DETERMINANTS OF FOOD SECURITY AND FOOD DEMAND ESTIMATION IN SUGARCANE AND TOBACCO GROWING ZONES IN MIGORI COUNTY

ANINO ERICK

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE DEGREE IN AGRICULTURAL ECONOMICS AND RESOURCE MANAGEMENT, SCHOOL OF AGRICULTURE AND NATURAL RESOURCES

MOI UNIVERSITY

2022

DECLARATION

Declaration by the candidate

I declare that this is my original work and has not been presented for an award of degree in any other University.

Anino Erick

Reg. No. SBE/PGA/015/14

Sign..... Date..22/11/2022

Declaration by the Supervisors

This thesis has been submitted for examination with our approval as universi supervisors from Moi University

Dr. Alfred Serem Sign..... Date..24/11/2022

School of Agriculture and Natural Resources,

Department of Agricultural Economics and Resource Management,

Moi University,

Eldoret Kenya.

Dr. Vincent Ng'eno Sign..... Date..23.11.2022

School of Agriculture and Natural Resources,

Department of Agricultural Economics and Resource Management,

Moi University,

Eldoret Kenya.

DEDICATION

This thesis is dedicated to my parents, Mr. Daniel Anino and Christine Anino for instilling in me virtues of hard work, discipline and honesty.

ACKNOWLEDGEMENT

First, I would like to acknowledge the almighty God for giving me good health and knowledge to write this thesis. I am heartily grateful to my supervisors, Dr. Alfred Serem and Dr. Vincent Ng'eno whose encouragement, guidance and support enabled me to develop an understanding to undertake this research. I also acknowledge my friend Ojwang, my brother Calvince and my lecturer Dr. Benard Lagat for his support as well.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

MoA: Ministry of Agriculture

FAO: Food Agricultural Organization

KESREF: Kenya Sugar Research Foundation

ASDSP: Agricultural Sectorial Development Support Program

CARD: Community Agriculture for Rural Development

MoH: Ministry of Health

HFIAS: Household Food Insecurity Access Scale

HFIAP: Household Food Insecurity Access Prevalence

LA/AIDS: Linearized Almost Ideal Demand System

LPG: Liquefied petroleum gas

ABSTRACT

Determinants of food security and its accurate measurement has posed a serious problem to development in Kenya. The level of food insecurity in Migori County is 34%. The general objective of the study was to evaluate determinants of food security and food demand estimation in sugarcane and tobacco growing zones in Migori county. The specific objectives of this study were to evaluate household food security determinants such as land size, age and off-farm income in sugarcane production zones and tobacco production zones in Migori County and to estimate Marshallian (uncompensated) elasticity on aggregated foods such as legumes, livestock products and cereals. The study was guided by consumer theory and was done in Uriri and Kuria sub counties in Migori County and used a cross survey design. The target population consisted of 238320 people. A sample size of 396 was determined using Yamane formula. Multistage sampling technique was applied to select the sampled households. The study used both primary and secondary data. Primary data was collected through self-administered structured questionnaires. Household Food Insecurity Access Scale and Linear Approximate Almost Ideal Demand System framework of analysis were used to analyze the data. Results showed 18.52% of the households were food secure, 38.89% severely food insecure, mildly food insecure households and moderately food insecure households were 9.26% and 33.33% respectively. Households that produce tobacco were 15.73% food secure and severely food insecure at 46.07%. Households that produce sugarcane were 18.97% and 44.83% severely food insecure. The findings revealed sugarcane and tobacco production does significantly affect food security in sugarcane and tobacco growing zones. The study showed that food security status was better in households that did not produce either commodity, sugarcane or tobacco. Tobacco, sugarcane, and unemployment were significant at 0.001. Price index and household size were significant at 0.001 after the estimation of food demand of households in Migori County. The largest budget share fell to livestock products at 30% while the least to cereals at 3%. The food categories according to expenditure elasticity were elastic products. All the Marshallian(uncompensated) elasticities were negative as expected. The study concluded that sugarcane and tobacco production had a negative impact on the state of food security in sugarcane and tobacco growing zones of Migori County while prices of food crops had positive influence in the demand of aggregated foods. The county government should establish short and long term plans for employment opportunities to the youths, as the study revealed, households who had members employed or engaged on off-farm activities were food secure. Estimates of consumer and producer demand show effect of prices and total expenditure on consumer behavior thus helps policy makers predict purchasing choices and decision of consumers and help design such policies.

CHAPTER ONE: BACKGROUND

1.1 Introduction

Food insecurity, and its accurate measurement, has posed a serious problem to development in Kenya (Food and Agriculture Organization, 2020). It has complicated aspects of identifying and planning for food insecure households. It is thus not easy to adopt policy interventions used in moderating the situation given the inaccurate data usually obtained at the national level. Extending food insecurity to the national level does not give the real picture, as it is prone to measurement errors (FAO, 2020). It is thus necessary to take the study of food insecurity to the household level where accurate data and statistics is obtained and measured.

Common underlying causes of food insecurity are crop failure, drought, diminishing resource base, civil strife and limited access to resources of production as attributed by Uzma and Butt (2004) in their analysis of household food security in Pakistan. Smith and Haddad (2000) also claim that there is a weak linkage between household food security and national food security. They imply that a country might be food secure but the interactions at the household level due to certain factors may limit access of food to some.

Considering the unwavering contribution of agriculture to the Kenyan economy, problems of food insecurity still exist among households. Food insecurity has a variety of meanings, in this study; it is a state in which all people, lack economic and physical access to adequate, safe and nutritious food to meet their dietary needs and preferences for an active and healthy living as quoted by Food and Agriculture Organization (2020).

Food security as a supply problem has been highly contested Sen (1981). He attests that food insecurity is more of a demand issue that affects access to food than a supply phenomenon influencing availability.

According to Food and Agricultural Organization quarterly crop prospects and food situation report, grain production had reduced by 6% in 2017 as compared to 2016. In 2016, 4 million tonnes of cereals were produced while in 2017 only 3.8 million were realized. Out of the 3.8 million, 3.3 million tonnes were made up of millet, maize, barley and sorghum as well as 500000 tonnes of wheat (2020). The Economic Survey of Kenya 2017 as noted by FAO (2020) also states that the country produced 37.1 million bags of 90 kilogram bags of maize, 117000 tonnes of sorghum and 54000tonnes of millet as well as 101500 tonnes of paddy rice. The FAO, (2020), also confirmed that 37.9 million tonnes of cereals would be achieved against a target of 40 million bags predicted at the start of that year.

The report also revealed that 18% that equals to 7.1 million Kenyans are chronically food insecure. It showed that Turkana County (54%), Kisii (41%), Migori (34%) and Isiolo (29%) were the most affected. Findings indicated that Migori County is chronically food insecure at 34%. Majority of respondents reached relied on own production at 35.4%, casual labor of any form at 23.3% and small businesses and traders at 24.5%. Further details showed that major food insecurity challenges stem from poor infrastructure affecting marketing activities leading to higher prices of food commodities. Rapid climatic conditions in forms of prolonged droughts and floods, as well as land parcels a portion to sugarcane and tobacco whose income rarely benefit the households have also been cited as some of the bottlenecks.

Rise in food prices has also led to food insecurity among poor households. This is related to households depending on food purchases rather than producing their own food. In essence, food price inflation leads to households spending a considerable amount of disposable income on food purchase that can be as much as 60-80%.

Kenya Natural Bureau of statistics report of 2013 in conjunction with African Women Studies Center found out that additional challenges to food security in Migori County are erratic climatic changes like droughts in dry seasons and floods in rainy season: fragmented and small land parcels which mostly are occupied by sugarcane and tobacco whose income hardly benefit children and women: limited access to extension officers thus resulting in ignorance of better methods of farming: little involvement in agricultural productivity by Migori youths: insecurity involving stealing of farm animals and crops: poverty and alcoholism as well as unemployment: large household sizes dictated by traditional and cultural ways which block development at all levels.

Consequently, consumer demand to policy makers and agribusiness participants is an important parameter to business policies. As demand for food in general is inelastic while supply and production vary, accurate estimation of demand helps in trade, price stability and even storage. Most governments, Kenya included, ensure a continuous supply of food throughout the year without interfering with pricing to meet food demand (KNBS, 2013). In early 2020 however, price fluctuations were rampant globally and nationally due to the onset of Covid 19 pandemic and thus future demand for local agricultural production and consumption was uncertain. This in itself is enough reason to study income elasticities, price estimation by analyzing consumer demand to aid in forecasting (Rahman, Surozzaman, Jahan, Haque and Palash, 2020).

Therefore, consumer demand is a component structure in the agricultural sector that works in any systematic economic program for development. To maintain balance between production and consumption, exchange of goods plays an important role. Thus information on food patterns is key to evaluate welfare of both producers and consumers while also impacting infrastructural and technological changes as well as economic policies Rahman et al (2020). Consumer demand in Migori County is thus changing due to urbanization, population increase, prices of goods and services and health problems. There is no detailed study on estimation of food demand in Migori County thus this study provided needed information in that regard.

The definition of food security as given by FAO, in 1996 and quoted in FAO 2020, includes stability and utilization indicating that food security has four characteristics: availability, access, utilization and stability that in the end form indicators. Key indicators or determinants are availability and access that can work to worsen or improve the state of food security. Outcome indicators like utilization reveal results in accordance to anthropometric weaknesses or inadequate food consumption.

Two approaches are used to study food security in Economics. One such approach is indirect approach. This focuses on economic theory of consumers to derive income and price elasticities for food, nutrients, and calories based on reduced form calorie demand equations for example (Subramanian & Deaton, 1996: Abdulai& Aubert, 2004) or estimated calorie elasticities for different food groups like (Pitt &Rosenzweig, 1985; Garrett &Ruel, 1999) as stated by Monica and Paul (2013).

The second approach uses probability to identify whether a household is food insecure using a home based energy production, and then evaluates determinants of food

insecurity with reduced form models. This allows evaluation of household demographics and endowments effects; agronomic, local economics, specific public policies and social conditions that are used majorly in developed countries as cited by (Bernell; Edwards and Weber, 2006) in Monica and Paul study of (2013). Both approaches will be employed in this study.

Food insecurity is a constraint to public health: in order to tackle its consequences, we need deep understanding and knowledge of factors that cause it (Gundersen and Garasky, 2012). Despite the fact that hunger and food insecurity are always associated with resource constraint, poverty and income measurements, these pointers do not give clear-cut evidence or information of food insecurity. Moreover, Bickel, Nord, Price, Hamilton and Cook (2000), in their findings reveal that empirical analysis of food security data show that low-income households appear to be food secure and a small percentage of high and middle-income households appear to be food insecure.

The study thus sought to find the gaps in such scenarios by evaluating determinants of food security and estimating food demand in sugarcane and tobacco growing areas that can improve framework of agriculture and policies of development pointed towards raising food security.

1.2 Problem Statement

The level of food insecurity in Migori County is 34% and is considered chronically food insecure (FAO, 2020; CARD, 2020; KNBS, 2013). The region has dedicated 60% of its productive land to sugarcane growing and another 20% to tobacco farming. Over 70% of the residents are farmers of the two commodities. Production of maize that is considered

a staple food crop for most of the households ranges between 6-10 bags per acre that is insufficient for the households according to Otieno (2018).

The increase in population within the last 20 years has also led to reduced sizes of land leading to the loss of 52% of arable land to housing. The region has a population of 917170 (2009 census) down from 666784 (1999 census). With the continuous decrease in the sizes of land, the FAO indicates that 40% of the local residents had to stop rearing livestock due to lack of grazing lands in the region (2020). Apart from the traditional vegetables growing in the area, most of the households have limited diversification of foods resulting to deficiency in nutrition. Inadequate clean water and sanitation together with lack of health facilities in the region have also contributed to malnutrition instances in the area (Ministry of Health 2020).

Reports by Kenya Sugar Research Foundation (2020) showed that the return per shilling invested on sugarcane has been on the decline due to high cost of inputs, labor and transport of the commodity. The returns per ton as paid by the factory have also declined from Kenyan shillings 3900 to 3200 in the current season. Moreover, the untimely payments occasioned by the factory and several bureaucratic procedures followed to obtain finances make farmers wait too long. Tobacco prices have also stagnated in the rate of 78 shillings per kilo instead of 120 shillings that makes the crop producers to foul exploitation by key players (FAO, 2020). Both crops take long to be harvested; sugarcane 18 months while tobacco 9 months. Tobacco, inasmuch, has degraded land and it can barely support growth of other food crops such as maize, groundnuts and cassava resulting to poverty in the area.

Poverty has a double impact in the households: it hinders households from accessing food due to their low or no purchasing power as well as preventing them from accessing farm inputs thus limiting expanded production due to limited capital. Additionally, poverty brings about poor health reducing ability of households to engage in physical food production (Community Agriculture for Rural Development 2020).

A study done by Ojala (2014) in Migori County examined socio-economic factors affecting only smallholder farmers growing maize in tobacco areas: the study indicated that production of maize affected food security but did not show to what extend that is. This study focused on all households who produce sugarcane, tobacco and non-producers. As cited by Ojala, the two cash crops use majority of the land that would otherwise be used to grow alternative food crops: competition for other resources like labour and capital also suffices between the enterprises. Moreover, there is scanty evidence on how participation in different crop enterprises contributes to food security amongst households in the region. This study therefore addressed the gaps by evaluating household food security determinants and estimating household food demand in sugarcane and tobacco growing zones on all households and to show prevalence of food security in the region as no such study has been done in the region.

1.3 Objective

To evaluate determinants of household food security and food demand estimation in sugarcane and tobacco growing zones in Migori County

Specific Objectives

i. To evaluate determinants such as land size, age and education level on food security in sugarcane and tobacco growing zones in Migori County

ii. To estimate Marshallian, uncompensated, elasticity of aggregated foods such as legumes, livestock products and cereals for food demand in sugarcane and tobacco production zones in Migori County

1.4 Hypotheses

The study hypothesized that:

H_{01}There is no relationship between determinants such as land size, age and education level on food security in sugarcane and tobacco growing zones in Migori County

H_{02}: There is no relationship between Marshallian, uncompensated, elasticity of aggregated foods such aslegumes, livestock products and cereals for food demand in sugarcane and tobacco growing areas in Migori County

1.5 Justification

A study on determinants of food insecurity and food demand estimation is vital as it provides needed information that allows implementation of policies and measures to: agricultural producers, consumers and other stakeholders. This improves food security status and plays a role in development of food security programs in Migori County. The study availed information that would help the county government to intervene and bring the severity of food insecurity to low levels in identified regions.

The study also sorts stabilization policies that would complement agricultural productivity policies for a sustainable framework to enhance food supply, reducing price distortions on food items sold and agricultural based market pricing. The policies extend to participants in the agribusiness market to formulate strategies to improve producer and consumer welfare.

Moreover, additional information was availed to Non-Governmental Organizations to help fight food insecurity in the region. The study focused on provision of information relating to status and determinants of food insecurity in the area.

1.6 Study Area

The study was carried out in Migori County.

1.6.1 Geographical

Migori County is located in Western Kenya and borders Kisii County to the North East, Homa Bay County to the North, Lake Victoria to the West, Tanzania to the South West and South and Narok County to the East and South East (Kaggikah, 2017).

1.6.2 Population

As per the 2009 Kenya Housing Census the population was 917170 with a population density of 353 people per kilometer square. Age distribution in years varies from 0-14(49%), 15-64(48%) and over 65(3%) with an annual growth rate of 2.38%.

1.6.3 Area and Climate

It covers 2597 kilometer square and has two rainy seasons with varying temperatures of 21-35 degrees Celsius (Kaggikah, 2017).

1.6.4 Economy

Main economic activity is agriculture with crops such as sweet bananas, sukuma-wiki, beans, sweet potatoes, cassava, groundnuts, sorghum, sugarcane, millet, maize and tobacco. Mining activities such as zinc, copper, galena, gold and carbon dioxide are also noted including fishing (Kaggikah, 2017).

1.6.5 Area

Uriri is located in Migori County as an administrative division. It borders Rongo, Awendo and Nyatike districts. As per the 2009 census, the population was estimated to be 115751. To note, 43% of the population lives below the poverty line in this region. It lies between longitude 34.47^0S and latitude -1.06^0E. The major crops grown for commercial purposes include tobacco and sugarcane amongst others like beans, cassava, rice, arrowroots and groundnuts. The altitude ranges from 1,145 m to 1,800 m above the sea level. It receives an annual rainfall ranging from 700 mm to 800 mm. The main study areas will include Central Kanyamkago, East Kanyamkago, North Kanyamkago, South Kanyamkago and West Kanyamkago.

Kuria East Sub County lies in the latitude of $0^0$15’ north and $1^0$45’ and longitudes of $35^0$15’ East and 34^0 West. The total area is 173.1 square kilometers. The topography is majorly hilly intercepted with flat lands with altitudes between 1400-1887 meters and temperatures of 27-31 degrees Celsius. Its annual rainfall ranges between 1500-2600mm per year. It has a population of 81833 persons (Nyamohanga, Wegulo, Ondimu 2016).Nyabasi East ward was selected in the region with Nyamegenga,

Kegonga,Getongoroma, Girigiri, Sakuri and Kugitimo sub-locations forming the base of study.

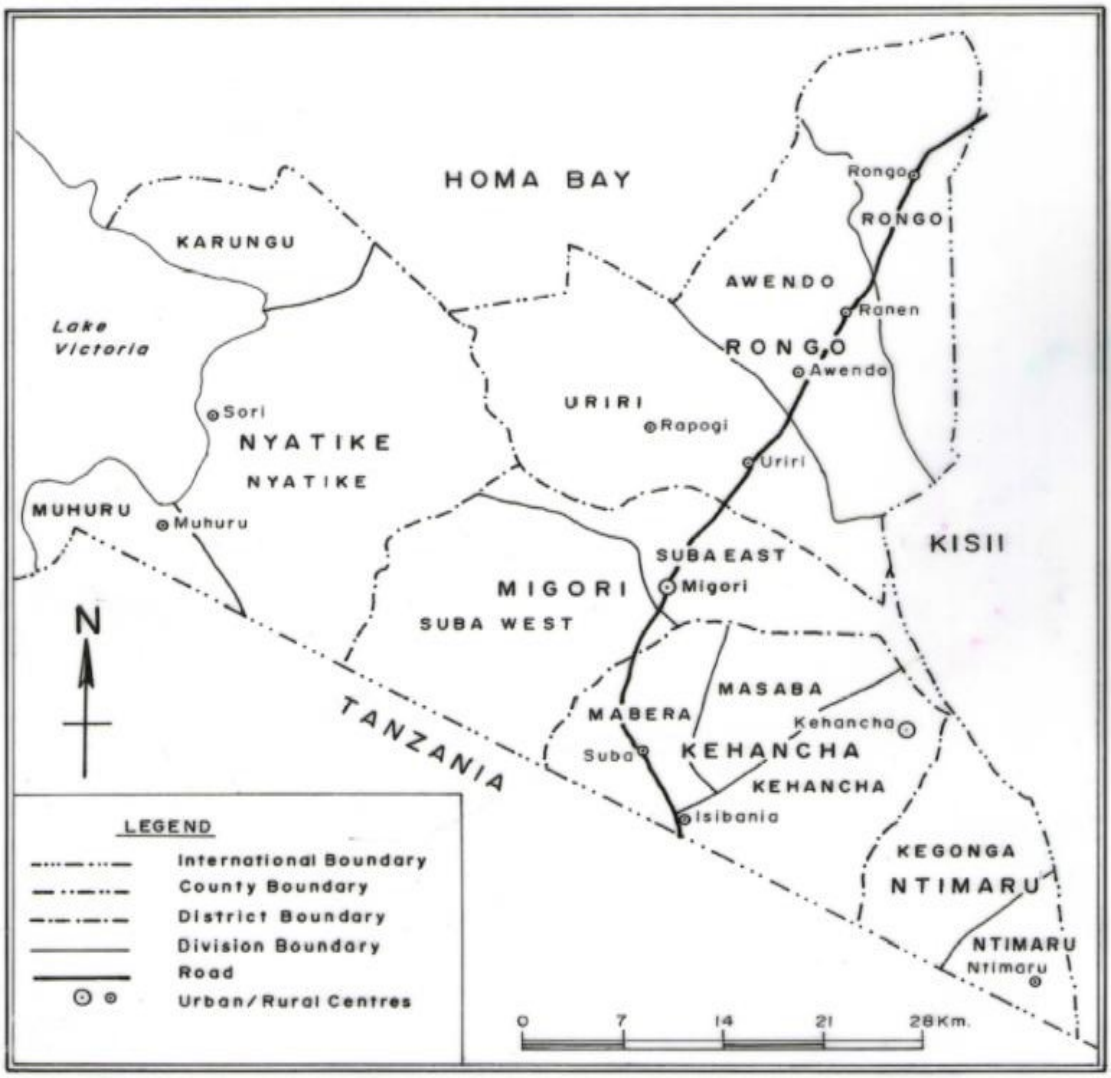

Figure 1.1 Map of Migori County: Source: (Kenyan map)

CHAPTER TWO: LITERATURE REVIEW

2.1 Definitions of Food Security

Food security is a multidimensional theory that has evolved over time and space. The initial status of food security was macroeconomic in dimension and looked at price stability of foodstuff at both national and international levels. Moreover, measures of food security revolved around food availability, food supplies, food adequacy and accessibility (Wheeler & von Braun, 2013). Due to droughts and famine in most developing countries, a better definition of this concept was sought. It now looks at constraints and access to food for each individual.

Definitions of food security thus evolved from the simple ones to more wholesome definitions. In 1974 during a world summit program, food security was defined as the availability of foodstuff to satisfy consumption and offset production and prices of basic needs. In 2001 the food agricultural organization defined food security as the sufficient availability of access to social, physical and economic dietary needs that meets consumers' preferences and help them live a safe and healthy life (Walker & Kawachi, 2012)

2.2 Variables of Food Security

Food availability: This is necessary but not sufficient. The focus on policy to remove constraints in marketing, natural disasters, transportation and price effects of policies both locally and internationally were to check and ensure food availability whether through imports, exports or from donor sources. This was based on macroeconomic effects (Tscharntke et al., 2012).

Food access: This implies that a person has a social and economic claim to food both physically and the place at which the food is found. In developing countries, access and availability are linked together. Access reflects effective demand while availability focuses on supply of food (Timmer, 2012).

Food utilization/consumption: It stresses on food processing, storage, consumption and digestion. It rotates on the nutritional aspects of the food and health of the consumer. Provision of education and management of family food status are also aspects to be examined (Shepherd, 2012).

Stability of access: Food stability is important because it affects decision-making during direct production and consumption. Its effect can be seen in terms of health and nutrition (Wheeler & von Braun, 2013).

Food insecurity like food security has a variety of definitions as proposed by various scholars. According to World Bank (1986), it is lack of capability for food production and access at all times to all people for healthy and active life. United States Department of Agriculture Food and Nutrition Service (2000) consider food insecurity as uncertain or limited availability of nutritionally safe and adequate foods or uncertain ability or limited ways to acquire foods in acceptable social ways. The World Food Summit (1996) explained that food insecurity occurs when people have no access to nutritious, safe and secure food for normal development, growth, active and healthy life.

2.2.1 Levels of Food Security

Food security can be studied at individual level, household and national level. Food at national level is related to existence of food from markets or own production: it is

associated with availability aspect of food security and is a function of commercial food imports, domestic food stocks, aid and country's own production. Household food security is the ability to acquire food of quality and meets nutritional requirements. On the other hand, individual level entails economic freedom and power to purchase which revolves around income distribution (Achenef, Alemayehu and Abera 2016).

2.2.2 Measures of Food Security

In developing countries, food insecurity is measured using anthropometric measures and poverty. It also involves concepts such as malnutrition, hunger, poverty which in many cases are extreme dimensions which do not reveal the whole view of food insecurity (Allen, 2013).

Due to unrepresentative national data, measuring food insecurity has never been accurate in Kenya. A more recent method is coping strategies index. It is an adverse response to shocks or events. The activities defined depend on drawing down savings, food rationing to more permanent measures such as selling household assets (Anderson, 2013).

There is no direct measure to identify food insecurity status as seen above. This implies that majority of studies done rely more on limited food access due to poverty and low incomes while other studies focus on availability of food measured in terms of caloric food intake. Moreover, some depend on extreme hunger and low weights which rely on dietary habits (Dibden et al., 2013). These also do not capture the multidimensional aspect of food security. Measures taken by the United States to measure food security have been proven to work in developing countries as seen in the case of Uganda, India and Bangladesh. The United States Agency for International Development adopted those

procedures and developed the Household Food Insecurity Access Scale. Actually the scale can be used to categorize a quantified survey done in a country and then grade using a scale (CARD 2020).

2.2.3 Social Aspect of Food Security

Social food security state is achieved with stable, secure and enough food that are of quality and nutritionally acceptable and not attained with loss of self-determination or dignity and consistent with basic needs realization. It is therefore important to find out if the population is aware that they are food insecure for which any implementation strategies will be accepted and adopted by them. It also looks at local consumption habits and cultural ways of the people such that when introducing new food patterns, they should be in line with indigenous food culture of the people (Anderson 2013).

Contribution from the international community has also reduced food insecurity in reference to adjustment policies such as guaranteed prices for farmers on produce sold, limiting tariffs and subsidies that hamper production in the end. Introduction of new technologies has as well aided in increased production focusing on improving the agricultural system (Jean 2015).

2.3 Determinants of Food Insecurity

Different works by (WFP, 2020; Von Braun et al., 1992; Mucavele, 2001; Bahiigwa, 1999) have established determinants of food security to be household size, sex of the head of household, education level, unemployment level, dependency ratio, land size, climate shocks, landslides, drought, insufficient rainfall, income of households, price volatility, credit access, savings, expenditure levels, asset ownership, access to social

networks, ownership of land, access to subsidized food, food availability, food source, inadequate land and labor, soil infertility, lack of crop diversification, health, technology, population growth, supply of foods to markets, food access and demand (Jean 2015).

These works show that food secure households depend on food taste and preferences, sanitation and access to clean water, informal social networks, employment and savings, assets, extension services, household demographics, land quality, farm size and adaptation to technology (Jean 2015).

A few food insecurity determinants are interrelated as revealed by studies:

Household demographics: Dependency ratio and size of households negatively affect food security exemptions coming in households where there are less than two elderly people or widows. Children headed households were food insecure.

Level of education: Illiteracy and low levels of education are associated with food insecurity. This is measured for household heads and other income earners within the households.

Status of employment: This implies diversity in income generation to shield against food insecurity shocks. Households whose members were not able to generate income were found to be mostly food insecure.

Assets: Households with greater possession of goods such as bicycles, radios, posho-mills and furniture tended to show aspects of food security including those who had food stores.

Savings: households with bank accounts, m-pesa and other aspects of savings such as livestock and other convertibles were able to survive shocks of food insecurity.

Adequate sanitation and access to clean water: lack of clean water and ways to dispose wastes result to ill health that in many ways lead to food insecurity through food absorption and utilization. When food is not properly ingested then it inhibits nutrition.

2.3.1 A Review of Models Used to Study Determinants of Food Insecurity

Jean (2015) in his study of determinants of household food insecurity in developing countries: evidence from a probit model for the case of rural households in Rwanda found out that rural households are exposed more to food insecurity than their counterparts in the urban centers. The result showed that households headed by females were food insecure. The mean and median of predicted probability of households becoming food insecure in gender perspective was 0.21 and 0.15 for males and 0.28 and 0.24 for females. Using a probit model, he found out that food expenditure, soil erosion index, household size, household farm animal, household food acquisition, household asset index, household spending, land suitability, membership to a cooperative and coping strategy index were significant at 1%. He concluded by stating that determinants of food insecurity differed among household heads headed by males and females. Males had more indicators than females but then females were exposed more to food insecurity than males.

A study by Girma (2012), determinants of food insecurity among households in Addis Ababa city described socio-economic characteristics of food secure and insecure households and used binary logit model to identify determinants. The result highlighted

that out of ten variables six were statistically significant determinants of food insecurity: access to employment, access to credit service, asset possession, household head education, age of household head and household size. Asset possession and household head were significant at less than 1% while age of house hold head, access to credit service, access to employment were significant at 5% and below. Household head education was found to be significant at 10%. Probability of being food insecure was determined by household size and age.

An analysis of the determinants of food insecurity with severe hunger in selected Southern States by Okwudili and Gerald (2006) used Rasch measurements and Logit model to predict food insecurity with severe hunger against moderate hunger in low-income households without children and with children. Results showed that income was a determinant of food insecurity amongst those households while food stamp was a predictor on households with children. Parameter estimates and statistical relationship of determinants of severe food insecurity for households with children showed that food stamps, income, were significant at 5% level with a success prediction of 69%. On the other hand, parameter estimates and statistical relationships of determinants of severe food insecurity for households without children indicated that income was significant at 5% and age was significant at 10% with a prediction success of 61.9%.

Zahid and Ahmed (2013) used logistic regression model in their study of socio-economic determinants of Household food insecurity in Pakistan. Out of 16 factors examined, education level of female was insignificant. Dependency ratio and access to safe water were counterintuitive to food insecurity. Annual income, education level of household head, household size square, number of rooms, and age were negatively

associated with food insecurity while age and household size had a positive association with food insecurity for general households.

What are the determinants of food insecurity in New Zealand and does this differ for males and females? In an attempt to answer this question Kristie, Tolotea, Kerri and Delvina(2010) found out that over 15% of the sampled population was food insecure. The prevalence was greater in females 19% than in males 12%. Adjusted odds of food insecurity were significantly higher in females as well (OR 1.6, 95% Cl 1.5-1.8). In their univariate analysis, food insecurity was associated with lower socio economic status, unemployment, renting, health status, younger age groups, unmarried status and sole parenthood. Income was the main predictor in multivariate modelling (OR 4.9%, 95% Cl 4.0-5.9 for highest and lowest income quantile). Socioeconomic and demographic associations of food insecurity were similar for females and males.

Monica and Paul examined determinants of food insecurity in Malawi rural households and found out that at 0.05% significance level, determinants such as distance to market, cultivated land per capita, number of elders, number of children, and education level were all significant. A gender analysis of determinants of vulnerability to food insecurity in a South African township by Fumane and Tshediso (2013); results for male headed households show income coefficient (income for household and other income) employment status, age as predictors of food insecurity at different levels of confidence. Results for female-headed households indicate that income coefficient (income for household and other income) age, marital status and household size are significant predictors of food insecurity.

Ejigayhu and Abdi-Khalil (2012) also found out that educational status at $p<0.01$was significant to food insecurity in their study. Other variables such as age of household head, household size, remittance and gift, household income, bank account ownership were significant at $p<0.05$. Dependency ratio, access to credit, sex of household and urban agriculture were not significant to food insecurity at $p<0.01$.

The models used herein have various limitations: the main one being interpretation of variables as comparisons of magnitudes as noted in (Zahid and Ahmed, 2013) studies. To rectify the issue mean derivatives is required to be computed as deployed by Jean 2015 study. Another disadvantage is noted on Zahid and Ahmed study where logistic regression was deployed. The outcome was limited to categorical variables like level of education while it could not analyze continuous variables like rainfall amount and index. An ambiguity also arose due to the multiple natures of variables studied and their relations during observations as illustrated by (Kristie et al, 2010 and Ejigayhu& Abdi-Khalil 2012). Logistic regression requires that each variable be independent from one another. The logit model is noted to have a more predictive power of the variables analyzed therefore overfitting the model; this is attributed to bias in sampling as attributed to Fumane and Tshediso study in South Africa.

2.4 Theoretical Framework and Model

2.4.0 Expenditure Function Analysis

In their evaluation of food demand in China, Gould and Villarrreal (2006), used a household expenditure based on aggregate analysis to find out how households allocate expenditure from home and away from home by applying Quadratic Almost Ideal Demand System. Their results revealed significant complementary and substitution

purchases as cited in Nyangweso (2010). Their approach was inclusive and thus this study also applied aggregate analysis as most residents in Migori County are poor and can barely afford two meals a day. Thus the aggregated model is more appropriate.

By proposing a new composite function and examining linear approximations using (QUAIDS), Matsuda (2006) did a simulation study. He stated that time series cannot be meaningful when nonlinear equations are used thus applied linear approximations to test various policy analysis as cited by Nyangweso (2010). This study also used linear approximations due to variables such as price that showed less variations as households live in close proximity. It is also useful when cross sectional data is involved as was the case in this study.

Using household consumption function, Anderson et al (2006) modelled determinants of poverty which they fitted in their household survey. He argued that most households would reveal their expenditure rather than income. This approach is a better proxy to measure household income and very amenable when used in estimation rather than probit and logit approaches. This study also used expenditure to model LA/AIDS and as cited by Nyangweso (2010), it is important when modelling food security equation.

Feleke et al (2005) used a recursive model of household food security in the consumer demand framework and emphasized on demand and supply side in Southern Ethiopia as cited by Nyangweso (2010). They noted that supply side had significant determinants and this approach was holistic and avoided narrowness in their findings. This approach was as well used in this study due to its broadness when dealing with problems of food security. He further cites Diewert et al (1988) who estimated normalized quadratic indirect utility and expenditure functions as two demand systems. His results revealed the flexibility of

normalized functions which only meant to support the importance of theory of consumer duality and its ease of manipulation to achieve utility. This study also benefited from duality theory.

While estimating household fuel demand and management in Kenya, Nyang (1999) used the LA/AIDS model to find importance of fuel mixes. His framework acted as a building block as it hypothesizes separability which was the foundation of food demand analysis in this study. He also concludes that the model can benefit from the normal regression analysis as long as price index is known or rather prices of commodities are given. This study thus borrowed this approach in the analysis. Nyangweso (2010) cites Rossi's (1988) introduction of budget share in the AIDS system in case of consumer units. He showed that demographic characteristics and expenditure have a role in the model and can be the reason for homogeneity rejection when not handled properly during aggregation.

2.4.1 Duality and Expenditure Function

Theory of consumer demand in neo-classical economics is founded on a utility function depicting consumer preferences over a bundle of commodities. According to Varian (1992), if axioms of completeness, reflexivity, continuity, transitivity, convexity and non-satiation are satisfied then preferences can be presented by a utility function.

To maximize utility u a consumer is assumed to incur expenditure M in purchasing commodity bundle x at price p giving the following objective function as outlined by (Jehle and Renny, 1998):

$$Max[u(X): M = P^T X] \quad 2.1$$

Where corresponding lagrangian function is:

$$L(X,M,\lambda)=U(X)-\lambda(PX-M) 2.2$$

To yield a global solution of consumer optimal (income or uncompensated constant) commodity demands the utility should be quasi-concave as:

$$X_T^m=f(P,M) 2.3$$

Indirect utility $u(x)$ is less preferred as its first order conditions are not easy to trace. The expenditure function is thus used mostly as it minimizes total expenditure to achieve a specific utility while direct utility maximizes consumer utility given a budget and non-negativity constraint. The latter depends indirectly on money income and prices via maximization process and x as a commodity bundle (Jehle and Renny, 1998).

Expenditure function is thus given as

$$e(P,U) 2.4$$

And by duality theorem contains information on preferences (see Jehle and Renny, 1998). Its minimum expenditure needed by consumer at price p to achieve utility; usually homogenous and concave of degree 1 in each fixed $u$for$p$. Total expenditure and income in static analysis are equal.

The objective function given below in dual formulation that minimizes expenditure to attain utility u

$$\min_x [P¿¿T¿X:(M)=u]¿¿ 2.5$$

Jehle and Renny (1998) state that it is usually not necessary to obtain first order conditions to get consumers optimal Hicksian (compensated) commodity demand depicted below

$$X_i^h = f(P, u) \quad 2.6$$

Or rather, these can be obtained by Shepherd's Lemma directly from the function:

$$X_i^h(P, u) - \frac{\partial e(P, u)}{\partial P_i} \quad 2.7$$

The indirect utility functions

$$V = (P, M) \quad 2.8$$

is the maximal obtainable utility with expenditure M at prices p. Roy's theorem enables us get Marshallian commodity demand directly from indirect utility function

$$X_i^m(P, M) - \frac{\partial V(P, M)/\partial P_i}{\partial V(P, M)/\partial M_,} \quad 2.9$$

Dual formulations are flexible to manipulate because they contain observable and measurable variables empirically (Jehle and Renny, 1998).

It is further alluded that in modeling food demand as a commodity, analysis start from approximating flexible unknown indirect utility functions and invoking Roy's identity or Sheperd's Lemma or just approximating expenditure function (Jehle and Renny, 1998). Examples of flexible functions include logarithmic (translog), transcendental, generalized Leontief, fourier flexible and miniflex. Neither dominates the other as each allows

configuration of price elasticity at some vector. This study will use the AIDS model which will be discussed below from Deaton and Muellbauer (1980a, b).

2.4.2 Aggregation, Separability and Two-Stage Budgeting

Consumer theory discussed above shows how consumers make choices to allocate total fixed expenditure over several order of goods. It can further be extended to provide utility to consumers like allocation of expenditure between leisure and work, labor supply, income allocation between consumption and saving as well as purchase of durable goods (Ondari, 2011). The theory assumes that these cases can be extended as separate problems however in principle each consumer has to simultaneously deal with them (Deaton and Muellbauer, 1980b). Moreover, consideration of consumer choice implies that such allocations closely interact. Deaton and Muellbauer (1980b) argue that it poses problems for economists and consumers trying to describe behavior from the interactions. This is why it is better to aggregate so that categories can be simply dealt with as single units or by separation.

2.4.2.1 Aggregation and the Composite Commodity Theorem

Aggregation allows commodities groupings to be dealt with in a single unit while separability of preferences enable commodities to be grouped into categories such as clothing, detergents, energy, shelter, entertainment and food (Ondari, 2011). Illicks (1936) identified the first conditions for existence of aggregates and was confirmed by Leontief (1936) according to Deaton and Muellbauer (1980b). It is the composite commodity theorem which suggests that if group prices move in parallel then the corresponding groups of commodities are treated as a single unit.

Deaton and Muellbauer (1980b) showed this theorem in a three-good model where two prices always move in proportion. Prices of the goods are $P_{1,}P_2 \wedge P_3$ and assume that $P_2 \wedge P_3$bear fixed ratio θ to some period based prices $P_2^\circ and P_3^\circ$ that is

$$P_2 = \theta P_{2,}^\circ P_3 = \theta P_3^\circ 2.10$$

where θ varies with time but is common to both prices so that ratio $\frac{P_2}{P_3}$ remain constant at

$\frac{P_2}{P_3}$. A possibility is that θ can act as a 'price' for a new combined commodity group of a 'quantity' defined by weighting individual quantities using the base period prices $P_2^\circ and P_3^\circ$. Therefore, composite quantity is defined as $P_2^\circ q_2 \div P_3^\circ q_3$. The cost function $C(u, P_1, P_2, P_3)$ can be written $C¿¿$ which since $P_2^\circ and P_3^\circ$ are fixed and can be treated as a function of $u, P_1 and \theta$ alone and this say $C'(u, P¿¿1, \theta)¿$ is the group cost function, that is

$$C'(u, P¿¿1, \theta) = C(u, P¿¿1, \theta P_{2,}^\circ, \theta P_3^\circ)¿¿ 2.11$$

It is shown that $C'(u, P¿¿1, \theta)¿$ satisfies properties of a proper cost function: increasing in $u, P_1, and \theta$ homogenous of the degree 1 and concave in $P_1 and \theta$ (Deaton and Muellbauer 1980b). If we further differentiate $C'(u, P¿¿1, \theta)¿$ with respect θ we have

$$\frac{\partial C'}{\partial \theta} = \frac{\partial C}{\partial P_2}, \frac{\partial P_2}{\partial \theta} - \frac{\partial C}{\partial P_3}, \frac{\partial P_3}{\partial \theta} = P_2^\circ q_2 \div P_3^\circ q_3 2.12$$

Hence $P_2^\circ q_2 \div P_3^\circ q_3$ is the quantity of the composite commodity corresponding to the price θ.

In estimating household demand for food, it is necessary to consider it as a single price of good with an index derived from individual prices of food. Aggregate food is never sold nor bought as it does not have a price. It is thus appropriate to combine household foods to a single commodity called aggregate foods which then defines weighting in quantities by their prices (Ondari, 2011).

Aggregation in this study is thus done using composite commodity theorem in which quantities of individual foods are weighted by their respective prices. Household food expenditure is thus quantity of the composite aggregate.

2.4.2.2Separability: Definitions of Strong and Weak Separability

Nyang (1999), Deaton and Muellbauer (1980b) state that a necessary and sufficient condition for existence of price and quantity aggregators is an existence of a weak separability of preferences. When a set of commodities $q_i(q_1, q_2 \ldots q_n)$ is partitioned into groups with preferences described independently of quantities in other groups then separability exists. For instance, if food is a group, a consumer can rank it differently into a bundle separate from housing, entertainment, fuel and any other outside the group. It means we can have a sub-utility for each group and in the end the sub-utilities combine to give total utility. For example, if six foods exist where

$q_1 \wedge q_2 are foods, q_3 \wedge q_4 are housing and fuel and q_5 \wedge q_6 are$ TV and watching sports then if separate groups of shelter, food, entertainment are formed the utility function is written as

$u = v(q_1, q_2, q_3, q_4, q_5, q_6) = F$ ¿2.15

Where $F'(u) > 0$ is an increasing function of u hence $v_F, v_S \wedge v_E$ are sub utility functions associated with food, shelter and entertainment respectively.

Deaton and Muellbauer (1980b) acknowledge that separable preferences are grouped as weakly separable and strongly separable. One of the most popular and restrictive assumption of utility theory about preferences of consumer is that utility is an additive function of utilities received from consumption of different goods (Silberberg and Suen, 2001). Direct utility function in this case is still made up of sub-utility functions for each group and combined additively. Therefore, according to Silberberg and Suen (2001) utility can be

$u(q_1, q_2, \ldots, q_n) = F$ ¿2.16

so that if multiplicability functions of a utility is separable, a monotonic transformation (logarithm) will still give an additively separable form without changing demand functions. For cases where there is one good in each group then preferences are occasionally said to be additive or wants are independent as per Deaton and Muellbauer (1980b).Therefore marginal utility derived from consuming a good q_i is a function of q_i only, $u_i^{'}(q_i)$. The marginal utility will not be affected by changes in consumption of other good q_j (Silberberg and Suen, 2001).

According to Deaton and Muellbauer (1980b) preferences are weakly separable if the whole commodity vector q can be partitioned to sub-groups where consumer preferences define ordering of goods independent of levels of consumption outside the group. If the vector is partitioned into N groups then the function is

$u = f(q_1, q_2, \ldots . q_n, q_{n-1} \ldots, q_N)$2.17a

It is weakly separable if it can be written as:

$V = F(u) = F$ ¿2.17b

Conditional demand functions are independent of the other groups.

In holding separability of preferences, sub-groups of partitioned commodities can be described independently over the consumption of other commodities. Separability is assumed because as a unit, the consumers also consume commodity groupings such as clothing, detergents, energy and transportation (Ondari, 2011).

2.4.2.3Separability and Two-Stage Budgeting

In two stage budgeting a consumer allocates expenditures in two stages according to Deaton and Muellbauer (1980b). The first stage household income determines expenditure allocation to broad group of commodities while at the second stage group expenditures determine allocation to individual commodities. Budgeting in this case involves aggregation and separable decision making for each sub group. Nyang (1999) alludes that the two stages are related but not equivalent to each other. However, in the first stage weak separability is necessary and sufficient for the second stage. For instance, in this study, quantities of food purchased will be expressed as a function of food expenditure and food prices within a food group alone hence smaller number of variables can explain consumer behavior.

2.4.3 The Almost Ideal Demand System (AIDS)

To evaluate determinants of food insecurity in households, the framework of analysis used is almost ideal demand system in its linear approximation form (Deaton and Muellbauer, 1980a, b). Its properties include:

a. A functional form consistent with household data

b. Simplicity of estimation in the linear approximate form

c. Satisfying the axioms of choice exactly

d. Ability to aggregate consumers perfectly without need to invoke Engel curves

2.4.3.1 Specification of the Almost Ideal Demand System

The model belongs to price dependant generalized logarithm (PIGLOG) consumer preferences which permits aggregation and is the most flexible complete functional form of demand-systems estimation (Ondari, 2011).

$$Lne(u,P)=(1-u)\ln[a(P)]-uLn[b(P)]2.18$$

where $e(u,P)$ is expenditure function, u is utility, $P$is vector of commodity prices. Functions $a(P)$ and $b(P)$ were chosen by Deaton and Muellbauer in a way that the demand functions have sufficient number of parameters to obtain flexible form of $a(P)$. As for $b(P)$, it is easier to incorporate Engel curves proposed by Working (1943) and Leser (1963) as informed by Deaton and Muellbauer (1980a).

The motive herein is to obtain demand functions with desirable properties. Exceptions given by Deaton and Muellbauer (1980a) is that u lies between 0 and 1: subsistence and bliss respectively. Moreover, functions of $a(P)$ and $b(P)$ are interpreted as costs of subsistence and bliss in that order. To ensure consistency of interpretations for the desired demand system the expenditure functions of $a(P)$ and $b(P)$ are specified respectively as

$$Lna(P)=\alpha_{\circ}-\sum_{k}\alpha_{k}\ln P_{k}+\frac{1}{2}\sum_{k}\sum_{j}\gamma_{kj}\ln P_{k}2.19$$

and

$$Lnb(P)=Lna(P)+\beta\prod_{k}P_{k}^{\beta_{k}}2.20$$

together it gives

$$\ln(P) = \alpha_\circ - \sum_k \alpha_k \ln P_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \ln P_k \ln P_j 2.21$$

Equation 2.21 is considered homogenous of degree 1 in prices as long as its parameters satisfy these restrictions: $\sum a_k = 1 \wedge \sum \gamma_{kj} = \sum \gamma_{jk} = \sum \beta_k$

Equations that define cost function 2.19,2.20,2.20 allow us obtain Hicksian demand function by invoking Shepherd's lemma and finding the differentiation with respect to $\ln P_k$. Expression given below thus gives expenditure form (Deaton and Muellbauer 1980a)

$$\frac{\partial Lne(u,p)}{\partial \ln P_k} = S_k = a_k + \sum_j \gamma_{kj} \ln P_k + \beta_k U \beta_\circ \prod_k P_k^{\beta_k} 2.22$$

where $S_k = \frac{P_k a_k}{M}$ and $\gamma_{kj} = \frac{1}{2}(\gamma_{kj} + \gamma_{jk})$

Specifically, demand function exists with variables observed by noting total expenditure M (also income) equals to the value $e(u,P)$ at equilibrium. Equation 2.14 given $a(P)$ and $b(P)$ given equation 2.15 and 2.16 when inverted solves u conditioned with P_k, M and any other linked parameters.

Substituting this equation to (2.18) results to budget share form of Marshallian demand function for operational version of AIDS as specified by Deaton and Muellbauer, (1980a).

$$S_k = a_k + \sum \gamma_{kj} \ln P_j + \beta_k \ln(\frac{M}{P}¿)¿ 2.23$$

Where P_j is jth price of goods, M is total expenditure and P is price index defined as

$$\ln(P) = \alpha_\circ - \sum_{\cdot} \alpha_k \ln P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln P_k \ln P_j \quad 2.24$$

This is the flexible form of AI model that makes it easy to be used in modeling and estimation of nonlinear equations. A much simpler approach is discussed below.

2.4.3.2 The Linear Approximate Almost Ideal Demand System

If the price index P is known, where M/P is considered exogenous then the model is linear and can be estimated using OLS according to Nyang (1999). A known price is usually employed in empirical work according to Deaton and Muellbauer (1980b). As per their advice, expression 2.20 above can be replaced by LnP to give Stone's Geometric Price Index as previously shown in 2.12 as

$$LNP = \sum_{i=1}^{n} S_i \, LnP \quad 2.25$$

which sums weighted logarithmic prices by expenditure shares. The index approximates translog price index of Almost Ideal system when inserted in the share equation giving it a feature of linearity in econometric viewpoint. It is thus referred to as Linear Approximate Almost Ideal Demand System (LA/AIDS) by Blanciforti and Green (1983). It is usually directly calculated so as equation (2.23) is easy to estimate a situation that differs with estimation of translog models.

When restricted it satisfies the following

a. Adding up property to total expenditure

$$\sum_i S_i = 1$$

b. Homogenous of degree zero in prices and expenditure

$$\sum_i \alpha_i = 1 \sum_i \beta_i = 0 \sum \gamma_{kj} = 0$$

c. And satisfy Slutsky symmetry

$$\sum \gamma_{kj} = \sum \gamma_{jk}$$

2.4.3.3 Elasticities of the AID System

Price elasticities are thus partial elasticities and are Marshallian due to monetary income involvement. Demonstrations by Green and Alston (1990) show the difference of elasticity formulae between LA/AIDS and a true AI demand system.

The uncompensated price elasticity is given as

$$\varepsilon_{ij} = -\delta_{ij} - \frac{\gamma_{ij}}{S_i} - \frac{\beta_i}{S_i} . \frac{\partial LnP}{\partial LnP_j} 2.26$$

Where δ_{ij} is the Kronecker delta: $\delta_{ij} = 1 \, for \, i = j \wedge \delta = 0 \, for \, i \neq j$

Therefore, according to Green and Alston (1990) price elasticities for AI demand is given by

$$\varepsilon_{ij} = -\delta_{ij} - \frac{\gamma_{ij}}{S_i} - \frac{\beta_i}{S_i} . ¿ 2.27$$

While LA/AIDS is given by

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{S_i} - \frac{\gamma_{ij}}{S_i} . [S_i + \sum_k LnP_k (\varepsilon_{kj} - \delta_{kj})] 2.28$$

Special approximations to LA/AIDS price elasticities can also be used as shown by Chalfant (1987) when

$\frac{\partial LnP_k}{\partial LnP_j} = S_j$ and uncompensated price elasticities are given by

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{S_i} - \beta_{ij}\frac{S_j}{S_i} 2.29$$

When homothetic preferences exist that is $\beta_i = 0$

In accordance to Green and Alstons's (1990) specification, LA/AIDS simplifies elasticity formula to

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{S_i} 2.30$$

Similarly, according to Green and Alston (1990), expenditure (income) demand elasticity for good i is

$$\varepsilon_{\Im} = 1 + \frac{\beta_i}{S_i} 2.31$$

For specification of either price index, parameter β determine goods whether necessities or luxuries. If $\beta_i > 0, S_i$ increases with income therefore good i is a luxury same for necessities where $\beta_i < 0$.

Compensated approximated price elasticities for LA/AIDS are

$$\varepsilon_{ij} = -\varepsilon_{ij} - \frac{\gamma_{ij}}{S_i} - S_j 2.32$$

Slutsky equation below gives the relationship between price, substitution elasticities and expenditure

$$\varepsilon_{ij} = S_j \delta_{ij} - S_j \varepsilon_{\Im} 2.33$$

Where δ_{ij} give elasticities of substitution as

$$\delta_{ij}=1+\frac{\gamma_{ij}}{S_i}-\frac{1}{S_i} \text{ for } i=j \quad 2.34$$

And

$$\delta_{ij}=1+\frac{\gamma_{ij}}{S_i S_j} \text{ for } i\neq j \quad 2.35$$

2.4.3.4 Extension to the AI System

Demand for any good is not only influenced by prices and income but also other factors such as age, gender, marital status, house hold head amongst others. These variables can be incorporated into AI model by incorporating ad-hoc methods that minimize and scale down variables in tandem with household expenditure theory.

A generalized equation of (2.23) as suggested by Deaton and Muellbauer (1980a,b) is

$$S_{hi}=\alpha_i-\beta_i \ln\frac{M_h}{K_h P}+\sum_j \gamma_{ij}\ln P_j \quad 2.36$$

Where K_h measures household size which entails demographic variables as a scaling parameter dependent on household characteristics. Scaling allows parameter to be used to reflect number of 'equivalent persons' in households measured on ($a$scales) with respect to commodity i (commodity specific scales). This allows us to both view demand behavior and preferences in relation to prices $(\frac{p_i}{k_i})$ and quantities $(\frac{q_i}{k_i})$ (Ondari, 2011).

Ondari (2011) argued that household utility does not only depend on number of meat demanded but on kilograms demanded per adult equivalent and this applies for price as

well. Therefore, market prices are scaled down to household characteristics such that $k(a)$. In case a house only had a single adult, then $k(a)$ would be an accounting function while K_h would be the number of people contained in the household (Deaton and Muellbauer 1980a). Anyway, this can be absurd where two adults and a child with expenditure three times of a single adult then the latter would be better off. It can then be expressed as $k(a)$ ejecting number of persons but as number of adult equivalent where children count as fractions:

$$S_i = \alpha_i + \beta_i \frac{M}{P^s} - \sum_j \gamma_{ij} P^s \qquad 2.37$$

Where $P_j^s = P_j k_j(a)$

$$LnP^s = LnP + \Sigma S_j \ln K_j(a)$$

Solving for P^s gives the general scaled linear approximate AI system in the share equation.

In order to exhaust total income with expenditure share the equations becomes

$$S_i = \alpha_i + \beta_i \ln \frac{M}{P} + \sum_j \gamma_{ij} \ln P_j + \sum_j (¿\gamma_{ij} - \beta_i) LnK(a) ¿$$

2.38

This is the Engels method that has been used widely as illustrated by Muellbauer (1977) when scaling British family expenditure data under the hypothesis

$$k = 1 - \delta_1 \alpha_1 - \delta_2 \alpha_2$$

2.39

Where $\delta_1 \wedge \delta_2$ are parameters, α_1 is number of children between 0 and 5 years and α_2 number of children between 5 and 16 years.

The given scaling function employed by Savadogo and Brandt (1988), simplifies the estimation procedure and also convenient for dummy variables taking values of zero such that

$$k(a) = \prod_r a_r^{\lambda_r} \prod_m e^{\lambda_m a_m} \qquad 2.40$$

The resulting stochastic scaled LA/AIDS observed over households $h = 1, \ldots, H$ is given by

$$S_{hi} = \alpha_i - \beta_i \ln M_h - \sum \gamma_{ij} LnP_j - \sum \lambda_m \ln \alpha_{rh} - \sum_m \lambda_{rm} \alpha_m - u_{th} \qquad 2.41$$

Where u_{th} is random error giving a summary of all effects of S_i not explained by income, prices and demographic attributes.

2.5 Conceptual Framework

Determinants used to examine food insecurity are conceptualized to include demographics: location, gender, marital status, age and household size. Demand side: price, labor, unemployment, education level, access to credit, capital sourcing, off-farm income, other crops, sugarcane and tobacco yield and land size. Supply side: extension services, social group, fertilizer purchased, dependency ratio and food expense. Food demand was estimated using aggregated foods which include: legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats.

Dependent Variables

Food Security

Food Demand

Production:
Sugarcane
Tobacco
Foods:
Aggregated foods
Price

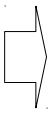

Figure 2.1: Conceptual Framework

Source: (Field data, 2021)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area

Migori County is located in Western Kenya and borders Kisii County to the North East, Homa Bay County to the North, Lake Victoria to the West, Tanzania to the South West and South and Narok County to the East and South East as detailed in chapter 1.

3.2 Research Design

The research employed a cross-sectional survey design. This was chosen over other designs because it had the advantage of not requiring assumptions in analysis, as the relationship between variables were stable overtime. It also enables the researcher to use a structured questionnaire as the research instrument that in essence produces statistical information for analysis (Olsen and Marie 2004).

3.3 Target Population

The target population consisted of 238320 people living in sugarcane and tobacco growing areas in Uririand Kuria sub counties.

3.4 Sample Size Determination

The total estimated census population of Uriri is 141448, and 29711 households reside in the five divisions and Kuria East had a population of 96,872 and 17,267 households

(Kenya Bureau of Statistics 2019). A sample size is thus considered using Yamane's formula (1967).

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the minimum number of sample size in the range of acceptable error margin

N= total number of households selected in the area of study

e= acceptable error margin (0.05)

Hence

$$n = \frac{46978}{1 + 46978(0.05)^2} = 396$$

3.4.1 Sampling Procedure

Multistage sampling technique was applied. The first stage involved the selection of two sub counties in the region purposively. The second stage involved the purposive selection of one constituency each in the two sub counties where sugarcane and tobacco production were dominant. The third stage involved the random selection of county wards in the two constituencies wherein 145 households were selected for Kuria East and 251 for Kanyamkago using household ratios as per (Kenya Housing Population Census, 2019). Kuria East had six wards and the chosen sample size was equally distributed at 24 households per ward. Kanyamkago had five wards. The sample size was distributed at 50 per ward which allowed for random selection of households within the wards. A household was then randomly selected from each ward.

3.5 Data Types and Sources

Cross sectional data types were used to collect information. These included both primary and secondary data sources.

3.5.1 Primary Data: types and sources

Primary data was collected through self-administered structured questionnaires in the field survey.

3.5.2 Secondary Data: types and sources

These were obtained from theses and dissertations, journals, books, economic surveys and statistical reports from the FAO, the district development plan and the World Wide Web (www).

3.6 Data Collection Methods and Analysis

A structured questionnaire was used to elicit information from respondents identified. To complement information that was gathered by use of the questionnaires, observation method was used in the farms to extract relevant information. Data analysis was done with Microsoft excel and STATA. Out of the 396 sample size only 378 responded and thus formed the sample size. To evaluate the first objective, Household Food Insecurity Access Scale and ordered logit model were used. To estimate the second objective, linear approximated almost ideal demand system was used.

3.7 Theoretical Framework

The study is based on consumer theory which shows how households make decisions and choices subject to their individual preferences and a budget constraint. Therefore, theory of consumer demand in neo-classical economics is founded on a utility function depicting consumer preferences over a bundle of commodities. According to Varian (1992), if axioms of completeness, reflexivity, continuity, transitivity, convexity and non-satiation are satisfied then preferences can be presented by a utility function. To maximize utility u a consumer is assumed to incur expenditure M in purchasing commodity bundle x at price p giving the following objective function as outlined by (Jehle and Renny, 1998):

$$Max[u(X): M = P^T X] \quad 3.1$$

Where corresponding lagrangian function is:

$$L(X, M, \lambda) = U(X) - \lambda(PX - M) \quad 3.2$$

To yield a solution of consumer optimal (income or uncompensated constant) commodity demands the utility should be quasi-concave as:

$$X_T^m = f(P, M) \quad 3.3$$

Expenditure function is thus given as

$$e(P, U) \quad 3.4$$

The objective function given below in dual formulation that minimizes expenditure to attain utility *u*

$$\min_x [P ¿¿ T ¿ X : (M) = u] ¿¿ \quad 3.5$$

Jehle and Renny (1998) state that it is usually not necessary to obtain first order conditions to get consumers optimal Hicksian (compensated) commodity demand as depicted below

$$X_i^h = f(P, u) \quad 3.6$$

Or rather, these can be obtained by Shepherd's Lemma directly from the function:

$$X_i^h(P, u) - \frac{\partial e(P, u)}{\partial P_i} \quad 3.7$$

The indirect utility functions

$$V = (P, M) \quad 3.8$$

is the maximal obtainable utility with expenditure M at prices p. Roy's theorem enables us get Marshallian commodity demand directly from indirect utility function

$$X_i^m(P,M) - \frac{\partial V(P,M)/\partial P_i}{\partial V(P,M)/\partial M_,} 3.9$$

3.8 Theoretical Model

3.8.1 Measurement of Food Security: Household Food Insecurity Access Scale

3.8.1.1 HFIAS Calculations

The indicator represents universal domains and subdomains by asking a set of questions more on lack of access to food. It has nine questions and represents severe occurrence of food shortage in the past four weeks. The frequencies used are rarely = 1 (once or twice), sometimes = 2 (3-10 times) and often = 3 (>10 times). Values are summed for the nine questions. It is suitable for estimating prevalence of food insecurity.

3.8.1.2 Validity

Commonalities examining expression of food insecurity and experiences across cultures revealed four domains and subdomains that are same across countries and thus recommended their use as the basis of future food insecurity scale measure.

The model gives food insecurity information in regards to access at the household level. Four indicators are used: household food insecurity access related conditions, household food insecurity access related domains, household food insecurity access scale score and household food insecurity access prevalence.

This study employed household food insecurity access scale score and prevalence.

3.8.2 Household Food Insecurity Access Scale Score

According to (Leroy, Ruel, Frongilio, Harris and Ballard 2015), HFIAS continuously measures food insecurity (access) in the household in the past 30 days. The score is summed and maximum is 27 while minimum is 0. At 27 it reveals a high food insecurity access and vice versa.

$$Sum frequency of occurence question response code ¿$$

And this is the sum of occurrence during the past four weeks for the 9 food insecurity related conditions and HFIAS Score (0-27)

Average Household Food Insecurity Access Scale Score indicator is calculated as below

$$\frac{Sum of HFIAS Scores in th e sample}{Number of HFIAS Score s (i.e. h ouse h olds) \int h e sample}$$

This indicator formed the basis of the study.

3.8.3 Household Food Insecurity Access Prevalence

The last indicator is a categorical variable showing food insecurity status. HFIAP is used to report food insecurity access and targeted reporting. Four level categories are used; food secure, mild food insecure access, moderately food insecure access, severely food insecure access.

A food secure household experiences none or just worry though seldom. A mildly food insecure household worries about not having enough food often or sometimes, unable to eat preferred foods, or a certain food repeatedly or undesired food but this is rarely. A moderately insecure household cuts back on quality most often by eating undesirable foods, cutting back quantity by reducing size of meals or eating a monotonous diet sometimes or rarely. A severe household experiences most of the severe conditions,

cutting meal size, number of meals, going hungry the whole night or day as frequently as always.

An HFIA category variable is then calculated by assigning food insecurity (access) code in which it falls and creating the categories. Coding responses of “no” should be coded as follows (Q1=0 then Q1a=0, if Q1a=0 then Q2=0 then Q2a=0…..) and given as

$$HFIAcategory = 1\ if\ [(Q1a = 0\ or\ Q1a = 1)\ and\ Q2 = 0\ and\ Q3 = 0\ and\ Q4 = 0\ and\ Q5 = 0\ and\ Q6 = 0\ and\ Q7 =$$

$$HFIAcategory = 2\ if\ [(Q1a = 2\ or\ Q1a = 3\ or\ Q2a = 1\ or\ Q2a = 2\ or\ Q2a = 3\ or\ Q3a = 1\ or\ Q4a = 1)\ and\ Q5 =$$

$$HFIAcategory = 3\ if\ [(Q3a = 2\ or\ Q3a = 3\ or\ Q4a = 2\ or\ Q4a = 3\ or\ Q5a = 1\ or\ Q5a = 2\ or\ Q6a = 1\ or\ Q6a =$$

$$HFIAcategory = 4\ if\ [Q5a = 3\ or\ Q6a = 3\ or\ Q7a = 1\ or\ Q7a = 2\ or\ Q7a = 3\ or\ Q8a = 2\ or\ Q8a = 3\ or\ Q9a =$$

These calculations of HFIAS for each household where 1 = Food Secure, 2 = Mildly Food Insure Access, 3 = Moderately Food Insecure Access, 4 = Severely Food Insecure Access (Leroy et al, 2015).

While prevalence of different household food insecurity (access) level is calculated as below

$$\frac{Number of\ house holds\ with\ HFIA\ category = 4}{Total\ number\ of\ households\ with\ a\ HFIA\ category} \times 100$$

And this is for each food insecurity (access) category under the four categories, food secure, mild, moderate and severe

Ordered logit model was used due to its continuous latent variable to evaluate determinants of food security such as age, location, education amongst others and allowed for the placement into the given four categories (food secure, mildly food

insecure, moderately food insecure and severely food insecure) as illustrated by (Mohammadi, Torabi and Dogani, 2015).

Therefore:

$$y_i^{\iota} = \beta x_i + \varepsilon_i \ldots\ldots\ldots -\infty < y_i^{\iota} < -\infty 3.10$$

Where

y_i^{ι}: Food Security

B_i: Vector of parameters estimated

x_i: Observed non-random independent variables

ε_i: Error term

y_i^{ι} a discrete variable that shows categories of food security as depicted below:

$$y_i^{\iota} = 1 if -\infty < y_i^{\iota} < \mu_1 \ldots\ldots i = 1 \ldots\ldots n: 3.11$$

$$y_i^{\iota} = 2 if\ \mu_1 < y_i^{\iota} < \mu_2 \ldots\ldots i = 1 \ldots\ldots n 3.12$$

$$y_i^{\iota} = 3 if\ \mu_2 < y_i^{\iota} < \mu_3 \ldots\ldots i = 1 \ldots\ldots n 3.13$$

$$y_i^{\iota} = 4 if\ \mu_3 < y_i^{\iota} < \mu_4 \ldots\ldots i = 1 \ldots\ldots n 3.14$$

Where n is the sample size and $\mu_{..}$ observed values that should be estimated.

3.8.4 Econometric Specification of the Model

Quantitative analysis of aggregated foods was done using LA/AIDS framework.

3.8.4.1 LA/AIDS Empirical Specification

The model belongs to price generalized logarithm (PIGLOG) consumer preferences given as

$$Lne(u,P)=(1-u)\ln\left[a(P)\right]-uLn[b(P)]3.15$$

where $e(u,P)$ is expenditure function from 3.14, u is utility, $P$is vector of commodity prices. Functions $a(P)$ and $b(P)$ were chosen in a way that the demand functions have sufficient number of parameters to obtain flexible form of $a(P)$. As for $b(P)$, it is easier to incorporate Engel curves.

To ensure consistency of interpretations for the desired demand system the expenditure functions of $a(P)$ and $b(P)$ are specified respectively as

$$Lna(P)=\alpha_{\circ}-\sum_{k}\alpha_{k}\ln P_{k}+\frac{1}{2}\sum_{k}\sum_{j}\gamma_{kj}\ln P_{k}3.16$$

and

$$Lnb(P)=Lna(P)+\beta\prod_{k}P_{k}^{\beta_{k}}3.17$$

together it gives

$$\ln(P)=\alpha_{\circ}-\sum_{k}\alpha_{k}\ln P_{k}+\frac{1}{2}\sum_{k}\sum_{j}\gamma_{kj}\ln P_{k}\ln P_{j}3.18$$

Equation 3.18 is considered homogenous of degree 1 in prices as long as its parameters satisfy these restrictions: $\sum a_{k}=1\wedge\sum\gamma_{kj}=\sum\gamma_{jk}=\sum\beta_{k}$

Equations that define cost function 3.16, 3.17, 3.18 allow us obtain Hicksian demand function by invoking Shepherd's lemma and finding the differentiation with respect to

$\ln P_k$. Expression given below thus gives expenditure form (Deaton and Muellbauer 1980a).

$$\frac{\partial Lne(u,p)}{\partial \ln P_k} = S_k = a_k + \sum_j \gamma_{kj} \ln P_k + \beta_k U \beta_\circ \prod_k P_k^{\beta_k} 3.19$$

where $S_k = \frac{P_k a_k}{M}$ and $\gamma_{kj} = \frac{1}{2}(\gamma_{kj} + \gamma_{jk})$

Substituting this equation to (3.15) results to budget share form of Marshallian demand function for operational version of AIDS as specified by Deaton and Muellbauer, (1980a).

$$S_k = a_k + \sum \gamma_{kj} Ln P_j + \beta_k \ln(\frac{M}{P}¿)¿ 3.20$$

Where P_j is jth price of goods, M is total expenditure and P is price index defined as

$$\ln(P) = \alpha_\circ - \sum_{.} \alpha_k \ln P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln P_k \ln P_j 3.21$$

This is the flexible form of AI model that makes it easy to be used in modeling and estimation of nonlinear equations. If the price index P is known, whereM/P is considered exogenous then the model is linear and can be estimated using OLS according to Nyang (1999). Expression 3.17 above can be replaced by *LnP* to give Stone's Geometric Price Index

$$LNP = \sum_{i=1}^{n} S_i LnP 3.22$$

which sums weighted logarithmic prices by expenditure shares. The index approximates translog price index of Almost Ideal system when inserted in the share equation giving it

a feature of linearity in econometric viewpoint. It is thus referred to as Linear Approximate Almost Ideal Demand System (LA/AIDS) by Blanciforti and Green (1983)

When restricted it satisfies the following

a. Adding up property to total expenditure

$$\sum_i S_i = 1$$

b. Homogenous of degree zero in prices and expenditure

$$\sum_i \alpha_i = 1 \sum_i \beta_i = 0 \sum \gamma_{kj} = 0$$

c. And satisfy Slutsky symmetry

$$\sum \gamma_{kj} = \sum \gamma_{jk}$$

In accordance to Green and Alstons's (1990) specification, LA/AIDS simplifies elasticity formula to

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{S_i} 3.23$$

Where δ_{ij} is the Kronecker delta: $\delta_{ij} = 1 \, for \, i = j \wedge \delta = 0 \, for \, i \neq j$

Similarly, according to Green and Alston (1990), expenditure (income) demand elasticity for good *i* is

$$\varepsilon_{\Im} = 1 + \frac{\beta_i}{S_i} 3.24$$

For specification of either price index, parameter β determine goods whether necessities or luxuries. If $\beta_i > 0, S_i$ increases with income therefore good i is a luxury same for necessities where $\beta_i < 0$.

Compensated approximated price elasticities for LA/AIDS are

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{S_i} + S_j \quad 3.25$$

Slutsky equation below gives the relationship between price, substitution elasticities and expenditure

$$\varepsilon_{ij} = S_j \delta_{ij} - S_j \varepsilon_{\mathfrak{Z}} \quad 3.26$$

Where δ_{ij} give elasticities of substitution as

$$\delta_{ij} = 1 + \frac{\gamma_{ij}}{S_i} - \frac{1}{S_i} \text{ for } i = j \quad 3.27$$

And

$$\delta_{ij} = 1 + \frac{\gamma_{ij}}{S_i S_j} \text{ for } i \neq j \quad 3.28$$

The fitted framework included economic factors like household expenditure, prices and crop production that reveal household income and socio-economic variables like age, household size, land size, extension, educational level amongst others. It is shown in appendix (2). It was also possible to deflate expenditures by dividing it by the number of households. Following Nyang (1999) and Pomboza and Mbaga (2007) specification for each food group was given as

$$S_{ih} = \alpha_i + \beta_i \ln X_h + \sum_j \gamma_{ij} \ln P_j + \lambda_{i1} LnCrop + \lambda_{i2} LnLocation + \lambda_{i3} LnAgegroup + \lambda_{i4} Lneducation + \lambda_{i5} Lnjob$$

3.29

Where

$S_{ih} - expenditure\ share\ of\ food\ group\ i\ for\ household\ h$

$X - total\ expenditure \in the\ food\ group$(divided by Hsz)

$P_j - price\ of\ food\ group\ j$

$\beta_i - coefficient\ of\ food\ group\ j$

This was estimated for all food groups using OLS after which parameter estimates were used to calculate expenditure elasticities (2.31).

3.8.2 Operational Variables

Location: This was deemed indeterminate. This was because household food insecurity was at household level and one moving from one location to another had mixed components. One such component was to have a better life that is with new assets of production such as purchased land or business to run. The second component was that one had no production assets and was either retreating back to ancestral home resulting to dependency ratio thus strain on food security. Roads were equally interconnected within the given locations with at least one major murram road passing through the villages allowing ease of access.

Food expense: The more a household spends on food, the better the household in regards to food security. More expenditure implies more food items are purchased to curb against shocks of food security. Households who spend less on food are either expected to be

heavy producers such that they get the food items from their own production. A case where that is contrary, such a household was food insecure. Food prices were slightly lower in Kuria compared to Uriri. A possible reason could be due to a high infiltration of illegal goods majorly foods from the neighboring country (Tanzania).

Age-group: Age was a proxy of experience in handling food insecurity situations and was a continuous variable. Younger households were expected to have poor experiences compared to older households. Older households were expected to be good at curbing food insecurity shocks due to prolonged exposure to such situations which result to better experience.

Gender: Female headed households were expected to be food insecure compared to their male counterparts. The correlation expected with household food insecurity is positive.

Education Level: This provides level of awareness and ability to diversify income and invest in such ways that households can purchase foods that they need as well as live safely. For farmers it was expected that they are better at absorbing and handling new technologies that come in hand with farming. Well educated households are expected to be food secure compared to those that are less or not educated. It was expected to have a positive influence on household food insecurity.

Fertilizer cost: This was money spend to buy fertilizers. The more money used the more strain on food security and better yields for the households. The less fertilizer cost incurred the more disposable income a household has to spend on food commodities yet less output from yields. It was also noted that households who spent high on fertilizers

were members of a social group or had access to credit facilities to facilitate such bulk purchases.

Labor type: This was either family labour or hired labour. Family labour was expected to minimize on expenditure and thus allow such households more disposable income to dispense towards purchase of food. Hired labour was expected to have a strain on food security as payments done to such undertakers were either borrowed or savings from households thus causing strain on stock of consumption for such households.

Capital sourcing: This was either borrowed or own capital. Borrowed capital was expected to weigh down on food security due to levied interest paid on monthly basis for those granted such facilities. Own capital was expected to be one off such that its impact on food security was anticipated to be minimal as such households have no interest levies to pay thus may have enough disposable income to spend on food lowering food security.

Contact to extension services: This was farmer's contacts with the extension agents in the past one year prior to the survey. It was expected that farmers who accessed the officers would be food secure due to better farming practices.

Membership to a social group: This is a case where a farmer has a membership in the local farmers' organization. Farmer groups are enterprises voluntarily owned and controlled by farmers themselves and offers alternative learning ground and advisory services. Farmers who are members of farmer groups are more likely to access market information, planting materials and other farm inputs. Therefore, it was expected that farmer's membership to a farmer group would positively influence food security.

Employment status: This was classified as households whose heads were in some form of employment and either earns a salary or wage. It was expected that with employment, households should be food secure due to availability of income that is used to purchase food. The priori was expected to be positive with household food security and vice versa for unemployment.

Access to credit: Ability to obtain financial aid or input from financial institutions. This has a positive influence on food security as it avails more funds or releases strain on funds that can either be used to produce more output. The aid can be free of interest or interest can be charged. Depending on either, it is expected that households who access it be more food secure.

Fertilizer bags purchased: This has a positive impact on food security. More bags of fertilizer would mean more yield output. However, for middle income households it means less funds will be available for food consumption thus it leads to food insecurity.

Cash crop grown: This was expected to have a negative influence on food security inasmuch as income is generated out of such production. The factories for sugarcane and tobacco are operating at their minimum. This implies less payment to producers and thus impacts on food security as such lands would have otherwise been used to grow other food crops.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.0 Socio-economic Characteristics of the Household Surveyed in Sugarcane and Tobacco Growing Zones in Migori County.

4.1.0 Household Food Insecurity Access Scale Score

This was computed and depicted as below

Table 4.1: Summary of HFIA

Variable	Obs	Mean	Std. Dev	Min	Max
HFIAS	378	7.05291	5.450754	0	26

*HFIAS: Household Food Insecurity Access Score. Source: (Field data, 2021)

HFIAS is the dependent variable and maximum cannot exceed 26 while the average mean of the sum of the scores is given as seven. The lower the score, the less food insecure a household is. The score ranges between 1 and 26.

Table 4.2: The Prevalence of Food Insecurity

Hfia_cat	Frequency	Percentage	Cumulative percent
Food Secure	70	18.52	18.52
Mildly food insecure	35	9.26	27.78
Moderately Food Insecur	126	33.33	61.11
Severely food Insecure	147	38.89	100
Total	378	100	

Source:(Field data, 2021)

The table shows only 18.52% of the surveyed households were food secure and 38.89% are severely food insecure. Mildly food insecure households and moderately food insecure households were 9.26% and 33.33% respectively. The findings are close to CARD (2020) who found out that 34% of households in Migori were chronically food insecure.

Table 4.3: Food Insecurity Prevalence per Sub-County

Sub_county	1	2	3	4	Total
Kuria					
Kuria East	18.28	12.37	32.26	37.10	100
Uriri					
Kanyamkago	18.75	6.25	34.38	40.63	100

Pearson chi2 (3) =4.2569,Pr = 0.235 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

The table reveals Uriri had more secure food households (18.75%) against Kuria (18.28%) and at the same time had high severely food insecure households (40.63%) against Kuria (37.10%). Kuria had (12.37%) mildly secure households while Uriri had (6.25%). Uriri moderately secure household were (34.38%) while Kuria (32.26%). Pr=0.235 shows no systematic relationship of food insecurity between the two sub counties and the selected locations.

According to Nyamohanga (2015), households in Kuria had improved on mitigations to curb food insecurity and that included ways such as selling assets, buying food from other farmers on credit, offering labor services and also selling livestock to buy food. A

few households in Uriri also offered services such as labor and bought food on credit albeit majority relied on proceeds from sugarcane.

Table 4.4: Food Insecurity Prevalence and Gender

Gender	1	2	3	4	Total
Female	15.22	9.24	34.24	41.30	100
Male	21.65	9.28	32.47	36.60	100

Pearson chi2 (3) = 2.7360, Pr = 0.434 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

On the surveyed households, 21.65% of the males were food secure as well as 15.22% of the females. Males 9.28% and females 9.24% were mildly food insecure; both males and females were moderately food insecure at 32.47% and 34.24% in that order. Females were severely food insecure at 41.30% while males were at 36.60%.

Gender roles influence food security as both males and females play different parts and at times complementary roles that include having access and purchase of food items. According to the findings, females were worse off in regards to food security status due to restricted land rights, outdated cultural traditions and inadequate education. This was similar to findings of KNBS and AWSC (2013) in Migori County.

This result is consistent with Jean (2015) who also noted households headed by females were food insecure. The mean and median of predicted probability of households becoming food insecure in gender perspective was 0.21 and 0.15 for males and 0.28 and 0.24 for females according to him. He concluded by stating that determinants of food insecurity differed among respondents headed by males and females.

Table 4.5: Food Insecurity Prevalence and age

Age	1	2	3	4	Total
19-24	29.73	10.81	17.12	42.34	100
35-52	14.68	7.80	42.20	35.32	100
53-70	10.2	12.24	30.61	46.94	100

Pearson chi2 (6) =28.2413, Pr = 0.000, Mean=41.5767 Std Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households were grouped into three categories. It was notable that between age 53-70 suffered severe food insecurity at 46.94% and only 10.2% were food secure. Age bracket 19-34 at 29.73% were the most food secure and were severely food insecure at 42.34%. Age 35-52 were 14.68% food secure and 35.32% severely food insecure. The Pr = 0.000 shows there is a strong relationship between age of a household and food insecurity status.

Households with older heads 53-70 as revealed by the table were food insecure at 46.94%. This is the most recorded in the category compared to younger households at 42.34%. Middle aged households 35-52 were the least severely affected at 35.32%. This indicates that majority of the elderly households were not endowed with enough resources to cushion them against food shocks. Possible explanation would mean their productive years are behind them and they offer less labor thus unable to cushion against food insecurity shocks. The middle aged group were better off as they had a lower percentage. This was because at that age greater responsibilities are shared and investments done too. The younger age was equally affected as at this age unemployment rate soars and majority of households in this category would suffer food insecurity shocks.

Age was used as a proxy for experience on households and its mean was 41.57. The mean reveal that most households were in their active years and making decisions of food security and mitigation measures should be accurate. It is expected that older households should have more shock cushions due to their knowledge on how to handle food situations. However, this was not the case in this study. The findings are similar to Gazuma (2018) who studied determinants and dimensions of household food insecurity in Addis Ababa city, Ethiopia and found out that a positive relation exists between age and household food insecurity. His result disapproved the hypotheses as age of household increases food insecurity decreases. Negash and Alemu (2013) also found that there exists a relation between age of a household and food security between females and males. Contrary, Fisher (2013) in her study found out that age essentially has no relation with food security.

Table 4.6: Food Insecurity Prevalence and Marital Status

Marital State	1	2	3	4	Total
Never Married	20	10	23.33	46.67	100
Married	17.82	9.67	34.14	38.37	100
Divorced/	50	0	20	30	100
Separated	0	0	57.14	42.86	100
Widow/widower					

Pearson chi2(9)=11.8307, Pr =0.223 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

The table reveals that 50% of the divorced/separated were food secure and was the highest and only 30% severely food insecure. Only 17.82% of the married were food secure and 38.37% food insecure. The never married were severely food insecure at

46.67% and 20% were food secure. The widows/widowers were severely food insecure at 42.86% and none was food secure. Pr = 0.223 shows no relation between the variables.

Married households are expected to be food secure. It is assumed they are responsible and make rational decisions to curb food shocks. Households who were not married were expected to suffer most due to their extravagant spending on non-food items. Widows and widowers were as well expected to be food insecure as responsibilities were shouldered by one individual. In this study, widows and widowers were found to be food secure. This was attributed to numerous support given by the community and various church organizations that take care of them both financially and materially. Households that were severely food insecure were not married.

Table 4.7: Food Insecurity Prevalence and Education Level

Education level	1	2	3	4	Total
Uncompleted primary	16.67	0	33.33	50	100
Primary	3.28	6.56	32.79	57.38	100
Secondary	10.62	13.27	38.94	37.17	100
College	28.21	10.26	27.35	34.19	100
University	28	5.33	34.67	32	100

Pearson chi2 (12) = 35.7580, Pr = 0.000 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households who did not complete primary school were food secure at 16.67% and severely food insecure at 50%. Households with primary level education were 57.38% severely food insecure and only 3.28% food secure. At secondary level, 10.62% were food secure and 37.17% were severely food insecure. At college level, 28.21% were food secure and 34.19% severely food insecure. Households with university level education were 32% severely food insecure and 28% food secure. The value of Pr =0.00 shows there is a relationship between households' level of education and their food insecurity status.

Education provides necessary knowledge needed to read and comprehend various issues in regards to food security mitigations. It also provides avenue for employment thus income needed to purchase food for households. According to the findings, the most educated households were food secure compared to the less educated.

The case holds true as less educated households are expected to have less knowledge and skills to manage resources and thus suffer food insecurity shocks. The study results correspond to Gazuma (2018) and Cui (2007) who studied Dynamics of food insecurity of families with children. In their findings there was a strong correlation between food insecurity and level of education. Fisher (2013) also found a significant negative association with food security. Negash and Alemu (2013) found out that in the short run, level of education affects food insecurity and in the long run reduces food insecurity. This came out that education is an investment in such households and before its completion, expenses are associated with it. After completion, knowledge and skills are attained that can positively contribute towards food security. This was also confirmed by Negash and Alemu (2013).

Table 4.8: Food Insecurity Prevalence and Employment Status

Job status	1	2	3	4	Total
Employed	26.19	10.48	36.67	26.67	100
Homemaker	8.82	7.35	32.35	51.47	100
Student	40	0	0	60	100
Retired	17.65	17.65	23.53	41.18	100
Unemployed	5.13	6.41	29.49	58.97	100

Pearson chi2 (12) = 44.7170, Pr = 0.00 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Results indicate 26.19% of employed households were food secure and equally severely food insecure at 26.67%. Homemakers were 8.82% food secure while 51.47% were severely food insecure. The student population had only two recorded categories that is 40% food secure and 60% severely food insecure as the worst recorded. Households

retired were severely food insecure at 41.18% and food secure at 17.65%. Unemployed households were severely food insecure at 58.97% and 5.13% food secure. There is a strong relationship between household food security and employment status as indicated by Pr=0.00.

Employment in this study refers to an individual who is active in employment on a full or part time basis and earns income. With employment, more food can be obtained by income received. Farming was the reference employment and was expected to have a positive effect on food insecurity while those engaged in non-farming occupations were expected to be food secure. A report finding by FAO (2012) suggests that only employment can reduce poverty and reduce inequalities so as to achieve long term food security. A study in rural Cambodia revealed that non-farm employment helped reduce food insecurity as income and wages generated were used in household food budget (Do, Nguyen and Grote 2019).

Table 4.9: Food Insecurity Prevalence and off-farm Income

Off-farm income	1	2	3	4	Total
No	17.12	8.22	29.45	45.21	100
Yes	19.4	9.91	35.78	34.91	100

Pearson chi2 (3) = 4.0436, Pr = 0.257 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households with off-farm income were 19.4% food secure and 34.91% severely food insecure while those with no off-farm income were 45.21% severely food insecure and

only 17.12% food secure. There is no relationship between off-farm income and household food security.

Households with extra income were expected to handle food shocks as dependency is distributed equally. This was the case in this study where households with extra income were only 34.94% food insecure compared to 45.21% of the rest. This was consistent with Gazuma (2018) in his study of food security in Thailand: Hunger in the midst of plenty. Off-farm activity was done majorly by youths who had no farms to tend or occupational jobs. Some households who had abandoned farming due to land degradation and low profits also engaged in other activities and service provision.

Table 4.10: Food Insecurity Prevalence and Household Size

Hhsize	1	2	3	4	Total
1-6	22.71	9.18	34.78	33.33	100
7-12	13.21	9.43	31.45	45.91	100
13-18	16.67	8.33	33.33	41.67	100

Pearson chi2 (6) = 8.4048, Pr = 0.210 Mean =6.4682 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households with at most 6 members were food secure at 22.71% and severely food insecure at 33.33%. Households with at most 12 members were severely food insecure at 45.91% and food secure at 13.21%. Households with at most 18 members were severely food insecure at 41.67% and food secure at 16.67%. No relationship exists between a household being food insecure and number of members as revealed by Pr=0.210.

Household size determines whether a household is able to cater for the needs of its members in regards to food provision. The mean household size was six as per the study. Households with more members were expected to be food insecure due to many people being fed. However, in a case where there are many members and such members are employed, then resources are pooled to buy food items thus reducing instances of food insecurity as noted in this study.

Table 4.11: Food Insecurity Prevalence and Dependency Ratio

Dep ratio	1	2	3	4	Total
No	17.65	9.24	36.13	36.97	100
Yes	18.92	9.27	32.05	39.77	100

Pearson chi2 (3) = 0.6437 Pr = 0.886 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households who had others depend on them were food secure at 18.92% and severely food insecure at 39.77% while those without dependants were food secure at 17.65% and severely food insecure at 36.97%. There is no relationship between the two variables Pr=0.886.

Table 4.12: Food Insecurity Prevalence and Membership to a Social Group

Social grp	1	2	3	4	Total
No	17.7	10.05	35.41	36.84	100
Yes	19.53	8.28	30.77	41.42	100

Pearson chi2 (3) = 1.5882, Pr = 0.662 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households with membership to social groups were severely food insecure at 41.42% and food secure at 19.53% while households with no membership were food secure at 17.7% and severely food insecure at 36.84%. No relationship was established Pr = 0.0662.

This is a social aspect to which households have access of belonging and entails networks, social groups or associations. Members to these organizations have access to information in regards to farming, market for produce and financial aid. It was thus expected that with such privileges, households who benefit should be food secure.

Table 4.13: Food Insecurity Prevalence and Access to Credit

Credit access	1	2	3	4	Total
No	16.51	5.50	24.77	53.21	100
Yes	19.33	10.78	36.80	33.09	100

Pearson chi2 (3) = 14.1125, Pr = 0.003 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households with access to credit were food secure at 19.33% and severely food insecure at 33.09%. Households with no credit access were severely food insecure at 53.21% and

16.51% food secure. There is a relationship between credit access and a household being food insecure.

Access to credit denotes a member who is able to get financial aid in form of formal credit from commercial banks and semi-formal credit from local shops in terms of food items. It helps solve short term financial constraints and in the event of a need, can be used to smoothen consumption and thus help mitigate food insecurity.

Households with access to credit can purchase fertilizers, pesticides and even engage on off-farm income generating activities that in the long run helps to reduce food insecurity. Negash and Alemu (2013) also found out that those who had access to credit were food secure compared to their counterparts. Ngema, Sibanda and Musemwa (2018) on the contrary found that access to credit negatively affected food security due to high interest rates on loans and seizing of property in case a household defaults in repayments.

Table 4.14: Food Insecurity Prevalence and Access to Extension Services

Extensn	1	2	3	4	Total
No	15.81	9.88	38.74	35.57	100
Yes	24	8	32.40	45.6	100

Pearson chi2(3), Pr = 0.007 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households attended to by extension officers were 24.00% food secure and 45.60% severely food insecure. Households not attended to were food secure at 15.81% and 35.57% severely food insecure. There is a relationship between extension and a household being food secure.

Extension is getting advisory from government agents on better and improved farming services and how to manage and use input. It also involves trainings that are tailored to specific households and how they can increase output on their farms.

It was expected that with assistance on farming techniques, provision of new technology and knowledge, households who engaged services of extension officers were to be food secure. This was contrary to the findings as majority of the households assisted were found to be severely food insecure. This was in line with the findings of Negash and Alemu (2013) who realized that such households had to spend more to achieve better farming ways as compared to their counterparts who spent less on such techniques and technology thus had more to spend on food.

Table 4.15: Food Insecurity Prevalence and Fertilizer Purchased

Fertilzerpurch(bags)	1	2	3	4	Total
1-400	14.61	9.46	35.82	40.11	100
401-800	60	10	0	25	100
801-1200	77.78	0	0	22.22	100

Pearson chi2 (6) = 49.6165, Pr = 0.000 Mean = 96.8968 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households that purchased highest amount of bags were food secure at 77.78% and were severely food insecure at 22.22% while the least household were 14.61% food secure and 40.11% severely food insecure. Average purchasing households were 60.00% food secure and 25.00% severely food insecure. A strong relationship exists between fertilizer purchased and a household being food secure at Pr = 0.00.

Soil fertility is its ability to operate with its natural or managed ecosystems within its boundaries. Fertile soils are crucial for increased yields both for home consumption and sale. This improves ability of households to get food by either purchase from proceeds or consumption from production. More purchases ensure land is well fertilized thus the growth of crops and enhanced yields. The study showed that amount of fertilizer purchased is strongly linked with a household being food secure. Dula and Berhanu (2019) also found out that use of low fertilizers affects productivity of land thus less yields are achieved hence affect food security status of a household.

Table 4.16: Food Insecurity Prevalence and Land Size

Land_size	1	2	3	4	Total
1-5	19.54	8.94	33.11	38.41	100
6-10	14.58	12.50	31.25	41.67	100
11-50	14.29	7.14	39.29	39.29	100

Pearson chi (6) = 2.0330, Pr = 0.917, Mean =3.9682 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households with land size less than five acres were 38.41% severely food insecure and 19.54% food secure. Households with greater than six and less than ten acres were 41.67% severely food insecure and 14.58% food secure while those with above eleven acres were 14.29% food secure and 39.29% severely food insecure. No relationship was established between land size and household food insecurity at Pr = 0.917.

Table 4.17: Food Insecurity Prevalence and Cash-crop Grown

Farmer producing cash crop	1	2	3	4	Total
No	19.65	10.98	38.15	31.21	100
Yes	17.56	7.80	29.27	45.37	100

Pearson chi2 (3) = 8.2974, Pr = 0.040 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households that produce sugarcane and tobacco were 17.56% food secure and 45.37% severely food insecure whilst non producers were 19.65% food secure and 31.21% severely food insecure. There is a relationship between production of the two crops and household food security at Pr = 0.040.

Table 4.18: Prevalence per Crop

Crop	1	2	3	4	Total
Tobacco	15.73	4.49	33.71	46.07	100
Sugarcane	18.97	10.34	25.86	44.83	100
Both	0	33.33	66.67	0	100
None	20	10.59	37.65	31.76	100

Pearson chi2 (9) =15.1871, Pr = 0.086 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

Households that produce tobacco were 15.73% food secure and severely food insecure at 46.07%. Households that produce sugarcane were 18.97% and 44.83% severely food insecure. Households who produced both crops had no reported instances of both food secure and severely food insecure. Non producers were 20.00% food secure and 31.76%

severely food insecure. There exists a relationship between households growing the cash crop and non-producers at Pr = 0.086.

Cash crops are integral to food security both at households and government level as their output are sold to earn income. It as well brings rural employment and wages to the community that trickles down to households. However, this is sometimes characterized by income fluctuations due to environmental and institutional factors. It is expected that with such tidings households directly or indirectly involved should utterly be food secure. The results in this study indicated otherwise as households who were involved in farming were severely food insecure. Tobacco farmers were affected most and this is because after years of production, tobacco lands become unproductive due to soil fertility loss. This makes it impossible to have food crops grown. Sugarcane farming also consumes large parcels of land rendering land for food crop production diminish. This leads to less yields and hence food insecurity. Income from the crops also delay or fail to be paid thus adding to frustrations to such households.

A research by Anderman, Remans, Wood, DeRosa and DeFries (2014) in Ghana revealed on the regression results that a significant relationship exists negatively between land dedicated to cash crop production and food access and availability. They also found a negative relation between metrics food utilization and cash crop production. They concluded by stating that farmers who dedicated large parcels of land to cash crop production had low food availability and a higher utilization.

Table 4.19: Food Insecurity Prevalence and Ethnic Background

Ethnic	Luo	Abagussi	Abaluhya	Abakuria	Others	Total
1	22.86	18.57	25.71	20	12.86	100
2	51.43	5.71	5.71	31.43	5.71	100
3	50	4.76	5.56	27.78	11.90	100
4	55.1	3.40	3.40	30.61	7.48	100

Pearson chi2 = 63.8745, Pr = 0.000 Source: (Field data, 2021) *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure

The results show that 22.86%, 51.43%, 50.00% and 55.10% of Luos were food secure, mildly food insecure, moderately food insecure and severely food insecure respectively. Luos were the most severely food insecure. Abagussi were 18.57% food secure, 5.71% mildly food insecure, 4.76% moderately food insecure and 3.40% severely food insecure. The most food secure were Abaluhya at 25.71%, 5.71% mildly food insecure, 5.56% moderately food insecure and 3.40% severely food insecure. At least 20.00% of Abakuria were food secure, 31.43 mildly food insecure, 27.78% moderately food insecure and 30.61% severely food insecure. Other tribes within the region were 12.86% food secure, 5.71% mildly food insecure, 11.90% moderately food insecure and 7.48% severely food insecure.

The tribes were distributed in two different locations and their prevalence given as:

Kanyamkago

Central Kanyamkago were 4.26% food secure and mildly food insecure. 40.43% of the households in the region were moderately food insecure and 51.06% severely food

insecure. It was the highest in the sub-locations. East Kanyamkago were 32.43% food secure, 2.7% mildly food insecure, 24.32% moderately food insecure and 40.54% severely food insecure households. Most secure households were found from this sub-location.

North Kanyamkago were 28.57% food secure, 7.14% mildly food insecure, 30.95% moderately food insecure and 33.33% severely food insecure households. South Kanyamkago were 23.53% food secure, 8.82% mildly food insecure, 29.41% moderately food insecure and 38.24% severely food insecure households. West Kanyamkago were 6.25% food secure, 9.38% mildly food insecure, 46.88% moderately food insecure and 37.5% severely food insecure households.

Most sugarcane farmers were from Kanyamkago and the locations indicated that they were severely food insecure. Sugarcane factories in the region like Sony Sugar company were closed down or at times operate in small scale due to financial constraints and most farmers sought distant factories like Riat Sugar company of which payments were not sufficient to curb incidences of food insecurity. It was also noted that most students came from this region and such households would pay for their tuition and prefer to maneuver with food security issues. Most households who had land did not consider other alternative crops and when they did, it was only meant for consumption.

Kuria East

Getongoroma were 34.62% food secure, 23.08% mildly food insecure, 7.69% moderately food insecure and 34.62 severely food insecure households. Girigiri were 26.32% food secure, 10.53% mildly food insecure, 42.11% moderately food insecure and 21.05%

severely food insecure households. Kegonga were 14.81% food secure, 7.41 mildly food insecure, 22.22% moderately food insecure and 55.56% severely food insecure households. This sub-location recorded the most food insecurity severity.

Kugitimo were 12.9% food secure, 6.45% mildly food insecure, 38.71% moderately food insecure and 41.94% severely food insecure households. Nyamegenga were 3.33% food secure, 10% mildly food insecure, 40% moderately food insecure and 46.67% severely food insecure households. Sakuri were 17.65% food secure, 17.65% mildly food insecure, 35.29% moderately food insecure and 29.41% severely food insecure households.

Kuria East reported many households being food secure and this is attributed to various programs that had been implemented by the ministry of agriculture to tobacco farmers on ways to curb and cushion food insecurity. Such programs included introduction of food crops to households that majorly relied on tobacco farming. Households who had livestock were able to sell and use the money to acquire food whenever needed. Moreover, the region again recorded most households being severely food insecure. This was due to land degradation in most households to the loss of productive land due to continuous growth of tobacco by such households.

4.2 Ologit Parameter Estimates

The results in this section are highlighted in the appendix

4.2.1 Marginal effects result after regression

Marginal effects regression was done by outlining the independent variables against HFIAS categories for each level of category ranging from 1 (Food secure) 2 (Mildly food insecure) 3 (Moderately food insecure) and 4 (Severely food insecure).

Table 4.20: Marginal Estimates

	1	2	3	4
Location	0.0030¿(0.78)	0.00089¿(0.77)	0.00054¿(0.75)	−0.0044¿(-0.78)
Social grp	−0.0141¿	−0.0044¿	−0.0028¿	0.0214¿
	(-0.45)	(-0.45)	(-0.44)	(0.45)
Othr_depens	0.0013¿(0.04)	0.0041¿(0.04)	0.0027¿(0.04)	−0.002¿(-0.04)
Gender	0.40133¿(1.37)	0.01249¿(1.37)	0.08122¿(1.20)	−0.0607¿(-1.38)
Agegroup	−0.046¿	−0.0138¿	−0.00839¿	0.0686¿*¿¿
	(-1.95)	(-1.93)	(-1.64)	(2.00)
Marital	0.01683¿(0.51)	0.05241¿(0.51)	0.0341¿(0.50)	−0.0254¿(-0.51)
Education	0.025¿(1.98)	0.00751¿(2.04)	0.00456¿(1.89)	−0.0373¿*¿¿(-
Un_emplymnt	−0.033¿*¿	−0.010¿*¿	−0.006¿*¿¿	2.10)
	(-3.23)	(-3.06)	(-2.06)	0.0482¿*¿
Food_expense	0.00000387¿*¿¿	0.00000115¿*¿¿	0.000000699¿	(3.38)
	(2.10)	(2.10)	(1.65)	0.00000571¿*¿¿
Credit_access	0.050¿(1.39)	0.0149¿(1.32)	0.0090¿(1.09)	(-2.5)
Extensn	−0.0213¿	−0.006¿	−0.004¿	−0.0739¿(-1.36)
	(-0.59)	(-0.58)	(-0.55)	0.0314¿
Land_size	0.0023¿(0.85)	0.0007¿(0.85)	0.0004¿(0.82)	(0.58)
Fertlzer_bough	0.0003¿*¿¿(2.6	0.000088¿*¿¿(2.	0.000053¿(1.63	0.0035¿(0.86)
Labor_type	2)	35)	)	−0.0004¿*¿¿(-
	−0.0259¿	−0.0077¿	−0.0046¿	2.55)
Capital_sourcing	(-1.09)	(-1.08)	(-1.05)	0.0382¿
Off-fam Inc	0.0778¿*¿(3.25	0.0232¿*¿(3.03)	0.0141¿*¿¿(1.99	(1.10)
HHsize	)	0.02749¿*¿¿(2.7	)	−0.115¿*¿(-3.35)
	0.0883¿*¿(2.84	3)	0.01787¿(1.92)	−0.1336¿*¿(-
1.Sugarcane	)	−0.00569¿*¿¿	−0.0037¿*¿¿	2.96)
	−0.01829¿*¿	(-2.68)	(-1.96)	0.0276¿*¿
2.Tobacco	(-2.81)	−0.05¿*¿	−0.0376¿*¿¿	(2.94)
	−0.197¿*¿	(-4.15)	(-2.30)	0.284¿*¿
3.Both	(-5.12)	−0.045¿*¿	−0.029¿	(5.35)
	−0.186¿*¿	(-4.38)	(-1.88)	0.260¿*¿
	(-4.64)	−0.0287¿	−0.004¿	(4.83)
	−0.136¿	(-1.48)	(-0.20)	1.69¿
	(-1.84)			(1.53)

Source: (Field data, 2021). *Notes: *p< 0.05, **p< 0.01, ***p< 0.001, *1 Food secure 2 Mildly food insecure 3 Moderately food insecure 4 Severely food insecure*

t statistics in parentheses: $t > 2.78$ then $p < 0.001$ (1%), $1.96 < t < 2.78$ then $p < 0.05$ (5%), $t < 1.96$ then $p < 0.1$ (10%)

The results indicate that for a unit increase in location change, there is a 0.003 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in location change, there is a 0.00089 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in location change, there is a 0.00543 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in location change, there is a -0.00444 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant with a significance ($p<0.05$). The positive signs on 3, 2, 1 indicate that with movements a household shifts to a higher HFIAC category respectively while the negative sign on 4 indicates that with movement a household will still be severely food insecure. Moving from one Sub County to another had a positive improvement on food security as noted with Uriri being more food secure at 18.75%. This is supported by the array of available foods available in the markets compared to Kuria and a more fertile soil that supports crop production. Diallo, Savadogo, Tiemtore, Diarra, Kouyate and Sangare (2021), in their study also reveal that areas endowed with better characteristics and diversity of foods are more food secure.

The results indicate that for a unit increase in age, there is a -0.046 decrease in the log odds of a household being food secure given all other variables in the model are held constant. For a unit increase in age, there is a -0.0138 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held

constant. For a unit increase in age, there is a -0.00839 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at significance ($p<0.05$). For a unit increase in age, there is a 0.0686 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). The negative signs on 1, 2, 3 indicate that an increase in mean age leads to a household shifting from a high HFIAC to a lower one respectively while on 4 the positive sign indicates with an increase in mean age, the household will shift to a higher HFIAC. This was consistent with the baseline survey of food security in Migori County KNBS and AWSC (2013) who also found a negative sign on the variable age and indicated that as household age increased they were likely to be food insecure. This is because as one becomes older his productivity declines and thus his/her income sources decline. Most elderly people depend on pensions and social security benefits which limits them compared to more productive youths who are still active in employment. In addition, failing health and functional impairments are common among elderly people reducing their capacity to produce (KNBS 2013).

The results indicate that for a unit increase in gender (male), there is a 0.4013 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in gender (male), there is a 0.0124 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in gender (male), there is a 0.0812 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a

unit increase in gender (male), there is a -0.0607 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant with a significance. The positive signs on 3, 2, 1 indicate that if a household is male headed then shifting from a lower HFIAC to a higher one is possible while on 4, the negative sign indicates that being a male headed household would not change the HFIAC category.

Males had more indicators than females but then females were exposed more to food insecurity than males. Negash and Alemu (2013) stated that males are physically fit and can endure more to achieve food security than females. They state that females have additional responsibilities at home making them unavailable to work extra hours to help curb food insecurity. On the contrary, they found out that females were food secure compared to their male counterparts.

The results indicate that for a unit increase in marital state, there is a 0.0168 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in marital state, there is a 0.0524 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in marital state, there is a 0.0341 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in marital state, there is a -0.0254 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant with a significance. The positive signs on 3, 2, 1 indicate that if a household is married then shifting to a higher HFIAC is noted while on 4, the negative sign signals no

changes. A study done by Dula and Berhanu (2019) in Western Ethiopia on determinants of rural households' food security and coping mechanisms also ascertained that households who were not married suffered from food insecurity shocks.

The results indicate that for a unit increase in household size, there is a -0.0182 decrease in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in household size, there is a -0.0056 decrease in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in household size, there is a -0.0037 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in household size, there is a 0.0276 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant. The negative signs on 1, 2, 3 indicate that with a mean increase in household size, a household moves to a lower HFIAC while on 4 a mean increase in age causes a household to move to a higher HFIAC.

It was expected that a household with many members be food insecure. While this holds in most studies such as Chelagat (2014), in some like Fisher (2013) it does not hold ground as she found out that it is positively associated with food security. In this study, households with larger family sizes beyond 13 members were not severely food insecure as compared to households with 6-12 members. This was attributed to most households' member's capability to earn and contribute to household expenditure as it holds for 6-12 members. This finding was similar to KNBS and AWSC (2013) done in Migori County.

4.2.2 Supply Side

The results indicate that for a unit increase in social group, there is a -0.0141 decrease in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in social group, there is a -0.0044 decrease in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in social group, there is a -0.0028 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in social group, there is a 0.0214 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant with a significance. The negative signs on 1, 2, 3 indicate that if a household joins a social group then the food security status would shift to a lower HFIAC while on 4, the positive sign shows that if a household joins a social group the state of food security will shift to a higher one.

It was established that households who had membership to social groups were severely food insecure due to multiple loans borrowed and not paid. This was either due to low yield output or late payment to contract farmers who had to pay fines and penalties of such loans. Inasmuch, households with membership to a social group were more food secure compared to households who were not members. This was in accordance to Gazuma (2018) who also found such evidence in Kindo Didaye district of southern Ethiopia.

The results indicate that for a unit increase in food expenditure, there is a 0.00000387 increase in the log odds of a household being food secure, given all other variables in the

model are held constant at ($p<0.01$). For a unit increase in food expenditure, there is a 0.00000115 increase in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). For a unit increase in food expenditure, there is a 0.000000699 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.05$). For a unit increase in food expenditure, there is a 0.00000571 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). The positive signs on 4, 3, 2, 1 indicate that with a mean increase in expenditure a household will shift to a higher HFIAC respectively. This study was consistent with that of Habyarimana (2018) who found a similar variable significant at 1%.

The results indicate that for a unit increase in extension services, there is a -0.0213 decrease in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in extension services, there is a -0.006 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in extension services, there is a -0.004 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in extension services, there is a 0.0329 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant all at ($p<0.05$). The negative signs on 1, 2, 3 indicate that if a household implements a service recommended by an extension officer then a shift from a higher HFIAC to a lower one is imminent while on 4, the positive sign indicates that with

implementation, a household will shift to a higher HFIAC.It was expected that with assistance on farming techniques, provision of new technology and knowledge, households who engaged services of extension officers were to be food secure. This was contrary to the findings as households who were assisted were found to be severely food insecure. This was in line with the findings of Negash and Alemu (2013) who realized that such households had to spend more to achieve better farming ways as compared to their counterparts who spent less on such techniques and technology thus had more to spend on food.

The results indicate that for a unit increase in fertilizer bought, there is a 0.0003 increase in the log odds of a household being food secure, given all other variables in the model are held constant at ($p<0.01$). For a unit increase in fertilizer bought, there is a 0.000088 increase in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). For a unit increase in fertilizer bought, there is a 0.000053 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.05$). For a unit increase in fertilizer bought, there is a -0.0004 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). The positive signs on 3, 2, 1 indicate that with each bag of a fertilizer bought and used a household will shift to a higher HFIAC while on 4, the negative sign shows with any purchase no shift is noted. This was augmented by findings of Habyarimana (2015) who in his study found the variable to have a positive influence on food security state.

The results indicate that for a unit increase in dependency ratio, there is a 0.0013 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in dependency ratio, there is a 0.0041 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in dependency ratio, there is a 0.0027 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in dependency ratio, there is a -0.002 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant. The positive signs on 3, 2, 1 indicate that with any unit increase in dependency ratio a household will shift to a higher HFIAC while on 4, the negative sign indicates that with any unit increase no shift is noted. In most studies, dependency ratio is the number of people in a household divided by the number of those who work to support the household according to Dula and Berhanu (2019). As the household size increases, resources become scarce and any member of the household who does not work brings pressure on consumption rather than production. Therefore, an increase in number on those who do not work results to an increase in food insecurity as revealed by this study at 39.77%.

4.2.3 Demand Side

The results indicate that for a unit increase in land size, there is a 0.0023 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in land size, there is a 0.0007 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access

category (HFIAC) given all other variables are held constant. For a unit increase in land size, there is a 0.0004 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in land size, there is a 0.0035 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant. The positive signs on 4, 3, 2, 1 respectively indicate that with a mean unit increase in share of land a household shifts to a higher HFIAC. Several studies, Jean 2015, Gazuma (2018) and Wangthrom (2010) indicate that as land size increases a household should be food secure due to availability and access to production land. Negash and Alemu (2013) also attest by their findings that the size of land has a significant influence on food security. Alemu concludes by saying it is the major source of income in rural households. This was not the case in this study as households with large parcels were found to be severely food insecure due to unutilized land that were left fallow. Introduction of land rates also contributed to food insecurity for such households as they pay more per year on unutilized land compared to those with less than five acres.

The results indicate that for a unit increase in off-farm income, there is a 0.0883 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in off-farm income, there is a 0.0274 increase in the log odds of a mildly food insecure household moving to a higher household food insecurity access category (HFIAC) given all other variables are held constant. For a unit increase in off-farm income, there is a 0.0178 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in off-farm income, there is a -0.1336 decrease in the log

odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant. The positive signs on 3, 2, 1 indicate that with any access to an off-farm activity, wages or gifts in kind received will result to a household shift to a higher HFIAC while on 4, the negative sign shows no shift is noted. A study by Gazuma in (2018) on empirical examination of the determinants of food insecurity among rural farm households in Ethiopia attested that with households involved in off farm activities, food insecurity severity is reduced significantly.

The results indicate that for a unit increase in education, there is a 0.025 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in education, there is a 0.00751 increase in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in education, there is a 0.00456 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant all at ($p<0.05$). For a unit increase in education, there is a -0.0373 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). The positive signs on 3, 2, 1 indicate that if a household head is educated then a shift to a higher HFIAC is achieved while on 4, the negative sign indicates that a household will remain in the lower HFIAC. Diallo et al 2021 also confirms in their study that level of education has a positive influence in food security as educated households have good dietary choices and behaviors compared to their counterparts.

The results indicate that for a unit increase in unemployment status, there is a -0.033 decrease in the log odds of a household being food secure, given all other variables in the

model are held constant at ($p<0.001$). For a unit increase in unemployment status, there is a -0.010 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.001$). For a unit increase in unemployment status, there is a -0.006 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). For a unit increase in unemployment status, there is a 0.0482 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.001$).The negative signs on 1, 2, 3 respectively indicate that with any episode of unemployment in the household, a shift to a lower HFIAC is noted while on 4, the positive sign shows a shift to a higher HFIAC. The descriptive results revealed that those employed were severely food insecure at only 26.67% and this showed that having a job influenced food security positively and was in line with the findings of a study in rural Cambodia that revealed employment helped reduce food insecurity as income and wages generated were used in household food budget (Do, Nguyen and Grote 2019). However, those who were homemakers (51.47%), students (60%) majorly in colleges and have their own cooking space, retired (41.18%) and unemployed (58.97%), were severely food insecure. Job status in this essence is implied on the categories: with the figures above, those who had no job status surpassed those in active employment and thus the negative sign. A study done in (2016) by Huang, Kim and Birkenmaier revealed that for any one episode of unemployement food insecurity increased by 8%. According to the baseline survey of food security in Migori County (2013), polygamy amongst household was at 19.5% and negatively affected food security: most female headed households in this bracket were homemakers. The survey

also revealed a high rate of early childhood marriages mostly between students leading to high dropouts who formed the bulk of unemployed people. A review by International Labor Office (2015) on decent work for food security and resilient rural livelihoods indicates that rural labor markets are characterized with informal arrangements and low level of skills which result to low or no wages, low levels of productivity and frail bargaining power.

The results indicate that for a unit increase in credit access, there is a 0.05 increase in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in credit access, there is a 0.0149 increase in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in credit access, there is a 0.009 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in credit access, there is a -0.0739 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant all at ($p<0.05$). The positive signs on 3, 2, 1 indicate that if a household has access to credit then a shift to higher HFIAC is noted while on 4, a credit access will not shift the household to a higher HFIAC. A study by Ngema et al (2018) found a contrary result that with access to credit the households were likely to be food insecure. This study found it otherwise as with access to credit households were able to get hold of production inputs that increased household food security state. However, a study by Gazuma (2018) found that households who had access to credit facilities were less likely to be food insecure.

The results indicate that for a unit increase in labor type, there is a -0.0259 decrease in the log odds of a household being food secure, given all other variables in the model are held constant. For a unit increase in labor type, there is a -.0077 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in labor type, there is a -0.0046 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant. For a unit increase in labor type, there is a 0.0382 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant. All were significant at ($p<0.05$). The negative signs on 1, 2, 3 indicate that if a household uses hired labour then a shift to a lower HFIAC is noted while on 4, the positive sign indicates any usage of hired labour the household shifts to a higher HFIAC. Hired labour was found to affect household expenditure thus leading to instances of food insecurity. Most households thus preferred family labor on their farms.

The results indicate that for a unit increase in capital sourcing, there is a 0.0778 increase in the log odds of a household being food secure, given all other variables in the model are held constant at ($p<0.001$). For a unit increase in capital sourcing, there is a 0.0232 increase in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.001$). For a unit increase in capital sourcing, there is a 0.0141 increase in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). For a unit increase in capital sourcing, there is a -0.115 decrease in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other

variables are held constant at ($p<0.001$).The positive signs on 3, 2, 1 indicate that if a household receives capital sourcing then a shift to a higher HFIAC is noted while on 4, the negative sign indicates that even with receipt of capital sourcing, a shift to a higher HFIAC is not noted. Sourcing involved getting capital for production from relatives, friends and well-wishers. This had a positive impact on food security as such household were able to engage in production by purchasing input.

The results indicate that for a unit increase in sugarcane production, there is a -0.197 decrease in the log odds of a household being food secure, given all other variables in the model are held constant at ($p<0.001$). For a unit increase in sugarcane production, there is a -0.0495 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.001$). For a unit increase in sugarcane production, there is a -0.0376 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.01$). For a unit increase in sugarcane production, there is a 0.284 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) given all other variables are held constant at ($p<0.001$). The negative signs on 1, 2, 3 indicate that if a household engages in sugarcane production then a shift to a lower HFIAC is noted while on 4, the positive sign indicates that if a household engages in sugarcane production then a shift to a higher HFIAC is noted.

For a unit increase in tobacco production, there is a -0.186 decrease in the log odds of a household being food secure, given all other variables in the model are held constant at ($p<0.001$). For a unit increase in tobacco production, there is a -0.0453 decrease in the log odds of a mildly food insecure household moving to a higher (HFIAC) given all other

variables are held constant at ($p<0.001$). For a unit increase in tobacco production, there is a -0.0294 decrease in the log odds of a moderately food insecure household moving to a higher (HFIAC) given all variables are held constant at ($p<0.05$). For a unit increase in tobacco production, there is a 0.260 increase in the log odds of a severely food insecure household moving to a higher (HFIAC) at ($p<0.001$). The negative signs on 1, 2, 3 indicate that if a household engages in tobacco production then a shift to a lower HFIAC is noted while on 4, the positive sign indicates that if a household engages in tobacco production there will be a shift to a higher HFIAC.

A study done in the region, formerly South West Nyanza, by Kenneddy and Cogill (1988) showed that shifting from maize to sugarcane production in that time had no effect in household food security. At the time the allocated land to both crops were similar and at the time sugarcane farmers in the region had high income than non-producers. They conclude that commercialization of sugarcane had no impact on food security as per their results. The results reveals that food security decreases as a household gets involved in sugarcane or tobacco.

Chepkurui (2013) found out that farmers who cultivated tobacco worsened food security when their labour and earnings are spent on tobacco instead of food production. She concludes by stating that such households take long working hours on their farms, have scarce land for subsistence production, have poor health due to tobacco fumes when roasting and generally live in abject poverty thus affecting food security.

A report by World Bank Group (2017) in Indonesia revealed that 72.2% of tobacco farmers in that region are poor and that 90% of them miscalculated their return on investment in producing the crop. It further indicates that most tobacco producers

disproportionately spent large amounts of revenues and time growing tobacco compared to non-tobacco farmers and thus concluded that tobacco production was not profitable to majority of the farmers. The report is similar with one in Kenya on the economics of tobacco farming in Kenya (Busia, Migori, Meru and Bungoma) by (Magati, Li, Drope, Lencucha and Labonte, 2016). In their regression results, labour intensity was significant and negative indicating that more labor intensive means for production led to food insecurity and their land was not also suitable to farm food crops. They concluded that tobacco production hindered economic development in the regions and urged the government to seek alternative livelihood ways for farmers in those regions.

A research by Anderman, Remans, Wood, DeRosa and DeFries (2014) in Ghana revealed on the regression results that a significant relationship exists negatively between land dedicated to cash crop production and food access and availability. They also found a negative relation between metrics food utilization and cash crop production. They conclude by stating farmers who dedicated large parcels of land to cash crop production had low food availability and a higher utilization. This augmented with this study as a similar result was found as land is locked inhibiting food crop production.

In conclusion, only one demographic variables had a significant impact on food security in the region: household size at 1%. On the supply side, out of the five variables included, only two had significant impact in the region: fertilizer purchase at 5% and food expense at 5%. On the demand side, out of the eight variables analyzed, four variables had significant impact on the outcome of food security: unemployment at 1%, capital sourcing at 1%, off-farm income at 1% and cash crop at 1%. It is thus noted that the demand side had a significant contribution to the state of food security in the region.

4.3 Test for Multi-collinearity

Collin method was used to test for the multi-collinearity among the explanatory variables in the first model. The result show that VIF of all the independent variables were below 2, as presented in Appendix 1. As a rule of thumb, if the VIF is greater than 5, then the variable is said to be highly collinear (Gujarati, 2003, pp. 328).

4.4 Hypotheses Testing Using Likelihood Ratio Test and Wald Test

The hypotheses were tested using likelihood ratio test as proposed by University of California Los Angeles (2020). Given in appendix (2) wherein: -

It is thus based on the following statistic test

$LR = -2\ln$¿¿

The statistic equal twice the difference between log-likelihood unrestricted estimate and the log-likelihood restricted estimate

In this test the null hypotheses is rejected when

$LR_n > z$

Decision rule is, if new fitted model is better than initial model then do not reject hypothesis

4.5Demand Elasticities of Households in Sugarcane and Tobacco Growing Zones in Migori County

A test of 49 elementary food products consumed by the households was reported in this section. The foods were aggregated into eight categories:

Cereals: maize grain and maize flour. Legumes: peas, cow peas and green/black grams. Secondary foods: rice, sorghum grain, sorghum flour, millet flour, wheat grain, wheat flour and prepared bread. Livestock products: beef, chicken, mutton, fish, goat, other meat, omena, eggs and fresh milk. Grean leafy vegetables: pumpkin and green bananas. Fruits: pineapples, oranges, ripe bananas, mangoes, pawpaws, avocadoes, guavas, lemon, loquarts and other fruits. Oil and fats: groundnuts, coconut, cooking oil, cooking fats, margarines, salads, other traditional oils and fats. Sugar: sugarcane, manufactured sugar and jaggery.

4.5.1Summary Statistics of Monthly Consumption and Production Quantity and Prices

Table 4.21: Consumption and Prices Summary

Food group	mean(foodgr~y) Consumption	mean(foodgr~e) Consumption	mean(foodgr~y) Production	mean(foodgr~e) Production
Legumes	6.239247	219.9382	0.456989	35.34274
Cereals	19.13742	156.9653	0.762508	9.326218
Secondary food	10.76171	85.87328	0	0.385675
Livestock products	259.7623	232.7433	2.734082	24.45931
Grean leafy vegetables	2.445313	18.9974	0.007813	0.520833
Fruits	18.00833	107.65	0	0
Oils and fats	7.153846	521.5385	0	0
Sugars	2.666667	23.33333	0	0

Source: (Field data, 2021)

4.5.2 Summary of Monthly Total Food Expense in the Aggregated Food Groups

Table 4.22: Expense Summary

Food group	Mean/Kshs	Std deviation
Legumes	1409.572	1509.264
Cereals	3004.241	4164.339
Secondary food	1021.218	1622.385
Livestock products	89951.66	1108072
Grean leafy vegetables	98.4375	442.0579
Fruits	1599.302	1526.153
Oils and fats	2829	7559.921
Sugars	52.5	74.2462

Source: (Field data, 2021)

The foods were aggregated into eight groups as described below

Legumes: Beans, green, black grams. Cereals: Rice, maize grain, maize flour, millet flour. Secondary foods: Wheat flour, prepared bread. Livestock products: Beef, chicken, mutton, goat meat, fish, omena/dagaa, fresh milk, eggs. Green leafy vegetables: pumpkin, green bananas. Fruits: Pineapples, oranges, ripe bananas, mangoes, paw paws, avocadoes, other fruits. Oils and fats: Groundnuts, cooking oils/fats, margarines, other traditional oils/fats. Sugar: Manufactured sugar, jaggary

4.5.2.1 Food Purchases

It is shown from table 4.21 that consumers average monthly quantities consumed were highest in livestock products (259.7623), cereals (19.13742), fruits (18.0083), secondary

foods (10.7617), and least in oil and fats (7.1538), legumes (6.2392), sugar (2.6666) and green leafy vegetables at (2.4453). The table also reveals consumers' monthly average expenditure on the aggregated foods and the highest was oils and fats (521.5385), livestock products (232.7433), legumes (219.9382), cereals (156.9653), fruits (107.65) and was least in secondary foods (85.8732), sugar (23.3333) and green leafy vegetables at (18.9974).

4.5.2.2 Home Production

In households that produced food the highest aggregate quantity was livestock (2.7340), cereals (0.7625), legumes (0.4569) and lastly green leafy vegetables (0.0078). The rest of the aggregated foods were never produced at home but rather factory processed at (0).The average monthly prices home producers would get if aggregated food groups were to be sold at the highest: legumes (35.3427), livestock products (24.4593), cereals (9.3262), green leafy vegetables (0.5208) and secondary foods (0.385

4.6Demand Elasticities of Aggregated Foods

In estimation of elasticities in Ordinary Least Regression model (OLS), the means of prices, demand and income are used

Table 4.23: Parameter Estimates of LA/AIDS

S_L	S_C	S_{SF}	S_{LP}	S_{GLV}	S_F	S_{OF}
γ_{bs}	0.08	0.03	0.12	0.30	0.10	0.19	0.19
γ_{pi}	0.46***	0.52***	0.488***	0.47***	0.489***	0.474***	0.395***
	(84,68)	(19.82)	(41.79)	(12.71)	(60.34)	(21.92)	(12.25)
$.S_L$	−0.067***	−0.005*	−0.018*		−0.001	−0.012***	−0.005*
	(-2.41)	(-1.51)	(-0.56)		(-1.49)	(-2.02)	(-1.13)
S_C	−0.001	−0.011***	−0.177***		−0.0001	−0.019***	−0.007
	(-0.47)	(-3.49)	(-3.43)		(-0.12)	(-3.24)	(-1.90)
S_{SF}	−0.00004	−0.0034	−0.007		−0.0001	−0.007	−0.027***
	(1.0)	(-0.42)	(-0.23)		(-0.16)	(-1.48)	(-2.50)
S_{LP}	0.00003	0.000008	−0.000004		0.000003***	−0.00006***	0.00001***
	(1.90)	(1.35)	(-1.14)		(3.81)	(-2.93)	(2.67)
$.S_{GLV}$	−0.016	−0.073	−0.022	−0.05	0.007	−0.0322	
	(-0.86)	(-1.45)	(-1.44)	(-0.37)		(0.28)	(-1.34)
S_F	0.026	−0.014	−0.016	0.09	−0.007	−0.0731	
	(1.66)	(-0.22)	(-0.68)	(0.68)	(-0.73)		(-1.92)
$.S_{OF}$	0.014***	−0.009	0.0006	−0.126***	−0.0001	−0.001	
	(7.43)	(-1.25)	(0.19)	(-4.31)	(-0.27)	(-0.55)	
LnCapS	9.32***	65.77	4.079	104.8	−1.189	9.26	35.72
	(3.98)	(1.94)	(0.29)	(0.49)	(-0.64)	(0.50)	(1.53)
LnLand	18.47	−17.35	−18.1	51.3	−2.06	−19.22	−51.03
	(1.51)	(-0.43)	(-1.55)	(0.34)	(-1.65)	(-0.97)	(-1.81)
Lnage	9.73	−88.33***	7.036	65.03*	−3.75	−10.42	−22.37
	(0.80)	(-2.52)	(0.70)	(0.35)	(-1.38)	(-0.55)	(-0.84)
LnHHs	0. 44***	1.388***	0.6711***	14.36***	0.0315***	1.7703***	3.187***
	(3.41)	(1.96)	(4.07)	(3.14)	(2.29)	(3.11)	(3.28)
D-W	1.82	1.73	1.63	1.52	1.41	1.53	1.29
R-squared	(0.99)	(0.99)	(0.99)	(1.0)	(0.99)	(0.93)	(0.98)

(Source: Author's, 2021) S_L legume, S_C Cereal, S_{SF} Secondary food, S_{LP} Livestock products, S_{GLV} Green leafy vegetable, S_F Fruits, S_{OF} Oil and fats, bs budget share, pi price index

In the legume equation; as the budget share for cereals increase by 0.03 the expenditure declines by -0.067, a 0.12 increase in budget share for secondary foods the expenditure declines by -0.005, a 0.30 increase in budget share for livestock products the expenditure

declines by -0.018, a 0.10 increase in budget share for green leafy vegetables the expenditure declines by -0.001and a 0.19 increase in budget share for fruits and oils and fats the expenditure declines by -0.012 and -0.005 respectively.

In the cereal equation; as the budget share for legumes increase by 0.08 the expenditure declines by -0.001, a 0.12 increase in budget share for secondary foods the expenditure declines by -0.011, a 0.30 increase in budget share for livestock products the expenditure declines by -0.177, a 0.10 increase in budget share for green leafy vegetables the expenditure declines by -0.0001 and a 0.19 increase in budget share for fruits and oils and fats the expenditure declines by -0.019 and -0.007 respectively.

In the secondary food equation; as the budget share for legumes increase by 0.08 the expenditure declines by -0.00004, a 0.03 increase in budget share for cereals the expenditure declines by -0.0034, a 0.30 increase in budget share for livestock products the expenditure declines by -0.007, a 0.10 increase in budget share for green leafy vegetables the expenditure declines by -0.0001 and a 0.19 increase in budget share for fruits and oils and fats the expenditure declines by -0.007 and -0.027 respectively.

In the livestock product equation; as the budget share for legumes increase by 0.08 the expenditure increases by 0.00003, a 0.03 increase in budget share for cereals the expenditure increases by 0.000008, a 0.12 increase in budget share for secondary foods the expenditure declines by -0.000004, a 0.10 increase in budget share for green leafy vegetables the expenditure increases by 0.000003 and a 0.19 increase in budget share for fruits and oils and fats the expenditure declines by -0.00006 and increases by 0.00001 respectively.

In the green leafy vegetable equation; as the budget share for legumes increase by 0.08 the expenditure declines by -0.016, a 0.03 increase in budget share for cereals the expenditure declines by -0.073, a 0.30 increase in budget share for livestock products the expenditure declines by -0.05, a 0.12 increase in budget share for secondary foods the expenditure declines by -0.022 and a 0.19 increase in budget share for fruits and oils and fats the expenditure increases by 0.007 and falls by -0.0322 respectively.

In the fruits equation; as the budget share for legumes increase by 0.08 the expenditure increases by 0.026, a 0.03 increase in budget share for cereals the expenditure declines by -0.014, a 0.30 increase in budget share for livestock products the expenditure increases by 0.09, a 0.12 increase in budget share for secondary foods the expenditure declines by -0.016, a 0.10 increase in the budget share for green leafy vegetables the expenditure declines by -0.007 and a 0.19 increase in budget share of oils and fats the expenditure declines by -0.0731.

In the oils and fats equation; as the budget share for legumes increase by 0.08 the expenditure increases by 0.014, a 0.03 increase in budget share for cereals the expenditure declines by -0.009, a 0.30 increase in budget share for livestock products the expenditure declines by -0.126, a 0.12 increase in budget share for secondary foods the expenditure increases by 0.0006, a 0.10 increase in the budget share for green leafy vegetables the expenditure declines by -0.0001 and a 0.19 increase in budget share of fruits the expenditure declines by -0.001.

A 0.08 increase in budget share for legumes increases its price index by 0.46. A 0.03 increase in the budget share for cereals increases its price index by 0.52. A 0.12 increase in the budget share for secondary foods increases its price index by 0.488. A 0.30

increase in the budget share for livestock products increases its price index by 0.47. A 0.10 increase in the budget share for green leafy vegetables increases its price index by 0.489. A 0.19 increase in the budget share for fruits increases its price index by 0.474. A 0.19 increase in the budget share for oils and fats increases its price index by 0.395.The positive signs on the price index indicate a decrease in demand on the given aggregate food. Therefore, a unit increase in price index on cereals leads to a 52% reduction in its demand, 46% in legumes, 48% in secondary foods, 47% in livestock products, 48.9% in green leafy vegetables, 47% in fruits and 39.5% in oils and fats. The price index in this study indicates market effects on demand of the aggregated foods which reveals a heavy impact on the cereals commodity and a least impact on the oils and fats commodity. This was similar to a study done by Pomboza and Mbaga (2007) who indicated that consumer price index does not show shifts in taste and preferences but the effect on demand in the markets.

The budget shares of the aggregated foods are depicted as follows: legumes 8%, cereals 3%, secondary foods 12%, livestock products 30%, green leafy vegetables 10%, fruits 19% and oils and fats 19%. The largest budget share fell to livestock products at 30% while the least share fell to cereals at 3%. Fruits and oils and fats had a similar budget share of 19%. Therefore, a shilling increase in food expenditure causes a rise in livestock expenditure by 30 cents in the region while for cereals the ripple effect is 3 cents; for legumes it is 8 cents, 12 cents for cereals, 10 cents for green leafy vegetables and 19 cents for oils and fats and fruits. Cereals thus was accorded low status in the region while livestock products accorded the highest status. Fruits and oils and fats had a similar status. In most developed countries, the budget share for food items will range from 10%-

20% and when converted to elasticities then it ranges from 0.2-0.4. In developing countries, the share is 60%-80% and when converted to elasticities it ranges from 0.7-1 Nyangweso (2010). The high ranges indicate high expenditure as was the case in this study. High expenditures on food items indicate inadequacy of income amongst households thus limiting their expenditure objectives as was noted by Nyangweso (2010). Demographic variables do not satisfactorily perform on the model: particularly their coefficients were insignificant in all the food groups. This led to a drop on variable: education, marital status, unemployment, labor type, crop and sugarcance/tobacco yield. It is not confounded why but a similar occurrence was also witnessed by Nyang (1999) who dropped variables while investigating household food demand and resource management in Kenya while using LA/AIDS model. The prices are significant in the model thus no need to invoke engel curves as per Working (1943) and Savadogo and Brandt (1988).

A 0.08 increase in budget share for legumes increases the mean demand of capital sourcing by 9.32 units. A 0.03 increase in budget share of cereals increases the mean demand for capital sourcing by 65.77 units. A 0.12 increase in budget share for secondary foods increases the mean demand of capital sourcing by 4.079 units. A 0.30 increase in budget share for livestock products increases the mean demand of capital by 104.8 units. A 0.10 increase in budget share for green leafy vegetables reduces the mean demand of capital sourcing by -1.189 units. A 0.19 increase in budget share for fruits increases the mean demand of capital sourcing by 9.26. A 0.19 increase in budget share of oils and fats increases the demand of capital sourcing by 35.72 units. Capital sourcing had the greatest impact in legumes equation as it was significant at 1%.

A 0.08 increase in budget share for legumes increases the mean demand of land by 18.47 units. A 0.03 increase in budget share for cereals reduces the mean demand of land by -17.35 units. A 0.12 increase in budget share for secondary foods reduces the mean demand of land by -18.1. A 0.30 increase in budget share for livestock products increases the mean demand of land by 51.3 units. A 0.10 increase in budget share for green leafy vegetables reduces the mean demand of land by -2.06. A 0.19 increase in budget share for fruits reduces the mean demand of land by -19.22 units. A 0.19 increase in budget share of oils and fats reduces the mean demand of land by -51.03 units.

A 0.08 increase in budget share for legumes increases the mean age by 9.73 units. A 0.03 increase in budget share for cereals reduces the mean age by -88.33 units. A 0.12 increase in budget share for secondary foods increases the mean age by 7.03 units. A 0.30 increase in budget share for livestock products increases the mean age by 65.03 units. A 0.10 increase in budget share for green leafy vegetables reduces the mean age by 3.75 units. A 0.19 increase in budget share for fruits reduces the mean age by -10.42 units. A 0.19 increase in budget share of oils and fats reduces the mean age by -22.37 units. Mean age had a significant impact on the cereals equation at 5% significance level.

A 0.08 increase in budget share for legumes increases the mean household size by 0.44 units. A 0.03 increase in budget share for cereals increases the mean household size by 1.388 units. A 0.12 increase in budget share for secondary foods increases the mean household size by 0.6711 units. A 0.30 increase in budget share for livestock products increases the mean household size by 14.36 units. A 0.10 increase in budget share for green leafy vegetables increases the mean of household size by 0.0315 units. A 0.19 increase in budget share for fruits increases the mean household size by 1.77 units. A

0.19 increase in budget share of oils and fats increases the mean household size by 3.18 units. Mean household size had a significant impact on all the equations at a significance of 1% in three out of four equations.

Capital sourcing was significant in legumes equation at 1%. Age was significant at 5% in cereals equation. Household size was significant at 1% in equations of legume, secondary foods, livestock products, fruits and oils & fats and significant at 5% in cereals and green leafy vegetables equations. These variables were important in allocation of budget share.

Livestock products was significant at 5% in oils & fats equation and significant at 1% in green leafy vegetables and fruits equation. Legumes was significant at 5% in the fruits equation while cereals were significant at 1% both in the secondary food, fruits and livestock product equation. Oils & fats was also significant at 1% in legumes and livestock products equation. Secondary foods were significant at 5% on oils & fats equation. The negative signs in the mix of each aggregated foods indicate a declining share as expenditure rise on the main share equation. This results are in line with Nyang (1999) who found out similar results in electricity and charcoal as having positive signs indicating superior goods and the rest such as lpg and kerosene as necessities with a negative sign while estimating demand of fuel in Kenya.

Table 4.24: Marshallian Elasticity Estimates (Uncompensated)

Variables	S_L	S_C	S_{SF}	S_{LP}	S_{GLV}	S_F	S_{OF}
$\varepsilon_{..}$	1.011	1.003	1.018	1.026	1.023	1.025	1.023
ε_{Leg}**-0.849**	-0.85	-0.849	-0.853	-0.843	-0.849	-0.85	
ε_{Cerls}	-0.856	**-0.856**	-0.856	-0.857	-0.854	-0.856	-0.856
ε_{SecFds}	-0.844	-0.845	**-0.843**	-0.85	-0.832	-0.843	-0.844
$\varepsilon_{LivPrds}$	-0.819	-0.823	-0.817	**-0.834**	-0.795	-0.819	-0.822
ε_{GLV}	-0.846	-0.848	-0.846	-0.851	**-0.837**	-0.846	-0.847
ε_{Fruits}	-0.834	-0.836	-0.833	-0.843	-0.819	**-0.834**	-0.836
$\varepsilon_{Oils \wedge Fats}$	-0.834	-0.836	-0.833	-0.843	-0.819	-0.834	**-0.836**

(Source: Author's, 2021)S_L legume, S_C Cereal, S_{SF} Secondary food, S_{LP} Livestock products, S_{GLV} Green leafy vegetable, S_F Fruits, S_{OF} Oil and fats

Legume elasticity estimates in each of the aggregated foods are -0.849, -0.85, -0.849, -0.853, -0.843, -0.849 and -0.85 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.853 while the least is on green leafy vegetable at -0.843. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Cereal elasticity estimates in each of the aggregated foods are -0.856, -0.856, -0.856, -0.857, -0.854, -0.856 and -0.856 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.857 while the least is on green leafy vegetable at -0.854. This indicates that the highest substitutability was on livestock products and the

least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Secondary foods elasticity estimates in each of the aggregated foods are -0.844, -0.845, -0.843, -0.85, -0.832, -0.843 and -0.844 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.85 while the least is on green leafy vegetable at -0.832. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Livestock products elasticity estimates in each of the aggregated foods are -0.819, -0.823, -0.817, -0.834, -0.795, -0.819 and -0.822 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.834 while the least is on green leafy vegetable at -0.795. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Green leafy vegetable elasticity estimates in each of the aggregated foods are -0.846, -0.848, -0.846, -0.851, -0.837, -0.846 and -0.847 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.851 while the least is on green leafy vegetable at -0.837. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Fruit elasticity estimates in each of the aggregated foods are -0.834, -0.836, -0.833, -0.843, -0.819, -0.834 and -0.836 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.843 while the least is on green leafy vegetable at -0.819. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

Oil and fats elasticity estimates in each of the aggregated foods are -0.834, -0.836, -0.833, -0.843, -0.819, -0.834 and -0.836 for legumes, cereals, secondary foods, livestock products, green leafy vegetables, fruits, oils and fats respectively. The highest elasticity is in livestock product equation at -0.843 while the least is on green leafy vegetable at -0.819. This indicates that the highest substitutability was on livestock products and the least was green leafy vegetables. The negative signs illustrate the substitutability rates on the aggregated foods for the given food group.

In the legumes equation, cereals had the highest substitutability rate at -0.856 and livestock products had the least at -0.819. In the cereals equation, cereals had the highest substitutability rate at -0.856 and livestock products had the least at -0.823. In the secondary foods equation, cereals had the highest substitutability rate at -0.856 and livestock products had the least at -0.817. In the livestock products equation, cereals had the highest substitutability rate at -0.857 and livestock products had the least at -0.834. In the green leafy vegetable equation, cereals had the highest substitutability rate at -0.854 and livestock products had the least at -0.795. In the fruits equation, cereals had the highest substitutability rate at -0.856 and livestock products had the least at -0.819. In the

oil and fats equation, cereals had the highest substitutability rate at -0.856 and livestock products had the least at -0.822. This result is similar to the findings of Pomboza and Mbaga (2007) who while estimating food demand in Canada found out that most families spent more money on livestock and dairy products and spent least on cereals.

The food categories according to expenditure elasticity are elastic products where on average, expenditure on them increase disproportionately than an increase in their total expenditure. Expenditure elasticity on livestock products was higher than all other food groups while the least was cereals. The findings are in line with Anand et al (2016). The positive signs indicate that all aggregated foods are normal goods and these finding are similar to Rahman et al, (2020) who found the same while analyzing aggregate food demand in the United States. Expenditure elasticity of demand measures the responsiveness of demand to changes in total expenditure. Unconditional demand would subject such a change to all food groups and non-food items which were not included in our study. Conditional demand subjects such changes to similar bundle products which was the case in this study William (2019). According to Moloko, Ng'ong'ola, Dzanja and Chilongo (2018), expenditure elasticities above one tend to indicate that such goods are luxurious. They further allude that it is a reflection of food insecurity in their study which was taken to be the case in this study.

All the Marshallian(uncompensated) elasticities are negative as expected (Vu 2020). All the food groups had a price elasticity less than unity with the lowest being livestock products and fruits (-0.834) while the highest being cereals (-0.856). Vu also indicates that expenditure is given a unit of one and in his study, he states that expenditure elasticity shows how the quantity was purchased in response to a change in consumers'

expenditure which acts as a proxy to income. He further alludes that if the % change demanded is greater than consumer expenditure, the demand becomes expenditure elastic. Results in this study show that the demand is expenditure elastic as all of them are above one. The low own price elasticity levels of the aggregated foods show that they are consumed daily within the households. No given food was found amongst the aggregated foods and further, the low elasticities reveal that any price changes would not have adverse changes in any of the foods consumed as per Moloko et al, (2018).Moloko et al concluded that the other figures in their table which were horizontal as for the above table can be used to interpret substitutability and complementarity. Positive figures reveal that aggregated foods are complements while negative figures reveal the aggregate foods are substitutes. For this study all the foods are substitutes.

Table 4.25: Parameter Estimates of LA/AIDS(Restricted) and Homogeneity Test

S_L S_C S_{SF} S_{LP}				S_{GLV} S_F S_{OF}
γ_{bs} 0.08 0.03 0.12 0.30				0.10 0.19 0.19
γ_{pi} 0.46 0.52 0.49 0.493				0.489 0.476 0.385
	(135.5)	(85.91)	(103.64)	(246.25) (42.76) (41.13)
(54.02)				−0.001 −0.013 −0.003
.S_L −0.067 −0.006 −0.037				(-2.26) (-3.05) (-0.64)
	(-7.11)	(-1.94)	(-0.85)	−0.00013 −0.02 −0.007
S_C −0.001 −0.011 −0.193				(0.0) (-6.62) (-1.85)
	(-0.69)	(-5.73)	(-7.80)	−0.0001 −0.007 −0.027
S_{SF} −0.0007 −0.0034 −0.024				(-0.03) (-1.52) (-4.23)
	(-0.24)	(-0.34)	(-0.60)	0.000029 −0.000067 0.00001
				(3.99) (-1.29) (1.49)
S_{LP} 0.00001 0.000007 −0.000004				0.006 −0.0322
	(0.35)	(0.60)	(-0.99)	(0.39) (-1.28)
.S_{GLV} −0.017 −.073 −0.024 −0.123				−0.003 −0.056
	(-1.6)	(-2.14)	(-1.87) (-0.61)	(-2.24) (-2.44)
S_F 0.01 −0.02 −0.026 0.20				−0.003 −0.002
	(1.05)	(-0.65)	(-2.37) (-1.36)	(0.52) (-0.52)
.S_{OF} 0.012 −.009 0.0007 −0.171				
	(3.33)	(-0.90)	(-0.18) (-3.35)	−104 8.28 38.22
				(-0.47) (0.47) (1.55)
LnCapS 8.82 65.02 3.512 73.8				−2.47 −17.51 −56.19
	(0.77)	(1.62)	(0.27) (0.43)	(-0.96) (-0.80) (-1.92)
LnLand 21.19 −16 −16.77 106.89				−3.73 −11.30 −23.09
	(1.67)	(-0.36)	(-1.10) (0.54)	(-1.49) (-0.54) (-0.81)
Lnage 10.9 −88.54 6.77 39.55				0.48 1.6703 3.81
	(0.89)	(-2.01)	(0.45) (0.21)	(2.58) (8.76) (12.38)
LnHHs 23.51 1.27 0.5741 9.886				
	(2.11)	(3.46)	(4.51) (5.91)	0.0 0.00.0
				1.41 1.54 1.29
Prob>F	0.0	0.0	0.0 0.0	(0.99) (0.93) (0.98)
D-W	1.81	1.72	1.63 1.53	
R-squared				
	(0.99)	(0.99)	(0.99) (1.0)	

(Source: Author's, 2021) S_L legume, S_C Cereal, S_{SF} Secondary food, S_{LP} Livestock products, S_{GLV} Green leafy vegetable, S_F Fruits, S_{OF} Oil and fats

In the restricted model most coefficients remained unchanged with only few differences noted. In the legumes equation household size became significant at 5% and at 1% in the cereals equation. Green leafy vegetables and fruits became 5% significant in the cereals equation and legumes 5% significant in the green leafy vegetables equation. Legumes became 1% significant in the fruits equation while secondary foods became 1% significant in the oils and fats equation. Fruits became 5% significant in the oils and fats equations while livestock products became insignificant in fruits and oils and fats equations. Homogeneity is not rejected for any of the equations as F-test reveals they are all at 0.000. The D-W in both models are fairly similar with no any sharp drop or increase noted. A study on U.S consumer behavior over the postwar period using the almost ideal demand system by Blanciforti, Green and King (1986) informs that no rejection should be subject to the model when F-test of the equations are closer to 0.000 while also looking at sharp changes in D-W. Changes in D-W are witnessed when F-test figures are greater than 0. The R-squared is not lowered with the introduction of homogeneity as noted in the model thus affirms the acceptance of the model (Blanciforti et al, 1986).

4.7 Symmetry Test for LA/AIDS

Likelihood ratio test was used to test all the aggregated food equations: unrestricted equations and restricted equations from the above models were employed.

Table 4.26: Symmetry Test

Variables	S_L	S_C	S_{SF}	S_{LP}	S_{GLV}	S_F	S_{OF}
$LR\,chi(3)$	2.28	0.46	4.17	7.79	3.65	0.46	7.31
Prob>chi2	0.51	0.92	0.24	0.05	0.30	0.92	0.06

(Source: Author's 2021)S_L legume, S_C Cereal, S_{SF} Secondary food, S_{LP} Livestock products, S_{GLV} Green leafy vegetable, S_F Fruits, S_{OF} Oil and fats

According to Deaton and Muelbauer (1980), symmetry is tested on a large sample likelihood and cannot be done equation by equation for restrictive and unrestrictive estimations. In the given test, equations of livestock products and oils and fats are rejected while all others are accepted. Symmetry is thus rejected whether or not homogeneity is maintained within the hypothesis on asymptotically valid chi square test. Deaton and Muellbauer note that for symmetry to hold some aspect of behavioral variables should be introduced to the demand function otherwise if ignored, symmetry is interfered with.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

The study sought to evaluate household food security in sugarcane and tobacco growing zones in Migori County. To measure food security, Household Food Insecurity Access Score was used where the last indicator is a categorical variable showing Food Insecurity Status.

The results showed only 18.52% of the surveyed households were food secure and 38.89% severely food insecure. Mildly food insecure households and moderately food insecure households were 9.26% and 33.33% respectively within the two regions. Results revealed Uriri had more secure food households (18.75%) against Kuria (18.28%) and at the same time had high severely food insecure households (40.63%) against Kuria (37.10%). Kuria had (12.37%) mildly secure households while Uriri had (6.25%). Uriri moderately secure household were (34.38%) while Kuria (32.26%). Pr=0.235 shows no systematic relationship of food insecurity between the two sub counties and the selected locations.

5.2 Conclusion and Recommendations

Sugarcane and tobacco production and its influence on food security has been contentious where its critics accuse it of causing food insecurity due to uptake of more land, high cost of production and late rewards in terms of profits. The study has shown that food security status was better in households that did not produce either commodity (sugarcane and tobacco) when all the other factors were held constant. Households that produce tobacco were 15.73% food secure and severely food insecure at 46.07%. Households that produce

sugarcane were 18.97% and 44.83% severely food insecure. Households that produce both crops had no reported cases of food security and severely food insecure. Non producers were 20.00% food secure and 31.76% severely food insecure asserting the critics fears. It is therefore noted that cash crop farming has a negative impact on the state of food security in sugarcane and tobacco growing zones of Migoricounty and capital sourcing, sugarcane and tobacco production were significant at 0.001.

The budget shares of the aggregated foods were depicted as follows: legumes 8%, cereals 3%, secondary foods 12%, livestock products 30%, green leafy vegetables 10%, fruits 19% and oils and fats 19%. The largest budget share fell to livestock products at 30% while the least share fell to cereals at 3%. The food categories according to expenditure elasticity were elastic products where on average, expenditure on them increase disproportionately than an increase in their total expenditure. Expenditure elasticity on livestock products was higher than all other food groups while the least was cereals. The positive signs indicated that all aggregated foods were normal goods. High expenditures on food items indicate inadequacy of income amongst households thus limiting their expenditure objectives. All the Marshallian(uncompensated) elasticities were negative as expected. All the food groups had a price elasticity less than unity with the lowest being livestock products and fruits (-0.834) while the highest being cereals (-0.856). Results in this study show that the demand is expenditure elastic as all of them are above one. The low own price elasticity levels of the aggregated foods show that they are consumed daily within the households.

5.2.1 Food Demand

It was noted that demand for high value foods was on the rise such as livestock products and fruits. The case of rising income caused the increased and simple starchy foods that include green leafy vegetables to have least demand. The county lacks price control mechanisms of such crops to protect producers of such resources therefore it calls for stabilization policies that would complement agricultural productivity policies. Sustainability framework to enhance food supply, reducing price distortions on food items sold and agricultural based market pricing are long term plans that the county should implement to help households curb shock in prices hence reduce food insecurity. Expenditure elasticities were less than one in each food group. Expenditure elasticities are useful in providing quantitative estimates of secondary and direct changes in unit values of expenditure and consumer demand. It can also be used to evaluate domestic policy measures regulating quality and food safety and quantify such cases across different consumers. Estimates of consumer and producer demand show effect of prices and total expenditure on consumer behavior thus helps policy makers predict purchasing choices and decision of consumers and help design such policies.

5.2.2 Food Security

The county government should also come up with short and long term plans for employment opportunities to the youths as the study revealed households who had members employed or engaged on off-farm activities were food secure. Youths being a majority in the region, focus should be directed towards such initiatives.This should be through promotion of sustainable alternatives such as agro-industries, jua kali sector and an extension to Kazikwa Vijana. There is also need for research based innovations to

determine optimal combinations for cash crop and food crop production to gain high yielding varieties that apply biotechnology in production. This is because the cash crops grown in the two regions should not be taken as a solution to solving food insecurity in the long run as they have low output prices. The county government and other stake holders should also market and promote contract farming as this will ensure that cash crop farmers in the region are protected against price shocks and insured against any unforeseen risks and uncertainties.

The county government should fund community based organizations through specific special programs so that they offer food support to the vulnerable at the grass root level. This is because the study showed positive influence on food security if a household is a member of a social group. Focussed programs like food nets should be directed towards areas with severe food insecurity cases like Uriri which reported a severe rate of 40%. Priorities should be on households who are aged greater than 55 years old with food relief efforts as they were severely food insecure at 46% compared to other age brackets. Promote and finance credit access institutions to offer more affordable services to households to help curb food insecurity otherwise with high interests, they contributed to food insecurity in the two sub-counties.

A functional extension services unit is needed within the county to promote workable strategies for farmers in the region in regards to mitigating risks and thus improve their social welfare.

A study on dietary diversity is recommended to reveal calorific intake of various food groups amongst food secure and food insecure households.

REFERENCES

Allen, P. (2013). Facing food security. *In Journal of Rural Studies* (*Vol. 29, pp. 135–138*).

Rahman, Surozzaman, Jahan, Haque&Palash.(2020). Analyses of Aggregate Food Demand in the United States. *American Journal of Food Science and Technology*. Vol, 8, No.2, 75-80

Anand, R., Kumar, N., &Tulin, V. (2016). Understanding India's Food Inflation: *The Role of Demand and Supply Factors. IMF Working Papers, 16(2*), 1. https://doi.org/10.5089/9781513581347.001

Anderman, T. L., Remans, R., Wood, S. A., DeRosa, K., &DeFries, R. S. (2014). Synergies and tradeoffs between cash crop production and food security: *A case study in rural Ghana. Food Security, 6(4),* 541–554. https://doi.org/10.1007/s12571-014-0360-6

Anderson, M. D. (2013). Beyond food security to realizing food rights in the US. *Journal of Rural Studies, 29,* 113–122.

Bickel, G., Nord, M., Price C.,Hamilton, W., and Cook, J. (2000). "Guide to Measuring Household Food Security. *U.S.A Department of Agriculture, Food and Nutrition Service, Alexandria VA.*

Blanciforti, L. a, Green, R. D., & King, G. a. (1986). US consumer behavior over the postwar period: *An almost ideal demand system analysis*. *Analysis, 40*.

Blanciforti, L., & Green, R. (August 01, 1983). An Almost Ideal Demand System Incorporating Habits: *An Analysis of Expenditures on Food and Aggregate Commodity Groups. The Review of Economics and Statistics, 65, 3,* 511-515.

Chalfant, J. (1987). A manual on self-monitoring strategies for improving on-task behavior.

Chepkurui, A. (2013). Impact of Tobacco Farming on Household Food Security in Ang'urai Kenya. *LAP LAMBERT Academic Publishing.*

Community Agriculture for Rural Development, (2020). Impact of beans production on Migori residents.

Cui, S. (2007). Dynamics of food insecurity of families with children. *AAI1443095, 2459*.

Deaton, A., &Muellbauer, J. (June 01, 1980). An Almost Ideal Demand System. *The American Economic Review, 70, 3*, 312-326.

Diallo, S. A., Savadogo, K., Tiemtore, A., Diarra, S., Kouyate, D., &Sangare, B. M. (2021). Determinants of Food Insecurity in Rural Areas in Mali. *Asian Journal of Agricultural Extension, Economics & Sociology*, *39*(3), 158–172. https://doi.org/10.9734/ajaees/2021/v39i330556

Dibden, J., Gibbs, D., &Cocklin, C. (2013). Framing GM crops as a food security solution. *Journal of Rural Studies, 29*, 59–70.

Do, T.L., Nguyen, T.T. & Grote, U (2019). Nonfarm employment and household food security: *evidence from panel data for rural Cambodia. Food Sec.* ***11,*** 703–718

Dula, T. (2019). Determinants of Rural Household Food Security and Coping Up Mechanisms in the Case of WolisoWoreda Western Ethiopia. *World Journal of Agriculture and Soil Science, 1(2),* 1–10. https://doi.org/10.33552/wjass.2019.01.000507

Ejigayhu, S. and Abdi-Khalil, E. (2012). Determinants of Food Insecurity in Addis Ababa City, Ethiopia. *Journal of Economics and Sustainable Development*.

Fisher, M., & Lewin, P. A. (2013). Household, community, and policy determinants of food insecurity in rural Malawi. *Development Southern Africa, 30(4–5)*, 451–467. https://doi.org/10.1080/0376835X.2013.830966

Food and Agriculture Organization (2020). "Declaration on world food security." *World Food Summit, FAO.*

Fumane, N and Tshediso., J., S. (2013). Determinants of Vulnerability to Food Insecurity in a Soth African Township: *A Gender Analysis. Mediterranean Journal of Social Sciences. Vol 4* No 14.

Gazuma, E. G. (2018). An Empirical Examination of the Determinants of Food Insecurity among Rural Farm Households: *Evidence from KindoDidaye District of Southern Ethiopia. Business and Economics Journal, 09(01),* 1–12. https://doi.org/10.4172/2151-6219.1000345

Girma, G. G. (2012). Determinants of Food Insecurity among Households in Addis Ababa City Ethiopia. *Interdisciplinary Description of Complex Systems 10(2),* 159-173.

Green, R., & Alston, J. M. (May 01, 1990). Elasticities in AIDS Models. *American Journal of Agricultural Economics, 72*, 2, 442-445.

Gundersen, C.G and Garasky, S.B (2012). "Financial Management Skills are Associated with Food Insecurity in a Sample of Households with Children in the United States." *Journal of Nutrition 142(10):*1865-1870.

Habyarimana, J. B. (2015). Determinants of Household Food Insecurity in Developing Countries Evidences From a Probit Model for the Case of Rural Households in Rwanda. *Sustainable Agriculture Research, 4(2),* 78. https://doi.org/10.5539/sar.v4n2p78

Huang, J., Kim, Y., &Birkenmaier, J. (2016). Unemployment and household food hardship in the economic recession. *Public Health Nutrition*, *19*(3), 511–519. https://doi.org/10.1017/S1368980015001603

International Labour Office. (2015). Decent Work for Food Security and Resilient Rural Livelihoods. *Work, Decent The, I N Economy, Rural Notes, Policy Guidance*.

Iram, U. and M.S Butt (2004) 'Determinants of Household Food Security: An Empirical Analysis for Pakistan', *International Journal of Social Economics 31(8):*753-766.

Jean, B. H. (2015). Determinants of Household Food Insecurity in Developing Countries Evidence From a Probit Model for the Case of Rural Households in Rwanda. *Sustainable Agriculture Research; Vol. 4*, No.2

Jehle, G. A., &Reny, P. J. (1998). Advanced microeconomic theory. *Reading, Mass: Addison-Wesley.*

Kaggikah, D. (2017). Available from: https://www.kenyacountyguide.co.ke/migori-county-044/

Kennedy, E., &Cogill, B. (1988). The commercialization of agriculture and household-level food security: *The case of Southwestern Kenya. World Development, 16(9),* 1075–1081. https://doi.org/10.1016/0305-750X(88)90110-6

Kenya Population and Housing Census (2019). Distribution of Population by Administrative Units. *Volume II.*

Kenya Sugar Research Foundation, (2020). Report

KNBS, & SID. (2013). Food Security Research Findings and Recommendations. *Migori county*.

Kristie, N. C., Tolotea, L., Kerri, K., Delvina. G. (2010). What are the determinants of food insecurity in New Zealand and does this differ for males and females? *Australian and New Zealand Journal of Public Health.*

Leroy, J. L., Ruel, M., Frongillo, E. A., Harris, J., & Ballard, T. J. (2015). Measuring the food access dimension of food security: *A critical review and mapping of indicators. Food and Nutrition Bulletin, 36(2),* 167–195. https://doi.org/10.1177/0379572115587274

Magati, P., Li, Q., Drope, J., Lencucha, R., &Labonte, R. (2016). The Economics of Tobacco Farming in Kenya. *Institute for Legislative Affairs and American Cancer Society*. https://www.cancer.org/content/dam/cancer-org/research/economic-and-healthy-policy/economics-of-tobacco-farming-in-kenya-full-report.pdf

Ministry of Health, (2020). Report

Mohammadi, H., Torabi, S., &Dogani, A. (2015). Application of Ordered Logit Model in Investigating the factors Affecting Peoples Income (A Case Study in Tehran City). *International Journal of Academic Research in Economics and Management Sciences*, *4*(1), 166–178. https://doi.org/10.6007/ijarems/v4-i1/1608

Moloko, H. B., Ng'ong'ola, D. H., Dzanja, J., &Chilongo, T. (2018). Food Budget Shares and Elasticities in Malawi's Prisons. *Sustainable Agriculture Research*, *7*(1), 109. https://doi.org/10.5539/sar.v7n1p109

Monica, F. and Paul A., L. (2013). Household, Community and Policy Determinants of Food Insecurity in Rural Malawi.

Muellbauer, J., &Portes, R. (1977). Macroeconomic models with quantity rationing. London: *Birkbeck College, University of London.*

Negash, T., &Alemu, S. (2013). Determinants and coping strategies of household food insecurity in rural areas of Tigray: *The case of rural Adwa Woreda. Ethiopian Journal of Agricultural Sciences, 23(1–2),* 119-144–144.

Ngema, P. Z., Sibanda, M., &Musemwa, L. (2018). Household food security status and its determinants in Maphumulo local municipality, South Africa. *Sustainability (Switzerland)*, *10(9)*, 1–23. https://doi.org/10.3390/su10093307

Nyamohanga, P. W. (2016). Assessment of Household Status and Determination of the Measures Used to Overcome Food Insecurity in Kuria East Sub-County, Migori County, Kenya. *Food Science and Quality Management*, *55*, 51–54.

Nyang, F.O. (1999). UvA-DARE (Digital Academic Repository) *Household energy demand and environmental management in Kenya.*

Nyangweso, P. M. (2010). Determinants of Sorghum Producing Households ' Expenditure and implications for food security in Western Kenya. *Fao.*

Okwudili, O., Gerald, C., W. (2006). An Analysis of the Determinants of Food Insecurity with Severe Hunger in Selected Southern States. *Southern Rural Sociology, 21(1).*

Ondari., W., O. (2011). Effects of tea Production and Socio-economic Factors on Food Consumption and Nutrition in Nyamira District Kenya. *Unpublished Thesis*

Otieno, A. C., Mugalavai, V., &Kamau, E. H. (2018). A Study On Impact Of Climate Change On The Food And Nutrition Security In Children Of Small Scale Farmer Households Of Migori Area, *2(1),* 67–71.

Otieno, O. D. (2014). Socio-economic factors influencing smallholder maize production in tobacco growing zones of Migori County Kenya. *Published thesis.*

Pomboza, R &Mbaga, M. (2007). The Estimation of Food Demand Elasticities in Canada. *Agriculture and Agri-Food Canada. Publication 06-071-RB (Issue August).*http://ageconsearch.umn.edu/bitstream/52705/2/estimation_e.pdf

Savadogo, K., & Brandt, J. A. (1988). Household food demand in Burkina Faso: Implications for food policy. *Agricultural Economics, 2(4),* 345–364. https://doi.org/10.1016/0169-5150(88)90023-0

Scientific Figure on Research Gate (n.d). Available from: https://www.researchgate.net/figure/Map-of-Kenya-showing-the-location-of-Migori-County_fig1_305148997

Sen, A. (1981) Poverty and Famines: *An essay on Entitlement and Deprivation*. *Clarendron Pr*.

Shepherd, B. (2012). Thinking critically about food security. *Security Dialogue*.

Silberger, E., &Suen, W. C. (2001). The structure of economics: *A mathematical analysis*. *Boston, Massachusetts* [etc.: McGraw-Hill.

Smith, L. C and L. J. Haddad (2000) Explaining Child Malnutrition in Developing Countries: *A Cross-Country Analysis. Intl Food Policy Research Inst.*

STATLEC (no date). https://www.statlect.com/fundamentals-of-statistics/likelihood-ratio-test

Timmer, C. P. (2012). Behavioral dimensions of food security. *Proceedings of the National Academy of Sciences.*

Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., … Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation.*

United States Department of Agriculture Food and Nutrition Service (2000). Guide to Measuring Household Food Security. *Revised*

University of California, Los Angeles (2020). How can I perform the Likelihood Ratio and Wald Test in Stata?.*Institute for Digital Research & Education. Statistical Consulting.*

Varian, H. R. (1992). Microeconomic analysis. *New York, NY: Norton.*

Vu, L. H. (2020). Estimation and analysis of food demand patterns in Vietnam. *Economies, 8(1),* 1–17. https://doi.org/10.3390/economies8010011

Walker, R. E., &Kawachi, I. (2012). Use of Concept Mapping to Explore the Influence of Food Security on Food Buying Practices. *Journal of the Academy of Nutrition and Dietetics, 112(5),* 711–717.

Wheeler, T., & von Braun, J. (2013). Climate change impacts on global food security. *Science (New York, N.Y.), 341(6145),* 508–13. http://doi.org/10.1126/science.1239402

Williams, R. (2019). Adjusted Predictions & Marginal Effects for Multiple Outcome Models & Commands *(including ologit, mlogit, oglm, & gologit2). 1–10.* https://www3.nd.edu/~rwilliam/xsoc73994/Margins05.pdf

World Bank 1986. Poverty and hunger: *Issues and options for food security in Developing Countries. A world Bank Policy Study*. Washington, D.C

World Bank Group. (2017). The Economics of Tobacco Farming in Indonesia. *The Economics of Tobacco Farming in Indonesia*. https://doi.org/10.1596/28568

World Food Program (2020). Report.

Xie2000_AppendixE.pdf. (n.d.).

Yamane, Taro. (1967). Statistics: *An Introductory Analysis. 2nd Edition*, New York: Harper and Row.

Zahid, A. and Ahmed, M. (2013). Socio-economic Determinants of Household Food Insecurity in Pakistan. *Munich Personal RePEc Archive*. Paper No. 21515.

APPENDICES

APPENDIX 1: COLLINEARITY DIAGNOSTICS FOR OLOGIT ESTIMATES

Table 29: Ologit Diagnosis

SQRT R-

Variable	VIF	VIF	Tolerance	Squared
Hfia_cat	1.37	1.17	0.7278	0.2722
Agegroup	1.11	1.05	0.9042	0.0958
Education	1.20	1.10	0.8325	0.1675
Job_status	1.25	1.12	0.8001	0.1999
Food_expense	1.13	1.07	0.8816	0.1184
Credit_access	1.26	1.12	0.7962	0.2038
Extensn	1.65	1.29	0.6045	0.3955
Soil_fertility_method	2.14	1.46	0.4662	0.5338
Fertlzer_bought	1.72	1.31	0.5802	0.4198
Fertlzer_cost	1.13	1.06	0.8845	0.1155
Labor_type	2.74	1.66	0.3645	0.6355
Capital_sourcing	3.17	1.78	0.3155	0.6845
Crop	2.03	1.43	0.4917	0.5083

Source: (Field data, 2021) VIF: Variance Inflation Factor

The result show that variance inflation factor (VIF) of all the independent variables were below 2. As a rule of thumb, if the VIF is greater than 5, then the variable is said to be highly collinear (Gujarati, 2003, pp. 328).

APPENDIX (2): HYPOTHESIS TESTING USING LIKELIHOOD RATIO TEST FOR OLOGIT PARAMETERS

Table 30: Approximation one

HFIA CAT	Coef	Std. Err	z
Agegroup	0.3716537	0.1648635	2.25
Crop	0.52152	0.05698	9.1526
Tobacco	0.49528	0.05698	8.6921
Sugarcane	-0.21682	0.21486	1.0091
Education	-0.2190648	0.0987488	-2.22

Source: (Field data, 2021)Pseudo R2 = 0.083, Prob>chi2 = 0.000, LR chi2(12) = 80.2

Table 31: Approximation two

HFIA CAT	Coef	Std. Err	z
Agegroup	0.35135	0.41311	0.8505
education	-0.19706	0.02429	-8.1128
job_status	0.25399	0.01732	14.664
food_expense	-0.00003	4.01e-06	-7.57
credit_access	-0.39143	0.06178	-6.3358
extensn	0.17414	0.68268	0.2551
soil_fertilitymthd	-0.17189	0.01971	-8.7209
labor_type	0.20672	0.04382	4.7174
capital_sourcing	-0.61674	0.04674	13.1951
crop	1.57754	0.82528	1.9115
tobacco	0.84209	0.23944	3.5169
sugarcane	0.84209	0.23944	3.5169
both			

Source: (Field data, 2021)Pseudo R2 = 0.082, Prob>chi2 = 0.000, LR chi2(11) = 79.27

LR chi2 (1) = 0.93

Prob> chi2 = 0.3361 (Accept hypothesis after test: tabulated figure is >)

APPENDIX 3: OLOGIT PARAMETER ESTIMATES

Table 32: Ologit Estimates

Variables	Coefficients	Std Error	z
Location	-0.0235733	0.030122	-0.78
Agegroup	0.3639895	0.1836046	1.98
Education	-0.1978869	0.0964712	-2.05
Job_status	0.2557124	0.791068	
Food_expense	0.0000303	0.323 0.000144	-
Credit_expense	-0.3921639	0.211 0.2875474	-1.36
Extension	0.1667479	0.2861774	0.58
Soil_fertility	-0.1747187	0.0861774	-2.03
Fertilzer_bough	-0.0023183	0.009263	-
Fertlizer_cost	-1.17e-0.6	0.250 0.000445	-0.03
Labor_type	0.2028897	0.1860508	1.09
Capital_sourcing	-0.6107323	0.1870594	-3.26
Crop	1.570841	0.3203449	4.90
Tobacco		0.3207925	4.51
Sugarcane	1.447473		
Both	0.966763	0.6064631	1.59
	Number ofobservation = 378, *Pseudo likelihood* = −422.1793		

APPENDIX 4: QUESTIONNAIRE

Questionnaire

SURVEY QUESTIONNAIRE
DETERMINANTS OF FOOD SECURITY IN SUGARCANE AND TOBACCO GROWING AREAS IN MIGORI COUNTY

Questionnaire No:			

SURVEY QUALITY CONTROL

Part I. IDENTIFICATION OF PARTICULARS

Name of Respondent ……. Tel NO…….

Name of the interviewer ……

Date of the interview……..

Start Time: ……/…../…… End Time: …./…../…….

Approved by the supervisor: YES/NO

Name of the Sub-county……..…

Name of Division……

Name of the Sub-location…….

Name of Location…….....

Name of the village……..

Name of the household……

This was a study of determinants of food security in sugarcane and tobacco growing areas in Migori County, conducted by Erick Anino student in the Department of Agricultural Economics and Resource Management, Moi University.

The information from this survey was used to better understand determinants of food security in the region.

Background Information

1. Gender

□Male □Female

2. What is your age?
3. What is your marital status?
4. What is the highest level of education you completed?

   □Primary □Secondary □College □University

5. Which of the following best describes your employment status?

   □Employed full-time □Employed part-time □Homemaker □Student

   □Retired □Unemployed, looking for work □Unemployed, not looking for work

6. Do you have off-farm income sources?
7. How much do you spend monthly on food?
8. How many people are you in your household?
9. Do you have other people who depend on you?
10. Are you a sugarcane farmer?

    □Yes □No

11. Are you a tobacco farmer?

    □Yes □No

12. Do you rotate the crops?

SECTION B: Household Food Insecurity Access Scale (HFIAS) questions

Question Code	Response option
1 In the past four weeks, did you worry that your household would not have enough food? 1a How often did this happen?	0 = skip to Q2 1 = yes 1 Rarely 2 Sometimes 3 Often
2 In the past four weeks, were you or any household member not able to eat the kinds of food you preferred because of a lack of resources?	0 = skip to Q2 1 = yes 1 Rarely 2 Sometimes

2a How often did this happen?	3 Often
3 In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = skip to Q2 1 = yes
3a How often did this happen?	1 Rarely 2 Sometimes 3 Often
4 In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = skip to Q2 1 = yes
4a How often did this happen?	1 Rarely 2 Sometimes 3 Often
5 In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = skip to Q2 1 = yes
5a How often did this happen?	1 Rarely 2 Sometimes 3 Often
6 In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = skip to Q2 1 = yes
6a How often did this happen?	1 Rarely 2 Sometimes 3 Often
7 In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = skip to Q2 1 = yes
7a How often did this happen?	1 Rarely 2 Sometimes 3 Often
8 In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = skip to Q2 1 = yes
8a How often did this happen?	1 Rarely 2 Sometimes 3 Often
9 In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = skip to Q2 1 = yes
9a How often did this happen?	1 Rarely 2 Sometimes 3 Often

SECTION C: Food Expenses and Home Production

Table1

	Food Purchases					Home Production	
	1Have you ever consumed (Food) during the past 12 months? If answer to Q1 is yes ask Q2-8	2 How many months in the past 12 months did you purchase (Food) If none, write 0 and go to Q5	In a typical month that you purchased (Food) How many did you purchase?	4How much would you have to spend to buy this quantity?		5 How many months in the past 12 months did you consume (Food) that you grow or produce yourself? If none write 0 and go to Q8	6In mo wh ate (Fo mu yo ho co of.
Food	Yes-1, No-2	Months	Qnty	Units	Kshs	Months	Qn

Staple food crops						
Maize						
Maize grain						
Maize flour						
Beans						
Peas						
Cow peas						
Green/black grams						
Secondary foods						
Cerials						
Rice						
Sorghum grain						
Sorghum flour						
Millet flour						
Breads						
Wheat grain						
Wheat flour						
Prepared bread						
Livestock products						
Meats						
Beef						
Chicken						
Mutton						
Fish						
Goat						
Other meat						
Omena						
Fresh milk						
Eggs						
Green leafy vegetables						
Pumpkin						
Green bananas						
Fruits						
Pineapples						
Oranges						
Ripe bananas						
Mangoes						
Paws paws						
Avocadoes						
Guavas						
Lemon						
Loquarts						
Other fruits						
Other Foods						
Oils and fats						
Groundnuts						
Coconut						
Cooking oil						
Cooking fats						
Margarines						
Salads						

Other traditional oils and fats **Sugar** Sugarcane Manufactured sugar Jaggery						

Source: (Ondari, 2011)**Unit Codes**: Kilograms.1, Tins(Debes).2, Gorogoro(2kg tin).3, 90KG Bags(Gunias).4, Crates.5, Bunches.6, Litres.7, Other(Specify).12, Bundles.11

SECTION C

Socioeconomic Questions Related to Production

1. Do you belong to any social networks?

   □Yes □No

2. Have you ever been assisted by an extension officer in your farm?

   □Yes □No

3. Do you consider your farm as fertile?

4. Which method do you use to fertilize your land?

5. How much fertilizer did you buy and apply on your farm in the past 12 months?.....kgs

   What price did you pay per bag? Kg….

6. Do you have access to a source of water?

   □Yes □No

7. Which kind of labour do you use on your land?

8. How many acres of land do you own?.....acres

9. What is the size of land under the crop(s) in the last two seasons?

10. What is the size of land under other crops in the last two seasons?

11. How do you source for capital used in your farming enterprise?

12. Have you any access to a credit facility

□Yes □No

If yes, how many times did you seek credit from any facility in the last 3 years?

13. How does access to credit affect your food security situation?

14. How much yield/output did you get from the enterprise in the last two seasons?

15. Do you engage in other crop enterprises?

□Yes □No