	0.13	11.5	0.36	51400
28	54799	19800	0.13	11.5	0.36	50200
29	54799	19800	0.13	11.5	0.36	49700
30	36000	19350	0.13	9	0.54	48450
31	28800	18900	0.33	8	0.66	48450
32	28800	18450	0.33	8	0.64	48450
33	35200	17550	0.5	9	0.5	48450
34	35200	17550	0.5	9	0.5	48450
35	41400	19800	0.13	25	0.48	48200
36	41400	23850	0.13	25	0.58	48200

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
37	41600	19800	0.25	11	0.48	45700
38	41600	20700	0.25	11	0.5	45600
39	29200	26100	0.25	8	0.89	45200
40	29200	26100	0.25	8	0.89	45200
41	52000	19260	0.13	27	0.37	43600
42	52000	21330	0.13	27	0.41	43600
43	57609	19800	0.12	14	0.34	43200
44	23100	19800	0.17	16	0.86	41200
45	24500	11700	0.17	16	0.48	41200
46	55600	18900	0.22	25	0.34	40600
47	55600	19980	0.22	25	0.36	40600
48	52000	20520	0.33	10	0.39	39100
49	52000	19800	0.33	10	0.38	39100
50	52000	3600	0.2	12	0.07	37600
51	39600	19800	0.5	10.5	0.5	37600
52	39600	19350	0.5	10.5	0.49	37600
53	39600	20700	0.25	10	0.52	37600
54	39600	11070	0.2	10	0.28	37600
55	52000	24300	0.2	12	0.47	37600
56	59200	20250	0.17	14	0.34	37600
57	59200	20250	0.17	14	0.34	35300
58	40600	23850	0.33	14	0.59	33700
59	40600	23850	0.33	14	0.59	33000
60	40600	23850	0.33	14	0.59	32750
61	40600	19350	0.33	14	0.48	32750
62	40600	20700	0.33	14	0.51	32350

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
63	40600	19350	0.33	14	0.48	32350
64	40600	20700	0.33	14	0.51	31800
65	66800	19350	0.25	5.5	0.29	31400
66	66000	19800	0.17	15	0.3	31400
67	68800	16560	0.22	13	0.24	31200
68	68800	20700	0.22	13	0.3	31200
69	68800	19800	0.22	13	0.29	31200
70	41600	23850	0.08	14	0.57	27500
71	37600	11250	0.25	8	0.3	27500
72	37600	25650	0.25	8	0.68	27500
73	112000	10800	0.4	30	0.1	27500
74	112000	23400	0.4	30	0.21	27500
75	42800	10800	0.18.	17	0.25	26400
76	42800	13950	0.18	17	0.33	26400
77	132400	25650	0.37	18.5	0.30.	26210
78	132400	25650	0.37	18.5	0.31.	26200
79	92000	22950	0.19	32	0.25	25000
80	92000	23400	0.19	32	0.25	24700
81	36700	20160	0.1	14	0.55	24700
82	64000	21600	0.17	16	0.34	24000
83	36700	20160	0.1	14	0.55	23460
84	101200	19800	0.27	26	0.2	22700
85	101200	19350	0.27	26	0.19	22600
86	67200	21150	0.25	18	0.31	22200
87	67200	21150	0.25	18	0.31	22200
88	137600	19800	0.33	35	0.14	19500

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
89	137600	25200	0.33	35	0.18	19500
90	76800	20700	0.09	20	0.27	19100
91	134400	13950	0.04	29	0.1	19000
92	46500	19800	0.4	21	0.43	19000
93	46500	19800	0.4	21	0.43	19000
94	46500	19800	0.4	21	0.43	18600
95	151600	20520	0.21	35	0.14	17000
96	151600	19800	0.21	35	0.13	17000
97	106400	19800	0.19	41	0.19	15800
98	106400	10800	0.19	41	0.1	15700
99	132400	10800	0.13	67	0.08	15400
100	115200	23400	0.29	49	0.2	14600
101	115200	22500	0.25	49	0.2	14400
102	134000	19800	0.17	62	0.15	14100
103	134000	19800	0.17	62	0.15	13720
104	87200	20250	0.25	38	0.23	13500
105	87200	19350	0.25	38	0.22	13500
106	160000	20700	0.21	40	0.13	13100
107	118900	20250	0.25	36	0.17	12600
108	118900	20700	0.25	36	0.17	12600
109	108400	11070	0.16	51	0.1	12600
110	108400	21150	0.16	51	0.2	11400
111	96800	20250	0.2	43	0.21	11300
112	26000	23400	0.25	38	0.9	9800
113	26000	11250	0.25	38	0.43	9800
114	106409	19800	0.2	43	0.19	9200

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
115	153200	10800	0.29	38	0.07	9200
116	153200	18450	0.29	38	0.12	9000
117	153200	20700	0.09	65	0.14	9000
118	153200	20430	0.09	65	0.13	8600
119	106409	19800	0.2	43	0.19	8600
120	165400	22950	0.13	58	0.14	8600
121	165400	23400	0.13	58	0.14	8600
122	108400	12600	0.16	46	0.12	8600
123	108400	21600	0.16	46	0.2	8600
124	87200	19800	0.06	38	0.23	8600
125	87200	16200	0.06	38	0.19	8300
126	114400	10800	0.2	36	0.09	8300
127	114400	20700	0.2	36	0.18	8300
128	99201	19800	0.21	42	0.2	8200
129	99201	19800	0.21	42	0.2	8100
130	177200	10800	0.29	67	0.06	5400
131	177200	20700	0.29	67	0.12	5400
132	55400	19800	0.06	74	0.36	5150
133	55600	18900	0.06	74	0.34	5150
134	125600	12150	0.13	70	0.1	4300
135	122300	19710	0.18	70	0.16	4300
136	132000	23400	0.13	72	0.18	2000
137	132000	25200	0.13	72	0.19	2000
138	132000	20700	0.18	70	0.16	2000
139	28600	19800	1	2	0.69	90800
140	27600	19350	1	2	0.7	90800

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
141	45600	23850	0.22	15	0.52	87300
142	37600	24750	0.19	15	0.66	87300
143	44000	11700	0.17	15	0.27	87300
144	12800	19800	0.13	3.5	0.55	83200
145	12800	19350	0.27	3.5	0.64	83200
146	33200	20700	0.17	3.5	0.62	82300
147	33600	20700	0.17	3.5	0.62	82300
148	24000	18450	0.25	5.5	0.77	73000
149	24000	19800	0.25	5.5	0.83	73000
150	24000	19800	0.25	5.5	0.83	72500
151	24000	20250	0.25	5.5	0.84	72500
152	43900	18450	0.5	18	0.42	63260
153	37600	19800	0.5	18	0.53	60900
154	28800	23400	0.33	17	0.81	60900
155	28800	24300	0.33	17	0.84	58900
156	28800	24300	0.33	17	0.84	58800
157	25600	19350	0.17	13	0.76	58800
158	25600	23850	0.17	13	0.93	58800
159	22400	23400	0.13	15	0.5	58800
160	22400	23400	0.13	15	0.55	58400
161	32000	19800	0.25	9	0.62	57400
162	32000	19800	0.25	9	0.62	56400
163	38800	19800	0.13	10	0.51	56400
164	38800	19350	0.4	10	0.5	56200
165	31200	19800	0.13	7.5	0.63	55400
166	31200	21600	0.16	7.5	0.69	55000

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
167	21600	21150	0.5	8	0.98	54300
168	21600	20250	0.5	8	0.94	54300
169	21600	20700	0.5	8	0.96	54000
170	26200	11070	0.5	6.5	0.42	54000
171	26200	18450	0.5	6.5	0.7	54000
172	73600	20700	0.05	19	0.28	52000
173	48800	23850	0.17	12	0.49	48450
174	48800	24750	0.17	12	0.51	48450
175	57600	19350	0.15	14	0.34	47400
176	57600	19800	0.14	14	0.34	47000
177	24400	22950	0.08	26	0.94	43630
178	24400	24300	0.08	26	0.34	43630
179	45600	18450	0.17	26.5	0.4	43500
180	57609	19800	0.22	14	0.34	43200
181	52000	25650	0.13	27	0.49	41400
182	52000	20700	0.25	25	0.4	41200
183	45600	21600	0.13	26.5	0.47	40900
184	45600	21150	0.13	26.5	0.46	40900
185	30800	18450	0.13	10	0.6	40100
186	30800	20700	0.13	10	0.67	40100
187	45600	18900	0.13	20.5	0.41	38900
188	45600	19800	0.13	20.5	0.43	38900
189	40600	23850	0.33	14	0.59	35300
190	40600	19800	0.33	14	0.49	33700
191	40600	19800	0.33	14	0.49	33000
192	67200	21150	0.25	19	0.31	31800

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
193	40800	18720	0.13	28.5	0.46	31200
194	40800	18450	0.13	28.5	0.45	30400
195	64400	23400	0.08	26	0.36	30400
196	64400	22500	0.08	26	0.35	30300
197	100800	19800	0.25	22	0.2	27409
198	100800	20700	0.25	22	0.21	27409
199	100800	20700	0.25	22	0.21	27100
200	100800	20250	0.2	22	0.2	27100
201	89700	23400	0.14	18.5	0.26	26200
202	41600	18900	0.08	11	0.45	25000
203	138000	24300	0.17	33	0.18	24300
204	138000	24300	0.17	33	0.18	24000
205	23700	19800	0.5	10	0.84	23000
206	23700	19350	0.5	10	0.82	22800
207	72400	27900	0.4	20	0.39	22800
208	72400	27900	0.4	20	0.39	22700
209	87600	19800	0.33	20.5	0.23	22700
210	87600	20700	0.33	20.5	0.24	22700
211	83200	21600	0.22	19	0.26	19500
212	134400	19800	0.20	29	0.15	19500
213	60200	20700	0.30	36	0.34	19000
214	60200	20700	0.30	36	0.34	19000
215	67200	21600	0.25	19	0.32	18600
216	108800	21150	0.22	28	0.19	18000
217	67200	19800	0.19	18	0.29	17700
218	67200	18450	0.19	18	0.27	17400

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
219	130800	20700	0.15	36	0.16	17000
220	106400	23850	0.06	42	0.22	16700
221	106400	10800	0.21	37	0.1	16700
222	106400	10800	0.06	42	0.1	16300
223	106400	27900	0.21	37	0.26	16300
224	128000	20700	0.29	35	0.16	15700
225	128000	18900	0.29	35	0.15	15400
226	128000	24300	0.29	35	0.19	15400
227	105680	22500	0.21	23	0.21	15300
228	105680	22950	0.21	23	0.22	15300
229	160000	19800	0.21	40	0.12	13100
230	160000	18450	0.21	40	0.12	13100
231	103200	19260	0.19	42	0.19	11400
232	103200	21330	0.19	42	0.21	11400
233	183200	18450	0.19	57	0.1	8300
234	87600	20700	0.21	39	0.24	8200
235	77900	20700	0.21	39	0.27	8200
236	183200	18900	0.19	47	0.1	8200
237	183200	18900	0.19	47	0.1	8100
238	144400	19710	0.17	52	0.14	8100
239	144400	10800	0.24	52	0.07	8100
240	114400	18450	0.25	41	0.16	5900
241	114400	19800	0.25	41	0.17	5900
242	55300	12600	0.33	3.5	0.23	82500
243	12800	19800	0.33	3.5	0.56	82500
244	30200	19800	0.17	2.5	0.66	68800

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
245	31400	19800	0.17	2.5	0.63	65300
246	28800	18450	0.13	26	0.64	64400
247	28800	18450	0.13	26	0.64	64400
248	22400	26550	0.13	6	0.47	63600
249	22400	19350	0.13	6	0.86	63260
250	28800	20250	0.25	7.5	0.7	59400
251	28800	20430	0.25	7.5	0.71	59400
252	28800	19350	0.5	7.5	0.67	59400
253	44800	19800	0.33	12	0.44	58800
254	44800	20250	0.33	12	0.45	58800
255	27600	20700	0.25	7.5	0.75	58300
256	27600	20700	0.25	7.5	0.75	57900
257	27600	20700	0.25	7.5	0.75	57900
258	22400	11700	0.11	6	0.52	57500
259	19600	19800	0.13	5.5	0.93	55900
260	27600	19800	0.14	5.5	0.72	55900
261	22400	23400	0.17	6	0.35	55000
262	22400	19800	0.17	6	0.88	54800
263	22400	20700	0.17	6	0.92	54800
264	19000	10350	0.25	5.5	0.54	54600
265	19000	10350	0.25	5.5	0.54	54600
266	68800	19350	0.25	16	0.28	54000
267	68800	19800	0.25	16	0.29	54000
268	25600	20250	0.17	7	0.79	52915
269	25600	20700	0.17	7	0.81	52915
270	36000	19980	0.20	9	0.56	49700

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
271	60800	18720	0.13	15	0.31	48450
272	50000	25200	0.25	70	0.5	47000
273	50000	19800	0.25	65	0.4	45700
274	35000	20250	0.13	26	0.58	45600
275	44800	20700	0.2	12	0.46	45000
276	44800	20700	0.2	12	0.46	45000
277	75200	12600	0.22	16	0.17	44400
278	75200	21600	0.22	16	0.29	43630
279	41360	11700	0.13	26	0.28	43600
280	89500	20700	0.33	26	0.23	43100
281	33670	20250	0.33	26	0.6	43000
282	42900	19800	0.13	26	0.46	43000
283	43900	23400	0.13	26	0.53	41500
284	52000	11250	0.13	27	0.22	41400
285	52000	20700	0.13	25	0.4	41200
286	50000	20700	0.17	26.5	0.41	37600
287	50000	19350	0.17	26.5	0.39	37600
288	49200	19800	0.17	12	0.4	37600
289	46600	19800	0.17	28	0.42	31200
290	30400	18450	0.15	19	0.61	30300
291	30400	11250	0.15	19	0.37	29400
292	60000	20700	0.33	26.5	0.35	29200
293	60000	11070	0.33	26.5	0.18	28000
294	76200	26550	0.22	39	0.35	28000
295	76200	21330	0.22	39	0.28	27900
296	64000	20250	0.04	17	0.32	27880

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
297	64000	23850	0.04	17	0.37	27880
298	20700	23850	0.08	15	0.5	27880
299	41600	11700	0.08	14	0.28	27500
300	47400	20160	0.17	13.5	0.43	24300
301	64000	21600	0.17	16	0.34	23900
302	67600	24300	0.08	32	0.36	23900
303	67600	23850	0.08	32	0.35	23500
304	67600	23400	0.17	33	0.35	23500
305	67600	14400	0.17	33	0.21	23500
306	74200	20700	0.17	37	0.28	22700
307	74200	22950	0.17	37	0.31	22700
308	75500	19800	0.25	39	0.26	22700
309	75500	20070	0.25	39	0.27	22700
310	94200	19800	0.17	36	0.21	22700
311	94200	19800	0.17	36	0.21	22700
312	66800	19350	0.18	21	0.29	22600
313	66800	19260	0.18	21	0.29	22400
314	66800	19260	0.18	21	0.29	22400
315	76800	19350	0.27	21	0.25	22400
316	76800	20700	0.27	21	0.27	22400
317	76800	20250	0.27	21	0.26	22400
318	76800	18450	0.2	21	0.24	22400
319	76800	18450	0.2	21	0.24	22300
320	67800	19800	0.4	21	0.29	22200
321	67800	20700	0.4	21	0.31	22200
322	115200	19800	0.17	27	0.17	21500

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
323	115200	19800	0.17	27	0.17	21500
324	47200	18900	0.16	18	0.4	21400
325	47200	18900	0.16	18	0.4	21400
326	95600	19800	0.1	22	0.21	20800
327	95600	21330	0.1	22	0.22	20800
328	54300	19350	0.17	32	0.36	20400
329	54300	20250	0.17	32	0.37	20400
330	57600	19800	0.22	21	0.34	19790
331	98000	20250	0.25	43	0.21	19790
332	98000	20430	0.25	43	0.21	19500
333	98000	19800	0.25	43	0.2	19500
334	76800	20430	0.27	21	0.27	19500
335	76800	10800	0.27	21	0.14	19500
336	76800	27900	0.09	20	0.36	19100
337	85600	19800	0.25	20	0.23	19000
338	122000	20700	0.33	62	0.17	18100
339	122000	19350	0.33	62	0.16	18100
340	108800	19800	0.22	28	0.18	18000
341	80000	10350	0.25	19	0.13	18000
342	80000	10350	0.25	19	0.13	17700
343	97000	10800	0.3	55	0.11	17400
344	97000	18900	0.3	55	0.19	17000
345	106400	11700	0.25	42	0.11	16000
346	106400	16200	0.25	42	0.15	15800
347	169000	10800	0.27	64	0.06	15400
348	169000	25200	0.27	64	0.15	15300

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
349	8000	10350	0.83	25	0.3	14900
350	134000	18450	0.2	62	0.14	14400
351	134000	10800	0.17	62	0.08	13900
352	134000	18900	0.17	62	0.14	13900
353	134000	18450	0.17	62	0.14	13750
354	134000	18450	0.17	62	0.14	13750
355	134000	19800	0.2	62	0.15	13750
356	147200	19350	0.19	38	0.13	12600
357	147200	19800	0.19	38	0.13	12600
358	102400	23400	0.42	28	0.23	12600
359	102400	19800	0.42	28	0.19	11600
360	132400	12150	0.17	57	0.09	11600
361	132400	12600	0.17	57	0.1	11400
362	96800	14400	0.2	43	0.15	11400
363	165400	23400	0.17	53	0.14	11300
364	165400	24300	0.17	53	0.15	11000
365	83800	13500	0.06	37	0.16	11000
366	83800	19800	0.06	37	0.24	10200
367	122000	20250	0.33	32	0.17	10000
368	122000	10800	0.33	32	0.09	9800
369	147200	10800	0.04	38	0.07	9800
370	147200	10800	0.04	38	0.07	9600
371	153200	19800	0.29	38	0.13	9200
372	153200	19800	0.29	38	0.13	9200
373	99600	19350	0.05	29	0.19	8600

S/N	Total Revenue (KSh.)	Food Price (KSh.)	CDI	Agricultural Yield (90 kg Bags)	FAI	Total Cost (KSh.)
374	99600	20070	0.05	29	0.2	8600
375	99200	19800	0.13	26	0.2	8200
376	99200	18450	0.13	26	0.19	8200
377	167200	19800	0.2	59	0.12	8100
378	167200	20070	0.2	59	0.12	8100
379	134000	11700	0.15	72	0.09	1600
380	134000	20700	0.15	72	0.15	1600

Table 4.9: Crop Diversity Index (CDI)

Mean CDI	Std. Deviation	Std. Error of Mean
0.2277	0.12310	0.00664

Table 5.0: Food Affordability Index (FAI)

Mean FAI	Std. Deviation	Std. Error of Mean
0.3743	0.01159	0.22499

Table 5.1: Average input variable costs (Ksh.) incurred by a crop farmer

	Maize		Bean		Millet		Total variable costs
	Seed	Fertilizer	Seed	Fertilizer	Seed	Fertilizer	
Response count	377	370	336	118	63	48	377
Mean (Ksh.)	1976.7	8122.6	2378.1	2656.8	1283.8	2143.8	18561.5
Std. Error of Mean	47.54	226.9	66.4	126.0	82	84.6	6.68
Std. Deviation	923.1	4364.2	1217.6	1369.2	650.5	586	1391.90

Skewness	0.390	0.484	0.370	3.307	0.327	-1.089	3.28
S.E of Skewness	0.126	0.127	0.133	0.223	0.302	0.343	.18

Table 5.2: Average labor costs (Ksh.) incurred by small holder farmers who use hired labor in crop farming

Average costs incurred	N	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
land preparation costs	374	5457.2	170.06	3298.96	0.633	.126
weeding costs	189	4799.21	3.4589	47.55180	4.514	.177
Harvesting costs	188	6558.60	5.3494	73.34750	3.994	.177
Total labor costs	189	183338.62	7.2163	99.20740	1.623	.177

Table 5.3: Average costs and revenue generated from crop farming in the region

	Total variable costs	Total labour costs	Total cost of farming	Total revenue	Gross margin
N	379	189	189	189	189
Mean (Ksh.)	23,100.09	18,338.62	41,438.71	103,290.13	51851.42
Std. Error of Mean	11.2003	7.0842	15.0344	31.7297	20.4061

Table: 5.4. Number of smallholder farmers per location

Location	Number of smallholder farmers in each location		Sampled number of smallholder farmers per location	Sampled farmer in %
	Target	Accessible		
Township	600	450	9	2
Khalaba	1025	300	15	5
Mechimeru	1725	371	26	7
Bukembe	2200	413	33	8
Musikoma	2770	410	41	10
East Bukusu	2970	400	44	11
Mwibale	3279	400	48	12
Marakaru	3345	377	49	13
Kibabii	3403	385	50	13
Namirembe	5300	390	78	19

APPENDIX 2

QUESTIONNAIRE FOR SMALL HOLDER FARMERS

You are one among several smallholder farmers in this area who have been selected for this study. The study seeks to evaluate the influence of crop diversification on the resilience of agricultural land production among the smallholder farmers. Kindly respond to the questionnaire by filling in the blank spaces or ticking in **(√)** the preferred answer where there is a provision for choices. The information you will give will be treated with the confidentiality it deserves.

Date……... (EN) Enumerators name…….....

PART A

GENERAL INFORMATION

County…… Sub-County……

Location…… Agro-ecological zone……..

Respondents gender Male ☐ Female ☐

1. What is your main occupation? ……

2. What are your households' main sources of livelihood?

(i) Food crop farming ☐ (v) Trade ☐

(ii) Cash crop farming ☐ (vi) off farm casual work ☐

(iii) Livestock ☐ (vii) off farm permanent employment ☐

(iv) Fishing ☐ (viii) Others' specify……..

3. Land Ownership

Ownership	**Size in Acres**
1.Own	
2.Leased	
3.Others (specify)	

4. How much cropping land do you own?

(i) $\frac{1}{2}$ an acre ☐ (ii) 1 acre ☐ (iii) 2 acres ☐ (iv) 3 acres ☐

(v) More than an 3 acres, specify how many acres

…….....

PART B: CROP DIVERSIFICATION

1. How many crops do you plant on your farm per season……

2.Pleaselist hem…….

……

PART C: FOOD CROP YIELD

1. Ask the following questions for all diversified crops produced in the last season **(Jan- Dec 2014)**.

Name of crop	**Yield in bags per kilogram**
Maize	
Beans	
Millet	
Potatoes	

PART C: FOOD AFFORDABILITY

1a.Do you normally experience famine? Yes ☐ No ☐

b.If yes, specify the period in month (s)…….....

2. Ask the following questions for the prices of the following crops produced in the last season **(Jan- Dec 2017)**

Crop	**Price in Ksh. Per Kilogram**
Beans	
Finger millet	
Sweet Potatoes	
Maize	

PART D: COSTS OF FARMING

1. What type of labour do you use? Family labour ☐ Hired labour ☐

2. Ask the following questions for the following crops produced in the last season **(Jan- Dec 2014)**.

Crop	Land prep" costs	Seed costs	Weeding Costs	Fertilizer costs	Harvesting costs	Total labor costs	Total variable costs	Total revenue	Gross margin (ksh)
Maize									
Beans									
Millet									
Potatoes									

APPENDIX 3

INTERVIEW SHEDULE FOR AGRICULTURAL SERVICE PROVIDERS

1. What type of crop farming do small scale farmers practice in Bungoma South Sub-County?
2. What factors do you think have contributed to the choice of crop farming method mentioned above?
3. Which type of crops do farmers plant in the Sub-County?

3. What challenges do farmers experience in crop farming?
4. What are some of the ways that farmers put in place to help them cope with such challenges?
5. Do you think crop diversification help farmers solve some of this challenges and how?
6. What is the relationship between crop diversification and the input costs per a given farming period?
7. Do you think crop diversification play any role in stabilizing the prices of various food stocks in the region and in which ways?

APPENDIX 4

INTERVIEW SHEDULE FOR THE LOCAL CHIEFS

1. Which type of crops do farmers plant in the Sub-County?
2. What type of crop farming do small scale farmers practice in the Sub-County?
3. What factors do you think have contributed to the choice of crop farming method mentioned above?
4. What challenges do farmers experience in crop farming?
5. What are some of the ways that farmers put in place to help them cope with such challenges?
6. Do you think crop diversification help farmers solve some of this challenges and how?
7. What is the relationship between crop diversification and the input costs per a given farming period?
8. Do people experience any problems in so far as accessing food items in this region is concerned?
9. Do you think crop diversification play any role in stabilizing the prices of various food items in the region and in which ways?

APPENDIX 5

OBSERVATION CHECKLIST

Respondents' No. …… Date……

The interviewer will make the following observations and tick or record the best description for the situation.

Sub-County…….Location……. Sub location……

Village …….. Household…….

1. Main socio economic activities in the region……. ……..…….
2. Average farm size
   (a) Large ( ) (b) Medium ( ) (c) Small ( )
3. General land use
   (a) Crop farming ( ) (b) Animal keeping ( )
   (c) Others' specify…….
4. Type of crops grown
   (a) Food crops (b) Cash crops (c) Industrial crops (d) Horticultural crops (d) others
   Specify……..
5. Type of crop farming mainly used by farmers
   (a) Monoculture (b) Crop diversification
6. Number of crop patches on the same piece of land
   (a) 1 (b) 2 (c) 3 (d) 4 (e) others specify……
7. General evaluation of food availability and affordability among the smallholder farmers by looking at the price lists of the following food items in the available shops.

Crop type	**Price per bag in kilogram in Kshs.**
Maize	
Beans	
Finger Millet	
Sweet Potatoes	

APPENDIX 6:

LETTER OF INTRODUCTION

The Farmer,

_____ Location,

Dear Sir/ Madam,

REF: CONDUCTING RESEARCH

I am a Master of Arts Geography Student in the School of Environment and Earth Sciences, Maseno University. The title of this study was is influence of Crop Diversification on Farmers' Resilience in Bungoma South Sub- County. I am glad to inform you that you have been selected to participate in this study. Your co-operation in this regard will be highly appreciated.

Yours faithfully,

Catherine Nyongesa

Graduate Student.

APPENDIX 7:

RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MS. CATHERINE NYONGESA JUMA
of MASENO UNIVERSITY, 1014-50200
Bungoma,has been permitted to
conduct research in *Bungoma County*

INFLUENCE OF CROP DIVERSIFICATION ON FARMERS' RESILIENCE AMONG THE SMALLHOLDER FARMERS IN BUNGOMA SOUTH SUB– COUNTY

for the period ending:
11th February,2018

Permit No : NACOSTI/P/17/28255/15338
Date Of Issue : 14th February,2017
Fee Recieved :Ksh 1000

.....
Applicant's Signature

.....
Director General
National Commission for Scienc
Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officer will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEACH CLEARANCE PERMIT

Serial No.A 12827

CONDITIONS: see back page