DETERMINANTS OF HOUSEHOLD DIETARY DIVERSITY AMONG SMALLHOLDER MAIZE FARMERS IN UASIN GISHU COUNTY, KENYA

BY

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A56/11809/2018

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DEPARTMENT OF AGRICULTURAL ECONOMICS

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DECLARATION

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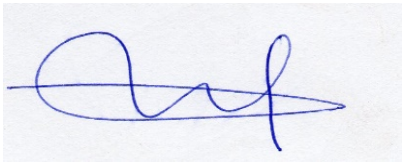
Signature:  Date: 29th July 2021

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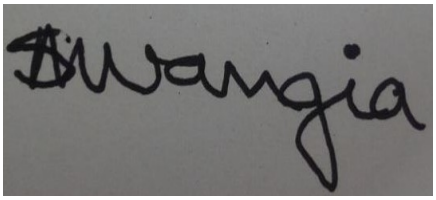
Signature:  Date: 29th July 2021

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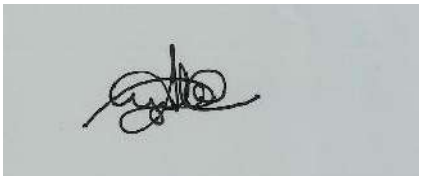
Signature:  Date: 29th July 2021

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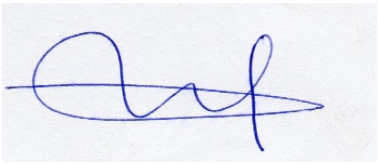
Signature:  Date: 29th July 2021

DEDICATION

This thesis is dedicated to my late father Panchol Magot.

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ASALs	Arid and Semi-Arid Lands
CIMMYT	International Maize and Wheat Improvement Center
ESA	Eastern and Southern Africa
FCS	Food Consumption Score
FIES	Food Insecurity Experience Scale
FNS	Food and Nutrition Security
FNSP	Food and Nutrition Security Policy
FNSS	Food and Nutrition Security Strategy
GDP	Gross Domestic Product
GoK	Government of Kenya
HDD	High Dietary Diversity
IDDS	Individual Dietary Diversity Score
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPIN	Integrated program for Improved Nutrition
KNBS	Kenya National Bureau of Statistics
LDD	Low Dietary Diversity
MDD	Medium Dietary Diversity
NFNSP	National Food and Nutrition Security Policy
SDG	Sustainable Development Goals
WCA	West and Central Africa
WFP	World Food Program

ABSTRACT

Kenya's economy is highly dependent on agriculture with maize being grown nearly in all parts of the country mainly under rain fed environmental conditions and is a food for 98% of the population in Kenya. With most of households with area dependent on maize production, this raises a need to raise income to purchase other food to diversify their diets by selling the portion of their maize produced. This will prove a problematic with the region experiencing a decline in production. Inadequate dietary diversity is a principal cause of malnutrition which amplifies health risk such as stunting and wasting. Their diets are mainly derived from the staples foods which are rich in carbohydrates but low in vitamins and minerals. Lack of nutritional awareness and education for those who prepare food among rural households make them believe that they have consumed enough food without taking into account the dietary requirements. Incorporating food groups with high micronutrients like animal products and fruits can improve the quality of diets through increased dietary diversity.

The purpose of the study was to establish the determinants of household dietary diversity among smallholder maize farmers in Uasin Gishu County of Kenya. The specific objectives were to estimate household dietary diversity status and to determine the various factors affecting household dietary diversity. A semi-structured questionnaire survey was employed, with a multistage sampling procedure undertaken to draw 384 farm households. Descriptive statistics was used to estimate household dietary diversity status and multinomial logit model was utilized to examine various factors determining household dietary diversity.

The results from the descriptive analysis showed that average dietary diversity score was 1.9 + 0.8 SD. About 25.5% of the sampled households reported a low dietary diversity status, 54.7% reported medium dietary diversity status and only 19.8% reported high dietary diversity status. The findings further showed high consumption of cereals, milk and vegetables in the last 24 hours. Results from multinomial logit model revealed that knowledge of dietary diversity, education level, age of household head, crop enterprises, livestock holding, extension, credit, storage and annual maize income have significant and positive effect on household dietary diversity. Meanwhile off-farm income, meal frequency and annual maize yield have negative effect on household dietary diversity. The study recommends policy intervention to continue

providing households with latest nutritional knowledge, awareness and training on the importance of diverse diets. The study further recommends provision of agricultural technologies and the promotion of the use of modern storage facilities to boost food production and income of smallholder farmers which in turn enhances household dietary diversity.
Keywords: Maize farmers, dietary diversity, household

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Maize is a high yielding grain being grown nearly in all parts of the country mainly under rain fed environmental conditions and is the main staple food for 98% of the population (Onono et al., 2013). Maize production currently in Kenya covers about 1.5 million hectares out of 5.3 million hectares of total arable land, with an annual average production estimated at 3.0 million metric tons, with a mean yield of 2 metric tons per hectare (CIMMYT, 2015). However, the potential national average yield is estimated at 5-6 tons per hectare, this leaves the country to relay on imports to meet the deficit (Mulwa et al.,2015). The reasons ascribed to this low yield are soil erosion, crop diseases, unpredictable weather, lack of extension services and inadequate fund to purchase fertilizers (Chebet el al., 2018). Nevertheless, Kenya experienced a sudden rise in maize production from 3.47 million tons in 2010 to 4.4 million metric tons in 2018, attributed to the increased area under production and use of fertilizer (World Bank, 2019).

Uasin Gishu County is among the leading maize producers in the Rift Valley ‘‘the country’s breadbasket’’ (Wamunga et al., 2015). About 75% of maize is produced by smallholder farmers who occasionally sell their surpluses to purchase other consumer goods. Additionally, maize production employs 70% of the rural population (Olwande, 2012). Therefore, any distortion in maize production has negative impact on both household per capita consumption and income. Maize has a great potential to enhance household income as can be utilized for human consumption, animal feed and as an industrial crop (Njagi, 2017). In recent years, increased maize production has been influenced by increased demand in consumption. However, about 58% of farmers’ total maize output in Kenya is purposely maintained for household consumption (Onono et al., 2013).

Food security exist when all people, at all times, have, physical, social and economic access to sufficient, safe and nutritious food which meet food choices and their dietary requirements for an active and healthy life (FAO, 1996). At population level, dietary diversity is a proxy of food security and as a true indicator of micronutrients intake (FOA, 2011). Inadequate dietary

diversity is attributed to food insecurity, poverty and low production among smallholder farmers, leading to chronic energy deficiencies among women and children (Eshete et al., 2018). Dietary diversity simply refers to an increase in the number of different food groups consumed by household in a reference time period, resulting in good health and nutrition (Taruvinga et al., 2013). Standard dietary intake needed to meet the nutritional requirements of a person is related to food groups consumed and the quality of diets (Abongo, 2017). Inadequate dietary diversity is a major obstacle facing most developing countries owing to poor diversity and repetitive diets (Mwanamwenge and Harris, 2017).

Food security implies four aspects that is access to food, availability of food, utilization and food stability (FOA, 2011). Food availability is attainable if all individuals acquired sufficient food quantities; while access is achievable when a household possess ample means of resources to have food to meet their dietary and nutrition prerequisites. Food utilization bears some components of public health; as a result, it is related to the use of essential nutrients, along with access to portable water, adequate sanitation and energy-based diets. Lastly, food stability relates to the ability to obtain food overtime, since food may be unavailable during certain period of time (IFAD, 2016). Furthermore, these four aspects of food security play a greater role in influencing dietary diversity status of a household (FOA, 2011).

Undernutrition is a stern global health issue that has not been addressed sufficiently. About 690 million people were undernourished in 2019, with the biggest proportion from Asia (381 million people), followed by Africa (250 million people) and Latin America and the Caribbean with 48 million people (World Bank, 2019). According to Kenya's Food and Nutrition Security Policy (FNSP, 2017) it is reported that 2.6 million people faced acute food shortage with a global hunger index score of 25.20% in late 2019. In spite that Kenya has been doing a significant change in nutrition security after decades of stagnant decline, inadequate child and infant feeding practices had led to high malnutrition. In Kenya, the prevalence of stunting, wasting and mortality rate in under-five years' children is 26%, 4.20% and 4.60% respectively; with 23% of the population undernourished (World Bank, 2019).

In 2018, Kenya had an estimated poverty rate of 29.2% a significant dropped from 36.8% in 2015 and 43.7% in 2005 (World Bank, 2018). With Kenya been classified as a lower middle-income country, its annual GDP per capita grew by 2.4% between 2007 and 2017 (World Bank, 2018). However, the country's rapid population growth from 37.7 million in 2009 to 47.6 million in 2019 jeopardizes efforts to fight undernutrition (KNBS, 2019). As a result of this upturn, parcels of land in high agricultural potential zones are diminishing in size leading to swaying production of food which contributes to an increase in the poverty rate and subjecting households particularly women and children vulnerable to malnutrition (WHO, 2010). The country's rate of poverty is not responsive enough to agricultural production, implying the requisite for comprehensive future growth in agricultural sector (Wamunga et al., 2015).

The United Nations Second Sustainable Development Goal (SDGs) that is "zero hunger" aims at enhancing nutrition, attaining food security, and to curb hunger through sustainable solutions by 2030 (Abidemi, 2016). The target is to ensure that everyone everywhere has enough good-quality food to lead a healthy life. Achieving this goal will require better access to food and the widespread promotion of sustainable agriculture in developing countries (Obayelu and Osho, 2019). This entails improving the productivity and income of small scale farmers by promoting equal access to land, technology and markets, sustainable food production systems and resilient agricultural practices (Njagi el al., 2017).

To achieve the above goal, Food and Nutrition Security Strategy (FNSS), developed from Kenya's Food and Nutrition Security Policy (FNSP, 2017) identifies priority interventions and delegates responsibilities among the key players in nutrition and food security. These responsibilities include; raising average caloric intake, promotion of agricultural led-growth, breastfeeding, Vitamin A and micronutrient supplementation for children; these interventions have been proven to be effective in reducing malnutrition and food insecurity in the country (Mohajan, 2014).

1.2 Statement of the Research Problem

In recent years, Kenya's maize production had gradually increased to 4.4 million metric tons in 2018, but decreased to 3.80 tons in 2019 (FAOSTAT, 2020). Yet this increase in maize yield had never been reflected in term of reducing malnutrition. Given Uasin Gishu County productivity, nearly 31% and 11% of children under-five years are stunted and wasted respectively; however, this trend is expected to increase (KNBS, 2019).

Inadequate dietary diversity continues to be a major problem for smallholder farmers in Kenya (Abongo, 2017). Their diets are mainly derived from the staples and starchy-based foods which are rich in carbohydrates such as ugali (stiff porridge), being the main staple food for Kenyans, but low in vitamins and minerals. Consuming staple food group can increase the availability of energy though does not enhance good nutritional outcome. Even if enough food is available, the majority of rural households do not receive proper nutrients due to poor knowledge of what comprises of an adequate diet. Lack nutritional awareness and education among those who prepare food in the household make them believe that they have consumed enough food without taking into account the dietary requirements. Incorporating food groups with high micronutrients like animal products and fruits to supplement staple-source food groups can improve the quality of diets through increased dietary diversity.

Lack of dietary diversity is the principal cause of malnutrition and as a disposing factor that amplifies health risks like child stunting and loss in weights, as is the case in Uasin Gishu County, reduces productivity, slow economic growth and perpetuate cycles of poverty. Poor maize yield results into low calories uptake and food insufficiency for households where maize is the primary source of livelihoods. This is of significance since maize provides 40% of dietary calories with 125 kg per capita consumption in Kenya (Kamenwa, 2017). Given Uasin Gishu County location, increased urbanization and rapid population growth, the demand for food especially maize is expected to increase (Wamunga et al., 2015). With most household with the area dependent on maize production, this raises the need to raise income to purchase other foods to diversify their diets by selling a portion of their maize produced. This will prove problematic with the region experiencing a decline in production.

Several studies argue that dietary diversity is directly related to higher socioeconomic factors of a household (Wamunga et al., 2015; Mukhoyani, 2017; Rajendran et al, 2017; Chebete et al., 2018). From the background information, it is clear that most of the previous studies have been undertaken on individual dietary diversity at the expense of population level dietary-quality (Kiboi et al., 2017; Gitagia et al., 2019). However, this study focuses on household level dietary diversity which is instrumental for individual dietary-quality policy intervention.

To ascertain the fundamental determinants on quality and diverse dietary intake, it is imperative to understand factors such as employment status, land and income characteristics of the household that influence access to food and dietary practices. Moreover, there is an insufficient information on how diversified these farming households in term of production and consumption. Furthermore, limited information has prompted a study to be undertaken about the determinants of household dietary diversity among smallholder maize farmers to fill these knowledge gaps.

1.3 Objectives of the Study

The overall objective of this study was to establish the determinants of household dietary diversity among smallholder maize farmers. The specific objectives were:

i. To estimate household dietary diversity status of smallholder maize farmers in Uasin Gishu County.
ii. To determine the various factors affecting household dietary diversity of smallholder maize farmers in Uasin Gishu County.

1.4 Research Hypotheses

The following hypotheses were tested:

i. Household's food consumption does not meet requirements for adequate dietary diversity status of smallholder farming households.
ii. Socioeconomic (gender, age, education), own production (annual maize yield, livestock holding) institutional factors (credit and extension) and postharvest practices (storage and threshing) do not affect household dietary diversity of smallholder maize farmers.

1.5 Justification of the Study

This study aims to show how lack of economic access to diverse food is the primary cause of malnutrition. Smallholder farmers are devoted to commercialization and production of maize, which may basically improve the income of a household, yet is not paramount to attain a corresponding decline in nutritional outcomes, but farm production diversification is a viable livelihood strategy that improves household dietary quality and food security. Since malnutrition and hunger are still eminent in Kenya, particularly among smallholder farmers, creates the need to establish the determinants of household dietary diversity on account that these diets are commonly limited in rural settings from developing countries. Furthermore, there is a need to induce food crop production and agriculture become highly nutritious-responsive.

Findings of the study will serve as a basis for interested researchers that study maize and notably its association with household dietary diversity in Uasin Gishu County, is of greater extent significance for research to inform the policy-makers. This will also advance knowledge of the determinants of farm household dietary quality in the context of institutional, socioeconomic, and post-harvest constraints face by farmers.

This research is important for policy makers in evaluating the extent of dietary diversity, which eventually would help inform both predictions about future development in household dietary diversity and policies that might improve household dietary diversity. The findings of the study will help Government of Kenya in meeting the United Nations Sustainable Development Goal number one and number two of ‘‘no poverty’’ and ‘‘zero hunger’’; Kenya’s big four agenda (manufacturing, affordable housing, health care for all and food security) and Kenya’s Vision 2030 (towards accelerating sustainable growth, reduce inequality and manage resource scarcity) under economic pillars.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concept of Smallholder Farmers in Kenya

The term ‘‘Smallholder farmers’’ exemplifies to farmers cultivating less than 2 hectares of land for maize farming, though the large- scale farmers do not exceed more than 40 hectares (FAO, 2014). Expediting smallholder’s transformation in relation to commercial- oriented production can be a viable step to reduce poverty among smallholder farmers and also enhance their access to modern inputs (Cheruiyot and Boit., 2017).

Maize farming has been practiced in the country for a long time since it was introduced by the Portuguese in the 16th century (CIMMYT, 2015). A report from the Government of Kenya in the year 2017 indicated that 70% of the total maize production comes from smallholder farmers, but their yield is significantly very low. The rest of 30% of maize is being produced by large-scale commercial farmers. Smallholder farmers reserve around 58% of their overall maize produce for consumption at the household level (GoK, 2017). This is an indication that most farmers produce maize for subsistence, but sell the surplus to generate necessary income utilize in the purchase of other consumer goods and farming inputs (CIMMYT, 2015). In this way, the producing households exhibit the dual character of being both producers and consumers (Njagi et al., 2017).

2.2 Maize Production Trends in Kenya

A report from the Ministry of Agriculture (2011) indicates that maize accounts for more than 51% of all staple food grown in the country. Maize is Kenya’s most important crop which accounts for 1.5 million acres out of 5.3 million acres of all crops harvested area. Counties highly suitable for maize productions are; Trans Nzoia, Uasin Gishu, Kakamega, Nakuru, Embu, Nyeri, Kirinyaga, Taita-Taveta and Kwale (CIMMYT, 2015). However, maize is produced in nearly all 47 counties.

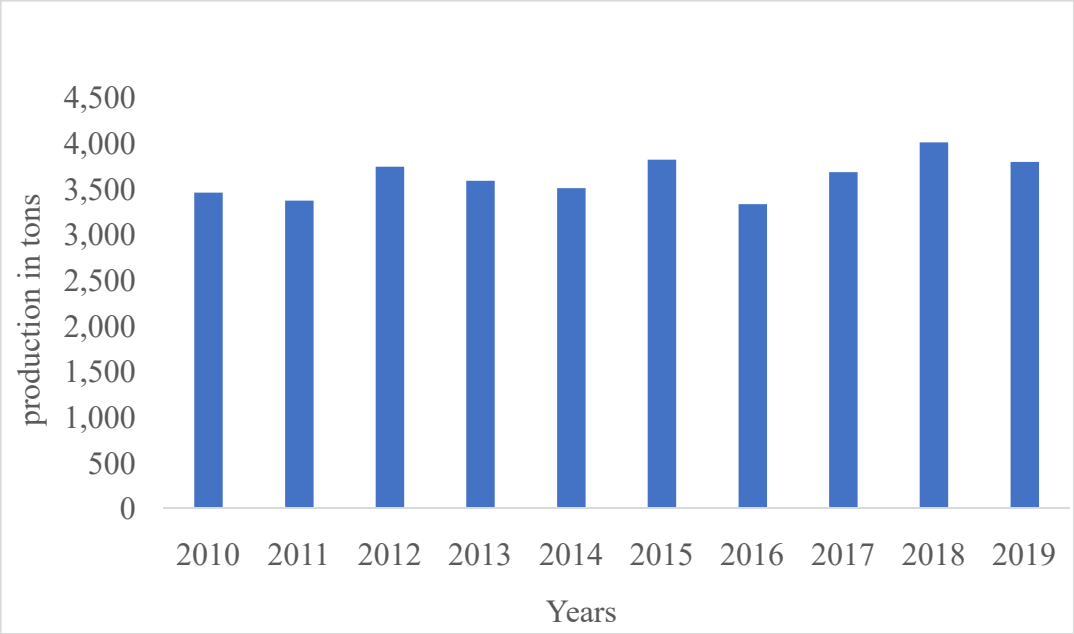

Figure 1.0: Kenya's maize production trends (2010-2019).

Source: World Bank (2019)

In Figure 1 above, maize production in Kenya was 3.5 million tons in 2010, and has remained relatively the same till 2014. This suggests that yields remained at an average of 3 tons per hectare below the possible attainable 6 tons. However, maize yield started to increase in 2015 to 3.8 tons and drastically began to reduce in two years of 2016 and 2017 at 3.3 and 3.6 tons respectively; with an increase in 2018 to 4.010 tons. Again, another slight decrease was experienced in 2019 with 3.8 tons. Increase in maize yield in 2018 attributed to the March-April rains that resulted in the normal rainfall in most parts of the county (World Bank, 2019).

Decline in maize production in 2016 and 2017 in Kenya had been as a result of drought that engulfed the country (Mulwa et al., 2015). Apart from changes in climatic conditions, other challenges that maize farmers faced include limited agricultural land expansion, low and declining soil fertility, low producer prices, inadequate amount of certified seeds and delayed supply in the market system and slow pace of hybrid replacement, crop disease and poor quality seeds (Mbithi, 2018).

The effects of changing climate are seen through increased incidence of floods and droughts, increased soil erosion, deforestation, loss of soil fertility and reduced productivity, especially in Kenya's arid and semi- arid lands (ASALs) in the North and East. Other parts of the country such as Rift valley province have been experiencing droughts and floods while the coastal areas have seen a rising sea levels and saltwater intrusion (Ochieng et al., 2016).

2.3 Maize Consumption and its Contribution to Dietary Diversity in Kenya

Given an average consumption requirement of more than 3.5 million tons per year, Kenyans consume maize in a wide variety of ways (ugali, porridges and as local breweries). Green maize, fresh on the cob, is eaten inform of roasted or boiled separately or mixed with legumes (Robert et al., 2014). The grain, cob, tassel, leaves, and stalk can all be used to produce a large variety of non-food products, animal feed and human food. Every part of the maize plant has economic value (Olwande, 2012). According to Cherop (2017), 44% of the Kenyan household consume ugali (stiff porridge) seven times in a week and about 10% of the households consumed it more than ten times a week. Githeri (boiled maize and beans) was consumed seven times a week by 35% of the families. This reaffirms the increasing consumption rate of maize in the country in the form of stiff porridge (ugali).

2.4 The State of Malnutrition: Africa and National Perspectives

2.4.1 Malnutrition in Africa

A report from International Fund for Agricultural Development (IFAD, 2016) noted that in the last decade, there had been impressive performance in improvement in economic growth, but in Africa, much progress has not been seen in overcoming its key challenges such as food insecurity, poverty and youth unemployment (Kalkuhl et al., 2013). As a result, many African countries have since 2008 reinforced their commitment to align with the comprehensive Africa agriculture development program (CAADP) strategies and policies to consolidate its implementation to their respective national agricultural strategies (FOA, 2018). In Africa, the prevalence of undernourished people marginally keeps on increasing in each year as shown in Fig 2, with the exception of successive slightly declined from 21.7% in 2010 to 20.9% in 2015. However, consecutive increment begins from 22% in 2016 to 23% in 2019 (World Bank, 2018).

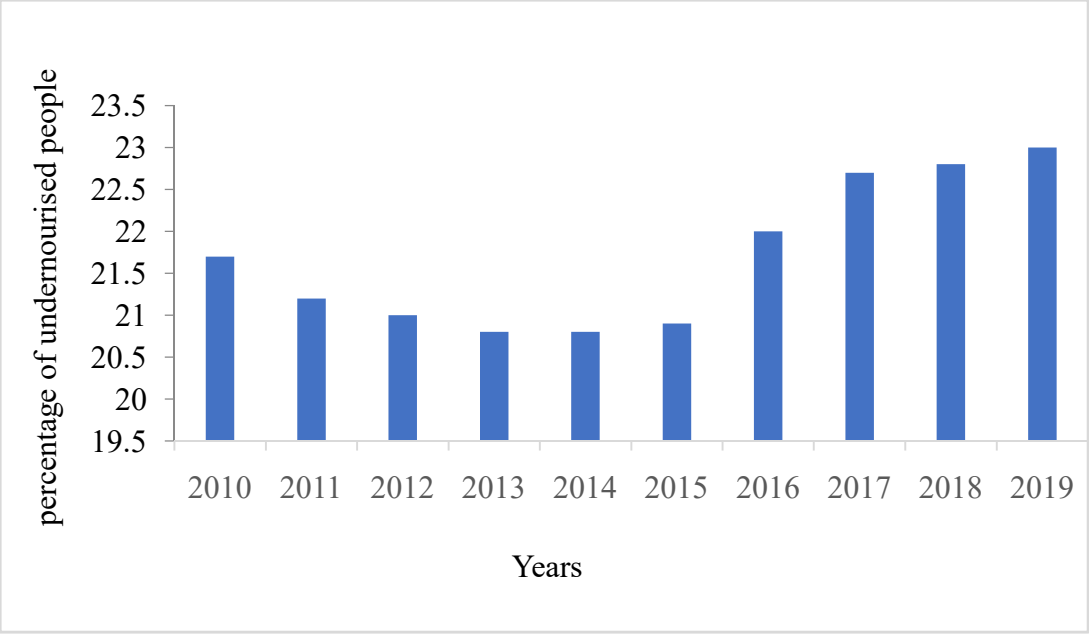

Figure 2.0: Prevalence of undernourishment trends in Africa (2010-2019).

Source: World Bank (2019)

Despite the minimal stability in general food prices in 2017, drought continued to affect some countries as a result of low rainfall, leading to rise in malnutrition in those countries like Ethiopia, Kenya, South Sudan, Burundi and Congo (IFPRI, 2019). In regards to 2019, over 40% of children -under five years were stunted and 6.4% wasted in Africa (UNICEF, 2020).

In 2019, Eastern Africa sub-region constituted the highest stunting rate at 34.5% though ranked second in wasting rate at 3.6% after Western Africa with 4.8% in 2019, as shown in Figure 2.1 below. Other African regions were ranked as follows, 31.5% in stunting in middle Africa, 29% in Southern Africa, 27% in Western Africa and 17.6% in Northern Africa (FAOSTAT, 2020). In the case of wasting, it was reported to be 2.1% in Northern Africa, 2% in Middle Africa and 0.2% in Southern Africa (UNICEF, 2020).

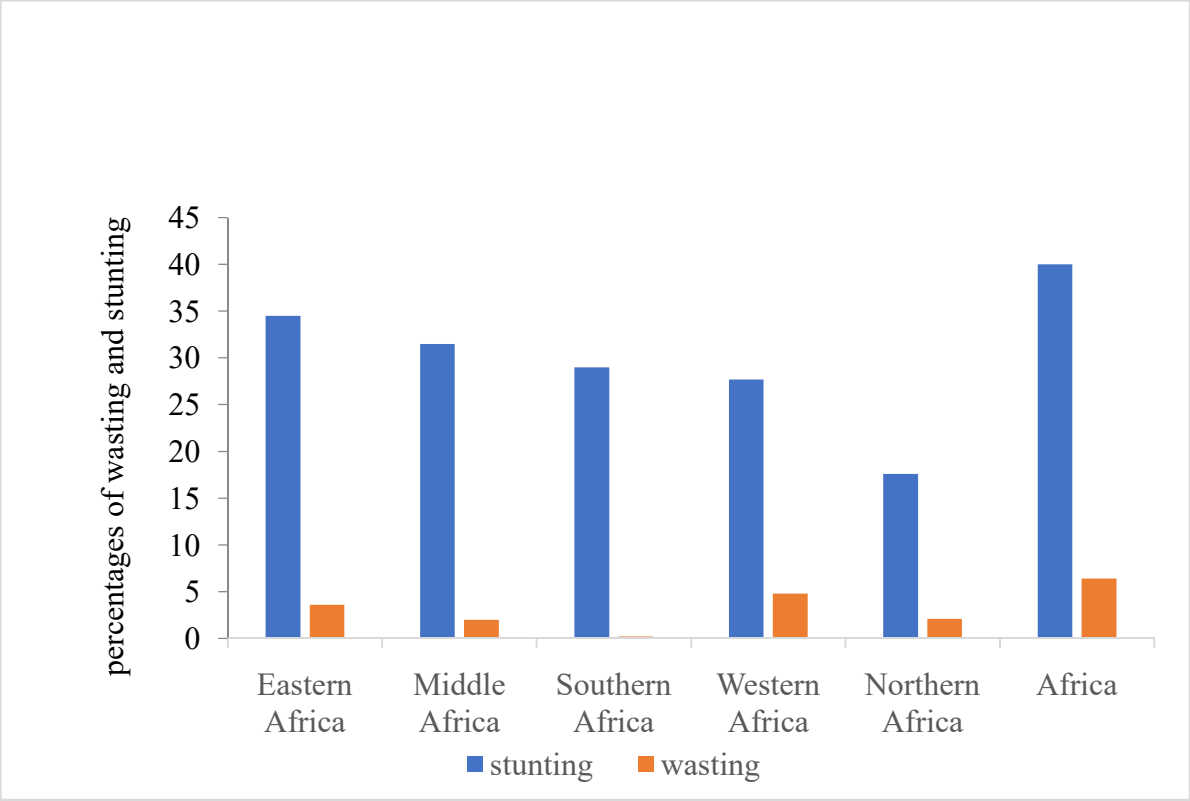

Figure 2.1: Africa's stunting and wasting by sub-region in 2019.

Source: World Bank (2020)

2.4.2 Malnutrition in Kenya

Prevalence of undernourishment rate in Kenya which reflects the proportion of the population with less recommended calories (less than 25,000 kal) consumption per a day (WHO, 2010) has been gradually declined from 23.5% in 2010 to 22.8% in 2014, but rise considerably from 25% in 2015 to 29.4% in 2017. This follows the same trend line with the African trend line. This hiking concurred with 2016-2017 droughts that tormented Kenya and its neighboring countries triggered a reduction in agricultural production and increase in food prices (World Bank, 2019).). Then followed a slight consistent drop to 24.2% in 2018 and 23.4% in 2019 as shown in figure 3 below (FAOSTAT, 2020).

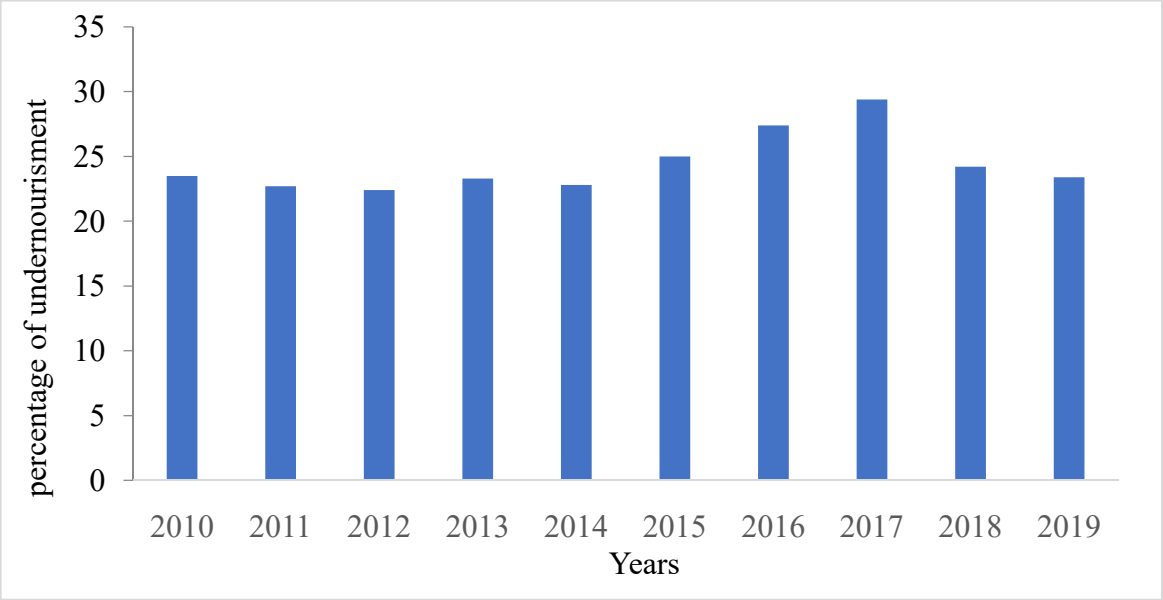

Figure 3.0: Prevalence of undernourishment in Kenya (2010-2019).

Source: World Bank (2019)

Kenya has made a substantial reduction in the stunting prevalence, though the rate of stunting is still very high in the Rift valley, Eastern and Coast, regions. Moreover, the country has not yet attained an acceptable target of 16% as set by the Kenya's National Nutrition Action Plan 2012-2017 (NNAP). In 2015, the national stunting rate was estimated at 17% dropped from 35% to 26% in 2008 and 2014 respectively (KNBS, 2015). Meanwhile, amongst children under five years of age, level of acute undernourishment (low weight-for-height or wasting) is relatively low (4%) in the country. Meanwhile the rate of underweight in children under-five years is 11% as shown in figure 3.1 below. Undernutrition in Kenya is not more associated with the degree of poverty but determined by set of complex components like, care giving practices and proper hygiene, feeding diseases along with dietary diversity (FNSP, 2017).

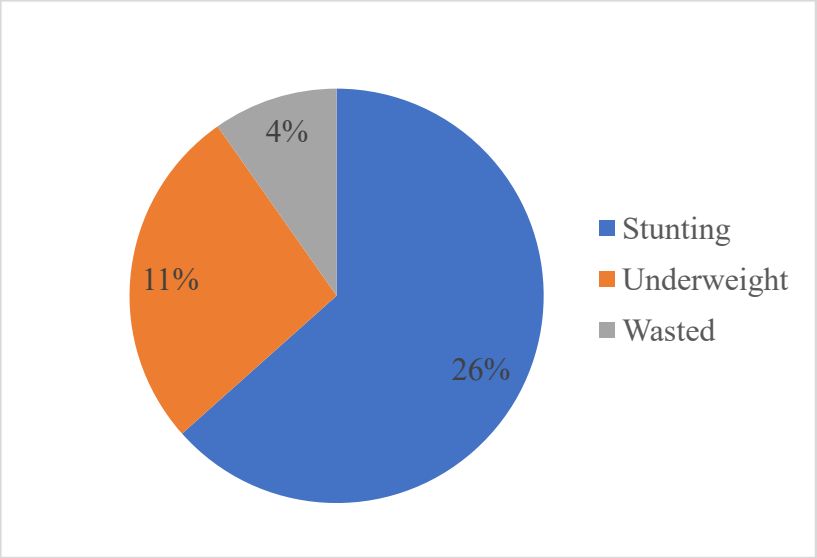

Figure 3.1: Undernutrition in children under-five years in Kenya

World Bank, (2014)

In 2018, Uasin Gishu County poverty rate was 34%, dropped from 41.4% in 2015% (FNSP, 2017). Given the county's rapid population growth from 894,179 in 2009 to 1,163,186 in 2019 (KNBS, 2019) package of land in the principal zones of immense farming practices are diminishing, negatively affecting yield of food and may give upturn in the rate of poverty among people, leading to the higher risk of vulnerability among women, children and young people to malnutrition in the County (KNBS, 2015).

Fig 3.2 below described the nutrition status of the children under-five years in Uasin Gishu County. Approximately, 31% of children under-five in the County are stunted, 11% underweight and 3% wasted. Generally, children who are stunted before the age of five have high probability of under-performing in school (KDHS, 2018). Factors such as poor care giving practices, burden of diseases, lack of access to adequate sanitation and low food diversity negatively affect level of child nutrition status in the County (KDHS, 2014).

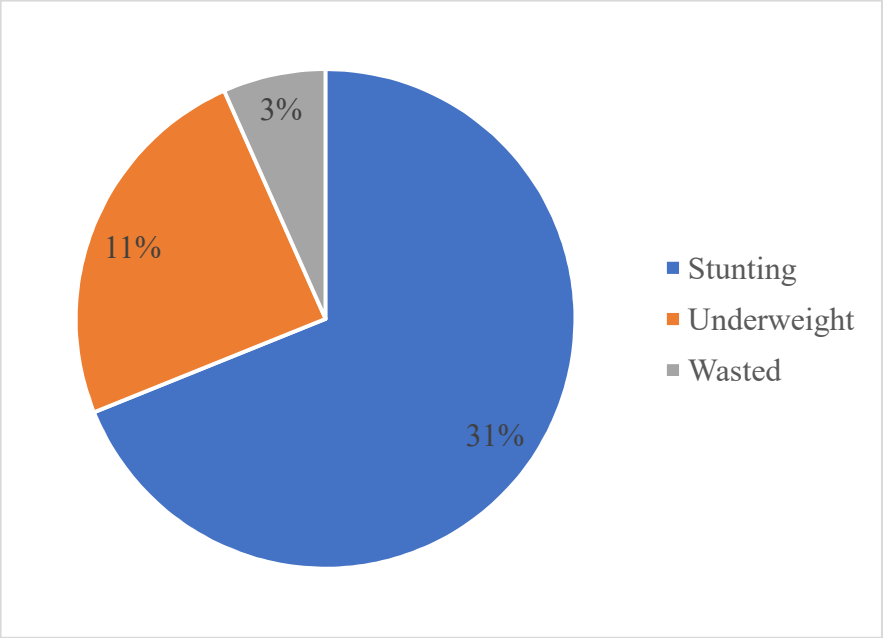

Figure 3.2: Undernutrition in children under-five years in Uasin Gishu County

Source: KNBS (2015)

2.5 Empirical Studies on Measures and Factors Determining Dietary Diversity

2.5.1 Approach for Measuring Dietary Diversity Status

2.5.2 The Food Consumption Score (FCS)

FCS is the counting of personal food units eaten over a certain period of time which incorporates dietary diversity and food frequency at the household level (WFP,2015). FCS is the complex food security indicator at the level of household which includes not only dietary diversity but the corresponding nutritional significance of various food types. FCS is an indicator which was invented by the World Food Program in 1996 (WFP,2015).

FCS can be calculated using the frequency of consumption of the 16 pre-defined various food combinations eaten by household in the course of seven days prior to the survey (FOA, 2011). The frequencies of consumption are added up and multiplied by the proportionate weight of foods. Consumption of food by a household could be divided into three tiers: acceptable, borderline or poor (Torheim et al., 2004)). Food like products from animal sources is bound to bigger weight than least nutritionally foods, like tubers and roots. FCS could feasibly be good

enough in scrutinizing households in various situations together with tracing periodical alterations in the household diet on the occasion of being collected regularly over seasons or annually (FOA, 2018).

2.5.3 Individual Dietary Diversity Score (IDDS)

IDDS is commonly used for children 6-12 months and women 6-49 years of age (FOA, 2014). Individual dietary diversity is the dichotomous indicator use to assess the sum of group of foods consumed by specific target group the previous day or night (FOA, 2014). IDDS is based on nine food groups for woman and seven food groups for children over the previous day (FOA, 2011) and can be utilized as an index of greater micronutrient competency. They are tightly associated with the dimension of diet quality like stunting, underweight and wasting, therefore considered as the reasonable proxy for the access dimension of food security (Marivoet et al. 2019; WHO, 2010).

2.5.4 Household Dietary Diversity Score (HDDS)

Household dietary diversity score concerns with the calculation of sum of all the different food groups a household had consumed over a certain time period (Swindale and Bilinsky, 2006). HDDS as a population-level indicator of household access to food which came into use in 2006 as component of Food and Nutritional Technical Assistant (FANTA Ⅱ) program. Furthermore, HDDS is a true indicator of the food security situation of a household since the degree of a household dietary diversity is associated with proportion of protein from animal sources and household income (IPIN, 2015).

HDDS is a ratio that serves to provide a glance of a household's socioeconomic status as well as its access to food (FOA, 2014). The highest household score is based on the nutritious twelve (12) combinations of foods: vegetables, Fish and sea foods, Sugar, Cereals, Condiments, Meat, Eggs, Roots and tubers, Oil and fat, Milk and dairy products, Fruit, Pulses and nuts.

Furthermore, there is no common threshold or target level showing that a household is adequately diversified. Any class of foods is assigned a score of 0 if not consumed, 1 if consumed (FOA, 2011). Food and Nutritional Technical Assistant (FANTA) in 2006, suggested two options for determining appropriate targets; first, the usage of the patterns of dietary diversity for wealthiest households, the richest 33% as target on the premises that, as income of poorer household increases, their dietary diversity increases as well. Secondly, is by setting a target through the average of 33% of households with highest diversity score (FOA, 2011).

This approach has been used by several researchers to ascertain the dietary diversity status of rural households. Taruvinga et al., (2013) used the household dietary diversity score to estimate household dietary diversity status among smallholder farm households in Nyandeni district, South Africa and found that about 53% had low dietary diversity status. Motuma et al. (2019) utilized this approach to discover that 69% of the smallholder farm households in Southwest Ethiopia were classified as high dietary diversity status.

2.6. Determinants of Household Dietary Diversity

There is mixed empirical evidence in the literature about the factors determining household dietary diversity. Different empirical studies discovered a couple of factors that affect households and individual dietary diversity (Njoroge et al., 2019; Mbithi, 2018; Akerele et al., 2017). Among the numerous factors are the following: 1. Socioeconomic factors (age of household head, the gender of household head, educational status). 2. Own-Farm production (quantity of own food produced, farm size). 3. Institutional factors (credit, market access and access to extension services) and 4. Postharvest practices (storage, threshing, millings, drying,).

2.6.1 Socioeconomic Factors

Household size was measured in total number of people living in the household and is a significant factor which influences households access and demand for food. Mbithi (2018) reported a negative relationship between house size and dietary diversity. The reason is that, household demand for food is dependent on household size, which entails that, the larger the household size, the higher the household demand for food. Household size was expected to negatively influencing household dietary diversity.

Gender of household head is very crucial in determining household dietary diversity because head of the household has control over decision-making regarding household resources. Gender was captured as female-headed or male-headed household. Taruvinga et al. (2013) found a negative significance association between gender and high dietary diversity. Reason being that households headed by females have higher probability of achieving high dietary diversity than male-headed households. Therefore, gender can have positive or negative influence on household dietary diversity.

Income is defined as the value of total earnings generated from the sale of farm produce, livestock and other assets as well as earnings from off-farm activities (Snapp and Fisher, 2015). Farmers in most cases are engaged in income generating activities, be it off-farm or on-farm income meant to complement what they normally obtain from their main farming activities which are not enough to finance their consumption expenditures (Sibhatu and Qaim, 2018). The nature of income activity a household head involves in could determine food access and other social services that the household wants. It was therefore theorized that both off-farm and on-farm income have positive influence on dietary diversity (Gitongaet al., 2015; Wakweya, 2010).

The effect of education on household dietary diversity was expected to be positive. Kiboi et at. (2017) who studied determinants of dietary diversity among women in Kenya reported that households who have more advanced level of education had higher odds of having inadequate dietary diversity. The higher the level of education, the greater the necessary clue on pertinent practices of feeding. On the other hand, Cherop (2017) reported that a mother's education level has visible influence on the nutritional status of the children.

Knowledge of dietary diversity enables households to ensure proper selection of food for good health. This implies that knowledge provides consumer information which would help to consume food wisely and relevant skills needed to prepare food well (Nsele,2014). However, Motuma et al. (2019) found a positive correlation between household knowledge of dietary diversity and dietary diversity. Knowledge of dietary diversity was hypothesized to be positive.

2.6.2 Own Farm production

Farm size is often measured in hectares, describes the overall land area a household possesses and uses for the cultivation of staple and cash crops, rearing of livestock among other agricultural activities. The findings of Rajendran et al. (2017) established a positive relationship between the size of farm land and improvement in income and dietary diversity status at the household level. Households with larger farm size are expected to increase the level of production and increase household access to food. Households with bigger size of land have great chances of having a higher dietary diversity in respect to households with a smaller size of land (Mbwana et al., 2016).

2.6.3 Institutional Factors

Access to credit characterizes the capacity of the household to acquire fund for the purpose of consumption or financing of their farm ventures. Studies have indicated that when households managed to secure credit to purchase agricultural inputs, it would enhance farm production which also augment household income and consumption thus, have positive effects on food security (Farida, 2014; Bimerew and Beyene, 2014).

Extension service is a vital factor to boost food production. As time goes, research has been conducted to discover new technologies that will enhance cost effectiveness in food production and agricultural investments. Affirming to this assertion, extension delivery to the smallholder farmers encourages the adoption of these new innovations to increase household food production and can positively influence household dietary diversity (Mazunda and Droppelmann,2012). Therefore, if the extension service is not delivered on time, then the smallholder farmers may misuse the technologies and incur losses in their farm investments which can eventually lead to low productivity and reduce income. The hypothesized influence of extension service was expected to be positive.

Market distance was measured as a continuous variable in kilometers from the farm to the closet market where food can be sold or bought. Market distance is an indicator of whether there is systematized and proximity of economic resources which influence household dietary diversity. Kiboi and Chege, (2017) reported a negative affiliation between farmer's market distance and

household dietary diversity. Distance to the market was expected to be negatively correlated with household dietary diversity. This is because the further distance to the market decreases the likely of households diversifying their diets.

2.6.4 Postharvest Practices

In Kenya, most of the smallholder farmers depend on the sun as a source of drying their crops before storage takes place (Kimiywe, 2015). High food losses happen due to unreliability of climate in the country that impedes the crop from drying adequately, compromising the quality and safety of food for human consumption. Koskei et al. (2019) reported that almost half of the sampled households (48.4%) dried by stoking, leaving the grains standing in the field until it dried. The findings of the study further indicated the lack of proper postharvest practices, leading to postharvest losses in grains due to mycotoxins contamination.

According to Njoroge et al. (2019) farmers in Kenya incurred losses in maize during storage and were estimated to be 20% to 30% of the crops during storage. On the other hand, Tefera et al. (2011) found that most of the farming households who used various traditional storage facilities like wooden basket, polyethylene and jute bags are associated with infestation of insects and thus leading to aflatoxin contamination and high food loses.

Threshing is the process of peeling cereals from the panicles over removing the cover or by rubbing as well as the combination of both exercises (AGRA, 2014). Threshing can either be carried out manually via trampling and hacking which is prevalent in African agricultural system, and therefore is a major cause of crop losses due to absence of mechanization process. Report from Abass et al. (2014) showed that dehulling, winnowing, drying, sorting and shelling were the most grain threshing activities practiced manually mostly by 65% of farmers in the study area.

Millings/processing of grains varied with different types of cereals such as wheat, rice, sorghum or maize. Millings is done manually particularly in remote villages. It is done manually by recast hitting or pounding of thick long stick in a mortar with the intention that the flour would be smoother (Tefera et al., 2011). This leads to a loss of food and exposes it to contamination.

Millings can also be done mechanically using the posho mills, which is quite expensive to be afforded by the rural dwellers. A study carried out by Shee et al. (2019) in Uganda indicated that farmers who received training on postharvest management loses (PHL) preferred the use of manual milling as being associated with lower losses compared to the commercial posho mill.

Most crops are transported using motor vehicles such as lorry, trucks, motorcycle or by head loads if the market distance is close to the farm (Abass et al., 2014). Poor roads infrastructure and lack of seasonal maintenance of roads result in the greatest losses. During any movement, some of the grains are lose as leaks in the process of loadings and unloading (Kimiywe, 2015).

CHAPTER THREE: RESEARCH METHODOLGY

3.1 Conceptual Framework

There is currently a general consensus on a conceptual framework that includes agriculture as a source of food through: 1) production of own consumption where households grow own consumption to improve dietary diversity in the house and 2) income effects which entails agricultural earnings via wages or sale of crop products are used to purchase more quality foods and additional incomes that may be spent on health care and school (FAO, 2017). This study propounded household dietary diversity as a dependent variable to a household's various own production, socioeconomic, institutional factors and postharvest practices.

Own-farm production through cultivation of additional crops and livestock species along maize influence household food accessibility both through the market-oriented production (indirect effects through increased agricultural income and greater food expenditures) and direct consumption. Furthermore, the extent of income of a household, be it from livestock produced or sold, off-farm earning and quantity of cash crops realized determine both the level of present and future consumption and production of farming household. Greater diversity of subsistence production could facilitate less spending on food if key staples and other food groups are made available through own production.

On the other hand, socioeconomic factors such as; age, gender, education and household size affect household decision-making regarding food choices of what the family eats or does not eat. Whereas institutional factors like access to extension and credit services influence household production capacity which in turn affects consumption. Distance to the market plays two important functions for rural smallholder rural farmers; they use market to sell their produce or buy inputs as well as to buy food items to diversify their diets. Thus, better infrastructure can play an important role in sustaining household dietary diversity through reduced food prices and transportation costs. In addition, lack efficient post-harvest technologies and safety practices like proper threshing, drying, milling, sorting and cleaning can lead to postharvest food loss and waste, hence, compromising the quality of food and availability and could instantly lead to diseases due to contaminations.

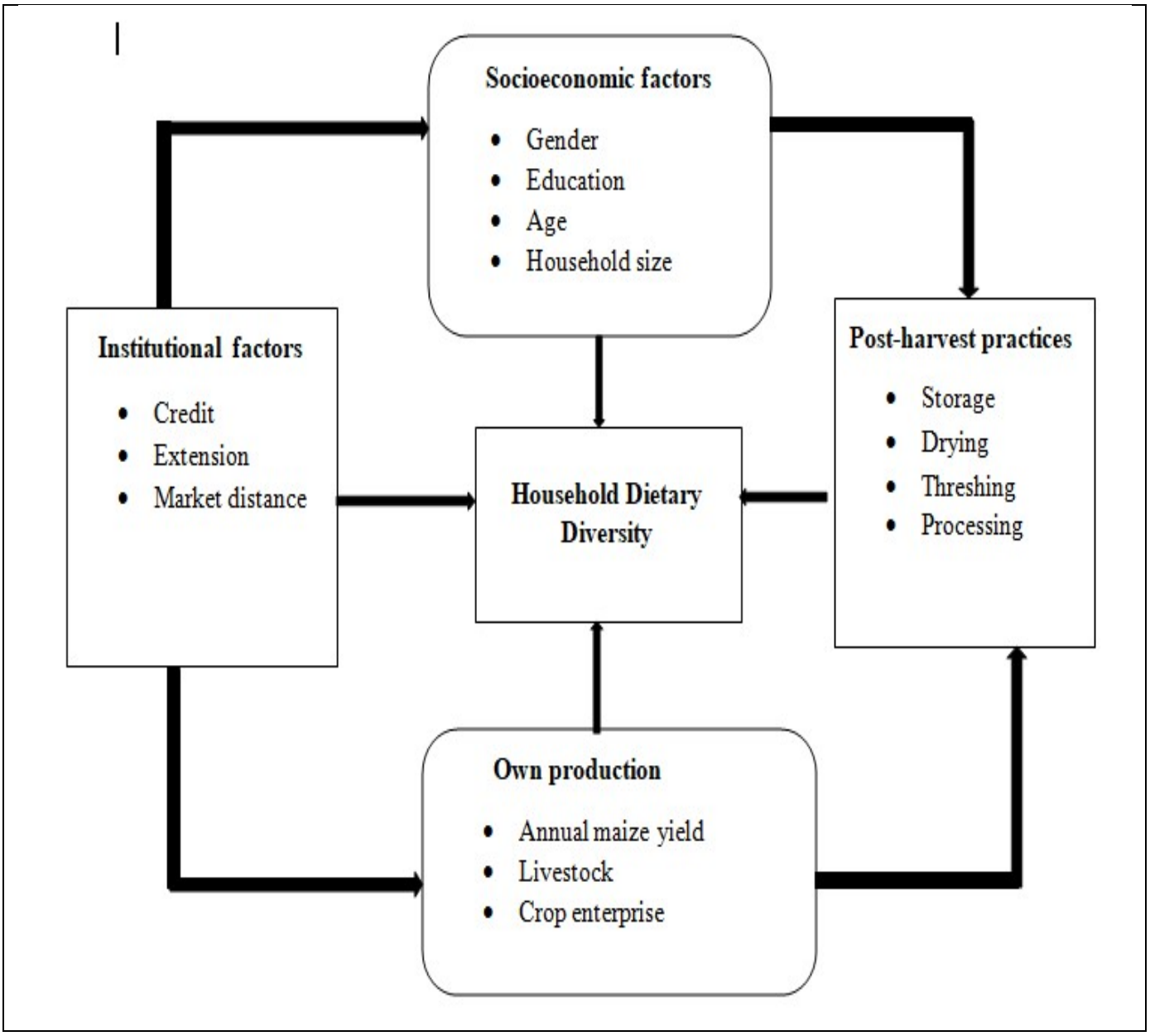

Figure 4.0: Conceptual framework of the nexus between own-farm production, institutional, socioeconomic factors, post-harvest practices and household dietary diversity.

Variation in own-farm production, socioeconomic and institutional factors and postharvest practices could have positive or negative effects on food accessibility; however, the study focused on dietary diversity at the household level.

3.2 Study Area

The study was conducted in Uasin Gishu County, as it is among the leading maize producers in the Rift Valley ‘‘the country’s breadbasket’’. The County is situated in the former Rift Valley province. Uasin Gishu County lies in the mid-west of the Rift Valley and borders; Baringo to the South East, Nandi on the South West, Kakamega to the South West, Kericho to the South, Elgeyo-Marakwet on the east, Trans Nzoia to the North. The County encompasses six sub-counties of Turbo, Soy, Ainabkoi, Moiben, Kesses and Kapseret as shown in figure 5 and has a total population of 1,528,671 according to 2019 population and housing census (KNBS, 2019).

The climate is cold and humid with an annual temperature ranging between 7 degrees Celsius and 29 degrees Celsius and is 2140 m above sea level. The County receives high and reliable rainfall throughout the year which ranges from 900-1,200 mm per annum with two different spikes occurring between March and September. The soil consists of red brown loam to clay soils. The County has three ecological zones of lower highlands, upper high lands and upper midland which support maize production (Wamunga et al., 2015). The area was purposely selected for the study because of its high agricultural potential particularly maize production. The primary livelihood activities in Uasin Gishu County are a diverse mix of crop-livestock farming and the main food crops produced in the area are maize, wheat, beans, finger millet, sorghum, and Irish potatoes (Wamunga et al., 2015). Uasin Gishu County covers a total area of 3327.8 km^2 and 91,010 hectares is used for maize production (Uasin Gishu County government, 2013).

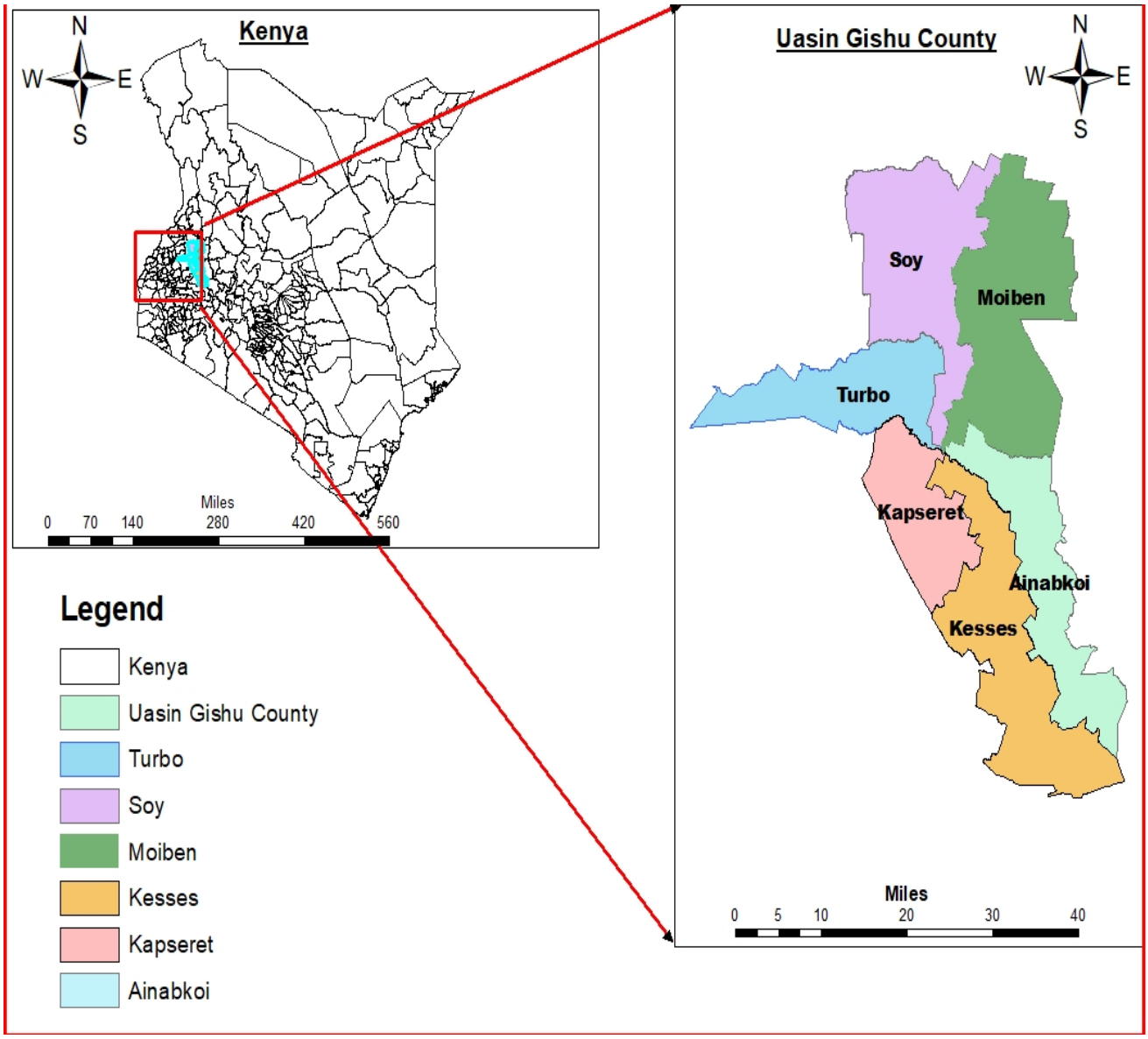

Figure 5.0: Map of Uasin Gishu County showing the study sub-counties
Source: Uasin Gishu County government (2013)

3.3 Sampling Design and Sample Size

3.3.1 Sampling Procedure

Multistage sampling procedure was used in this study (Kothari, 2004). In the first stage, Uasin Gishu County was purposively selected because it is the heart of Kenya's maize growing zones and the area under maize production in the County is estimated to be 102,753 hectares out of 235,400 hectares of high potential arable land in the County (Uasin Gishu County, 2009).

In the second stage, Moiben, Soy, Ainabkoi and Kesses sub-counties were purposively selected respectively from the County. The reason for choosing these four sub-counties is being large in term of land area in the entire County, representing 82% of the total land area in Uasin Gishu County. This implies that, majority of smallholder farmers are predominately found in the four sub-counties. Moiben is the largest sub-county with total land area of 778.2 km^2, representing 24% of total area in the County. Soy, Kesses and Ainabkoi sub-counties consist of 778.2 (23%) km^2, 692.1(21%) km^2, 472.5(14%) km^2 of land area respectively (Uasin Gish County, 2009).

In the third stage, random sampling was used to select eight villages (two each from the four sub-counties) and simple random sampling method was used to select the individual farm households (respondents). Given that the list of the households to be interviewed was not obtained, the first respondent at entering point who cultivate maize became the first respondents. However, all the respondents were given equal chance to participate.

3.3.2 Sample Size Determination

The sample size was calculated according to Godden (2004) sample size determination for unknown population. The population of smallholder maize farmers (target population) in Uasin Gishu County was large and very difficult to know the variability of its population. Hence, the study used 0.5 (proportion) because the proportion of the target population was not known. This is a confidence interval method use to predetermine the accuracy of the sample result. The sample size was calculated using the formula below:

$$\mathbf{n}= \frac{\boldsymbol{Z^2 p(1-p)}}{\boldsymbol{E^2}}$$

Where;

n = Sample size required

Z = Critical value of the standard normal distribution for 95% confidence interval (1.96).

P= Proportion expected of interest being studied (farmers in this case) at 50% and is the prevalence of unknown proportion (Godden, 2004).

E = is the acceptable margin error set at 5%.

Where;

Z = 1.96 P = 0.5 E = 0.05

$$n = \frac{0.5(1-0.5)(1.96)^2}{(0.05)^2} = 384$$

Therefore, the sample size consisted of 384 maize farmers to be selected in any of the six sub-counties in Uasin Gishu County. This was meant to ensure equitable representation of the population in the sample.

3.4 Methods of Data Collection and Analysis

3.4.1 Data Collection Procedure

The study used primary data collected in February, 2020 among smallholder maize farmers in Uasin Gishu County, with the aid of a semi-structured questionnaire. Data were captured using open data kit (ODK), an application found in android where the questionnaire was uploaded in XLS form. Open data kit was preferred because data can be transferred to the server at the end of each day and it is therefore accurate and reliable when accessing the data for future use. Before data collection began, the questionnaire was pretested using smallholder maize farmers that have engaged in farming for at least the last five years and whose land size ranged from 1-10 hectares. Farmers were selected in order to capture experiences with maize farming and household dietary diversity. The pretest was done during the training of enumerators who were fluent in the indigenous language, residing in the study area and experienced in carrying out surveys. Household level cross-sectional data were collected by interviewing the head of smallholder maize farming households on particular factors such as food consumption, Socio-demographic and institutional factors.

3.4.2 Data Analysis

A data analysis method is the process through which a researcher reduces raw data into meaningful information that answers the study objectives simultaneously upon seeking for concession that prevails in the midst of data set (Kothari, 2004). Descriptive statistics (standard deviations, means and percentage distribution) was used to analyze dietary diversity status of the households. Chi-square analysis was used for comparing group such as gender, knowledge of dietary diversity, access to credit and extension of the household head. Meanwhile, one-way ANOVA test was employed for comparing group such as age, education, and livestock holding of household head. Multinomial logit model was used to determine the relationship between the dependent variable and the set of explanatory variables. STATA version 15 was used to analyze the data.

3.5 Theoretical Framework

3.5.1 Agricultural Household Model (AHM)

This study is anchored within the framework of Agricultural Household Model (Singh et al., 1986). In AH model, a smallholder agricultural household in developing countries is both a consumer and a producer. Given the assumption of the model, production and consumption decisions are non- separable (Feleke et al., 2003). This means that household preferences affect production decisions.

Smallholder farmers produce goods for consumption and sale at local markets. Access to credit and postharvest technologies remain a constraint for them. The constraint of cash can be overcome basically through farm sales of crop and livestock or from off-farm jobs. In this model, household members utilize their labor and farm resources with the ambition of utility maximization over consumption of goods and leisure in an economic environment defined by market failures, controlled prices, overt subsidies and market uncertainties inherent in rain-fed agriculture where market infrastructure is inadequate. The utility function (U) of a household is given as follows:

Max U (f_i, f_m, f_l, D_h) Utility function…… (1)

Where:

U = utility function which depends on the consumption of goods and leisure; f_i = household's consumption of home produced goods; f_m = household's consumption of market purchased goods; f_l= leisure time and D_h= socio-demographic characteristics like household size, education, age, gender of household head that influence choices of goods to be consumed.

The household as both a producer and a consumer is assumed to maximizes its utility from the consumption of goods subject to farm production (z); an income (P_i) and time (T) constraints given as follows:

z ($z_{i,}z_{l,}z_{a,}D^0$) = 0: Production constraint……(2.1)

$P_a z_a + P_m C_m = P_i(z_i\text{-}F_i) + P_l\,(\,l^s - F_l)$ + N: income constraint……..... (2.2)

$l^s + F_i$= T: Time constraint.…… (2.3)

Where;

z = production function; z_i= quantities of goods produced on-farm; z_l = household labor supply for on-farm; z_a= postharvest practices; D^0= household's fixed quantity of land and stock of capital; P_a = prices of postharvest technologies; P_i = prices of good i; C_m = household consumption of market goods; P_m = prices of market purchase goods; $(z_i - f_i)$ = are the marketed surplus of good i; P_l = wage rate; N = non-farm income; l^s= time worked and T= total stock of household time available to apportion between leisure and work.

Institutional supports such as credit and extension services are crucial in farm production which is included directly in the production function, thus influence farmer's output and profit which in turn enhances food availability for household. However, a new variable **S** was added in the household's production function (z) to express farmer's use of institutional support services. Hence, the production function above in equation (2.1) constitutes the following form:

z ($z_{i,}z_{l,}z_{a,}D^0, S$) = 0: Production function with institutional support …… (2.1.1)

To obtain full income constraint, time and income are however merged with the combination of equations (2.3) and (2.2) for the ease to solve household maximization problem:

$P_i z_i + P_m f_m - P_l f_l = (P_i z_i - P_l z_l - P_a z_a) + P_l T + N$: full income constraint…… (3)

This can be rearranged as:

$P_i z_i + P_m f_m - P_l f_l = \pi + P_l T + N$……..…… (3.1)

The left-hand side in equation (3.1) is the household expenditure on food which includes purchase of its own farm-produced goods ($P_i z_i$) and household's purchase of the market goods ($P_m f_m$) and the household's purchase of its own leisure time (P_l). Meanwhile the income side comprises of the value of agricultural yield (π); the value of household's entitlement of time and the labor value on the farm including hired labor ($P_l T$**)** and non-farm income N.

Finding a solution for agricultural household model involves two steps: The **first** step requires solving problem of farmer's maximization of agricultural profit with the support from institution is given as:

$\pi^* = \pi^*(P_{i,} P_{l,} P_a, D^0, S)$…… (4)

Where;

π is the level of profit from farm production; ($P_{i,} P_{l,} P_a, D^0, S$) consists of on-farm production, postharvest technology, market and leisure time which influence farm annual yield and **S** being the institutional support such as credit and extension services from relevant institution (government or development partners).

The **second** problem for the farm household is to maximize utility function for consumption of f_i good with respect to income constraint, following a reduced form equation is given as:

$f_i = f_i[P_i, P_m, P_l, D_h, \pi^*(P_i, P_l, P_a, D^0, S), P_l T, N]$ …… (5)

A vital item in this model is that, it is cyclical to the extent that production choices are first formulated and apply in apportioning the entire income amidst the consumption of goods and leisure. The decision on consumption of the bundle (f_i**)** is influenced by the decision to produce

quantities (z_i). Profit component is represented by: $\boldsymbol{\pi}^*$ (P_i, P_l, P_a, D^0, S) with $\mathbf{f}^*$; and the rest of the expression: (P_i, P_m, P_l, D_h,P_lT, N with **P.** This produces a final reduce form equation as follows:

$f_i = f_i(\mathrm{P}, \mathrm{Y}^*)$ …….. (6)

$\boldsymbol{f_i}$ = consumption level of household; P is household characteristics and market factors such as distance to the market which also influence consumption; $\mathbf{Y}^*$ is the level of farm production in equation (6) above. As a consumer, a household maximizes its utility by equating the marginal rate of substitution between leisure and consumption of goods i to (**P**). The household supply of labor is determined by opportunity cost of taking leisure, which is expressed in terms of marginal product forgone.

3.6 Empirical Framework

3.6.1 Estimating Household Dietary Diversity Status

Household dietary diversity status was estimated with household dietary diversity score. HDDS represents the number of distinct foods consumed over a given reference period (Kennedy et al., 2007; Swindale and Bilinsky 2006). Dietary diversity score is an indicator that is used as proxy indicator of economic access to food at population-level as household meals (FAO, 2011). HDDS is preferred due to the fact that standard questions are easy and simply understood by both enumerators and respondents and also subject to recall bias. Usually, a set of 12 questions takes less than 10 minutes per respondent (FAO, 2011).

There is no agreed target level in classifying the number of food groups that indicates adequate or inadequate dietary diversity but Food and Nutritional Technical Assistant (FANTA) suggested two options for determining appropriate targets; first, the patterns of dietary diversity of richer households as a threshold. Second, is to establish a target using sum of food group consumed by any household member from the total of twelve food groups. Food information was obtained through 24-hour diet recalls, given Kenya's food consumption table from the set of the following twelve food groups: vegetables, fish, sugar, cereals, meat, eggs, roots and tubers, oil and fats,

milk, fruit, pulses and nuts and condiments. Hence, this study employed the method that establishes a household target score of dietary diversity by considering the simple count of 12 food groups (0-12). A single point was assigned to each of the food group consumed by a household in the last 24-hours. Three mutually exclusive household dietary diversity categories were created from the 12-food groups. A household was categorized as low dietary diversity status if the sum score is 0 - 3, medium dietary diversity status if the sum score is 4 -6 and high dietary diversity status if the score is 7-12.

3.6.2 Factors Determining Household Dietary Diversity

From the literature, models such as multinomial logit model, Poisson and ordered logistic regression analysis have been used to estimate the research of this nature. Ordered logit model could produce biased estimates and fairly unreasonable outcomes due to the violation of assumption of proportional odds ratio. Multinomial logit model was used in this study to estimate the factors determining household dietary diversity. MNL simply is an extension of a binary logistic regression and can be used to estimate categorical variables that are unordered and take more than two values (Gujarati, 2003). In this study, the dependent variable is taking three values from the created mutually exclusive household dietary diversity categories; Low Dietary Diversity (LDD), Medium Dietary Diversity (MDD) and High Dietary Diversity (HDD), with dummy value of 1 for medium Diversity (MDD), Low Dietary Diversity (LDD) with a dummy value of 0 and High Dietary Diversity (HDD) with a dummy value of 2. Medium Dietary Diversity (MDD) was chosen as the base category. Past studies have used multinomial logit model to estimate factors influencing household dietary diversity (Mbwana et al.,2016; Taruvinga et al., 2013).

The limitation of multinomial logit model includes the Independence of Irrelevance Alternative (IIA) assumption in which any improvement or introduction of any alternative will have the same proportional impact on the probability of each other alternative. Despite its draw backs, multinomial logit model is preferred against multinomial probit because it is easier to estimate and simple to interpret (Wooldridge, 2015).

Assuming that a model with probability that a household belongs to a discrete category j, (j = 0, 1, 2) condition to having characteristics x.

$P_r(y = j/x)$ …… (7)

The MNL has the extreme value distribution in the following form;

$P_r(y = 0/x) = 1 - P_r(y = 1/x) - P_r(y = 2/x)$ …… (8)

$$P_r(y = 1/x) = \frac{\exp(x'\beta_1)}{1+\exp(x'\beta_1)+\exp(x'\beta_2)} \text{ ……..…… (8.1)}$$

$$P_r(y = 2/x) = \frac{\exp(x'\beta_2)}{1+\exp(x'\beta_1)+\exp(x'\beta_2)} \text{……. (9)}$$

Where P_r is the probability indicator of household being in one of the household dietary diversity category (y); j = 0, 1, 2 only represent the categories of the response variable (HDD in this case); exp = is the exponential; x represents socio-demographic factors; β is the vector of parameter to be estimated; y = 0 for low household dietary diversity. y = 1 for medium dietary diversity; y = 2 for high household dietary diversity.

Table 1.0: Description of the hypothesized explanatory variables

Variable	Measurement	Type	Expected Sign
Gender	1 male, 0 female	Dummy	+/-ve
Age	Age in years	Continuous	+ve
Education level	Years of schooling	Continuous	+ve
Household size	Number of people living in a House	Continuous	-ve
Land size	Total land in use in acres	Continuous	+ve
Maize income	Kenyan Shillings	Continuous	+ve
Annual maize yield	Kilograms	Continuous	+ve
Off-farm income	Kenyan Shillings	Continuous	+ve
Livestock holding	Tropical livestock units (TLU)	Continuous	+ve
Farm experience	Number of years in farming	Continuous	+ve
Crop enterprise	Varieties of crops produced	Continuous	+ve
DD knowledge	1 Yes, 0 No	Dummy	+ve
Credit	1 Yes, 0 No	Dummy	+ve
Extension	1 Yes, 0 No	Dummy	+ve
Drying	1 mechanical, 0 sun drying	Dummy	+ve
Storage	Types of storage facilities use	Continuous	+-ve
Market distance	Kilometers	Continuous	+ve
Threshing	1 machine, 0 manual threshing	Dummy	+ve
Meal frequency	Number of meals per a day	Continuous	+ve
Millings/processing	1 posho mill, 0 traditional milling	Dummy	+ve
Aflatoxin knowledge	1 Yes, 0 No	Dummy	+ve

3.7 Diagnostic Tests

3.7.1 The Independence from Irrelevant Alternatives (IIA)

To ascertain the existence of the independence of irrelevant alternatives assumption of the multinomial logistic model, which assumes that any pair of outcomes variable categories are determined without reference to the other categories (Woodridge, 2015). This assumption is very

crucial in MNL. If this assumption holds, then MNL is appropriate to be used. However, the assumption of the independence of irrelevant alternatives was tested by the Hausman specification tests, proposed by Hausman and McFadden (1972). According to the result, the insignificant overall chi-square (ch2 0.468, 0.251 and 0.83) suggests that the multinomial logistic regression assumption of IIA is met and then the estimators of the restricted model are consistent.

3.7.2 Multicollinearity Test:

Multicollinearity occurs when the independent variables used in the model are correlated. Presence of multicollinearity leads to large standard errors conflated with high pseudo-R-squared and high correlation between estimated coefficients. The existence of multicollinearity was checked by inspecting the correlation between the repressors by computing the variance inflation factor (VIF). The variance inflation factor for x_μ is given by:

$$\text{VIF}\ (x_\mu) = \frac{1}{1-R_\mu^2}$$

Where; R_μ^2 is the R-squared that results when x_μ is regressed with intercept against all independent variables.

According to Gujarati (2003), a value of VIFs greater than ten, represents the critical level of multicollinearity and should not be included in the model. The results of the VIFs in this study indicates that none of the values surpassed 10 (Appendix 2) suggests that there is no multicollinearity in MNL model.

3.7.3 Heteroscedasticity Test:

Heteroscedasticity happens when the variance of the error term is not the same for all observations. If the residuals (errors) for regression model are not homoscedastic, then the coefficients are thus less precise which in turn increases the likelihood that the coefficient estimates are far from the correct population (Woodridge, 2015).

The presence of heteroscedasticity was tested by Breusch-pagan test, following null and alternative hypotheses:

H_O: The residuals are homoscedastic

H_a: The residuals are heteroscedastic

The ‘‘hettest’’ command in STATA produced the following results:

Chi^2 (1) = 2.40

Prob > chi^2 = 0.1210

The insignificant chi^2 value of 2.40 did not warrant the rejection of null hypothesis and concluded that heteroscedasticity is not present (Appendix 3).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Descriptive Results

4.1.1 Household's Dietary Diversity Status

The results of the study indicated that, from 384 households, 98 (25.5%) participants consumed up to three food groups (classified as low dietary diversity status), 210 (54.7%) consumed four to six food groups (categorized as medium dietary diversity status) and 76 (19.8%) participants consumed more than seven food groups (high dietary diversity status) in their diets during previous 24 hours. The household dietary diversity scores range from 2 to 10 food groups with a mean of 1.9 + 0.7 SD. The mean dietary diversity score of low dietary diversity was 2.5, the medium was 5.6 and the high was 7.4 (Table 2). Similar findings were reported earlier by Huluka and Wondi (2019) who reported more than half of the sampled households fall in medium dietary diversity.

Table 2.0: Distribution of respondents by household dietary diversity status

HDD Level	Frequency	%	Range	Mean	SD	Min	Max
Low	98	25.5	1-3	2.5	0.6	1	3
Medium	210	54.7	4-6	5.6	0.9	4	6
High	76	19.8	7-12	7.4	0.8	7	12
Total	384	100	12	1.9	0.7	1	12

''Max stands for maximum'', ''min'' for minimum. Source:

Author's survey data (2021)

4.1.2 Description of the Sampled Household Socioeconomic Characteristics in Relation to Households Dietary Diversity Status

Descriptive statistics of households' socioeconomic factors are presented in Table (3) and assessed by means and percentage distributions in order to capture the existing distinction across all household characteristics. The average total livestock holding in tropical livestock units (TLU) was 2.2 and a significant mean difference observed across household dietary diversity categories. Higher TLU was reported for households with high and medium dietary diversity

categories at 3.3 and 2.2, respectively. Meanwhile, households with low HDD had the lowest TLU of 1.6. This observation is consistent with Mekuria (2018) who reported that majority of the households with livestock in the study had crop-livestock mixed farming as a food diversification option. The proportion of livestock holdings varied among farmers according to socio-economic factors, which often does result in the improvement of the food security situation for a household, hence leads to high household dietary diversity (Akerele et al., 2013).

The average total off-farm income of farming households was 12,393 Ksh with a significant mean difference across all categories of household dietary diversity. The mean for a household with high HDD was 15,685.5 Ksh, medium at 12, 750.5 Ksh, and low at 9073 Ksh. Rural households diversify their income sources by working off the farm. This means that households with high and medium dietary diversity have other sources of income to diversify their diets and do not rely much on the farm source of income. Similar observations were reported by Wakweya (2010) who noted that off-farm income could lead to a positive effect on food expenditure, particularly non-produced food items as explained by the fact that households with high HDD had more off-farm income than those in the low and medium HDD.

The average total household size was 5.7 with a significant mean difference across the three HDD categories. Households with a medium HDD category had an average household size of 5.9, followed by high at 5.8 and low at 5.5. Many members in the house signify more mouths to feed and more expenditure on food items, suggesting inadequate dietary diversity for medium HDD households. Similar results were reported earlier by Silvestri et al. (2015) who found that bigger household size negatively affect calorie availability in the house.

The mean total land size for maize and other crops production was 3.4 acres but was higher for the households who belong to high dietary diversity at 3.6 and the same average land size across medium and low HDD at 3.3 respectively. Households with larger size of cultivable land can produce diversified foods and therefore have positive effects on their consumption (Kiboi et al., 2017). This is however evidence in this study where households who belong to high dietary diversity have bigger size of total land in use than those of medium and low HDD.

Table 3.0: Characteristics of the Sampled Households

Variable	Description	Low (n =98)	Medium (n =210)	High (n=76)	Pooled (n=384)	
Continuous		**Mean**				**F – test**
Age	Age of household head in years	51.6	51.5	55.7	52.3	0.211^{NS}
Education	Education in years of schooling	10.8	10.3	11.6	10.7	0.279^{NS}
Livestock	Tropical livestock unit	1.6	2.2	3.3	2.2	64.29***
Off-farm income	Non-farm earnings in Ksh	9073.5	12750.5	15685.5	12393	24.75***
Household size	Total number of people living in the house	5.5	5.9	5.8	5.7	6.378*
Maize yield	Annual maize yield in Kgs	1062.4	1266.4	1166.4	1194.6	0.076^{NS}
Land size	Total land in use	3.3	3.3	3.6	3.4	10.98**
Categorical		**Percentage**				**X^2**
Gender	% of male headed households	80.6	61.4	53.9	64.8	15.72***
DD knowledge	% of households with knowledge of DD	44.9	45.2	67.1	50.0	6.303**
Credit	% of households with access to credit	43.9	39.3	26.3	35.2	5.945*
Drying	% of households who had used sun drying method	100	100	98	99.5	19.16^{NS}
Extension	% of households with access to extension	16.3	7.6	13.2	10.9	5.680*
Milling	% of households who had used posho milling method	100	100	100	100	8.607^{NS}

Level of significance; *** 1%; ** 5%; * 10%. NS = non-significant. Ksh = Kenyan shillings

Source: Author's survey data (2021)

More than half (64.8%) of the households interviewed were male-headed, with most 80.6% with low HDD being male-headed, followed by medium 61.4% and high at 53.9%. Intra household resource allocation and internal decision-making on the role of gender plays a critical task in household food security and nutritional status (Wambua et al., 2018).

Household's knowledge about nutritional importance of consuming diverse food did not deviate across the three dietary diversity status. About half of the sampled households (50%) had knowledge on dietary diversity. A chi-square test indicated that there was a significant difference among household dietary diversity categories in term of the knowledge of dietary diversity. Higher proportion was observed among high HDD 67.1%, medium 44.9% and low 44.9% respectively. This result corroborates with earlier observation (Motuma et al., 2019).

Overall, 35.2% of the sampled households have access to credit, with a higher proportion of the households within the low dietary diversity category accessing credit at 43.9%. Meanwhile, small percentages were reported for those in medium and high HDD at 39.3% and 26.3%, respectively. This implies that households with low dietary diversity status lack money to buy essential agricultural materials like seeds and farming tools, which compelled them to seek credit. Due to misuse of loan by the farming households would result in low yield which in turn had led to inadequate dietary diversity. A similar result was reported before (Annim and Frempong, 2018).

About 10.9% of households interviewed had access extension services, with distribution across the three HDD categories being 16.3% for low, 13.2% for high, and 7.6% for medium. Extension initiative is considered as an important function that results in an increment in farm yield, income and improves household dietary diversity. The indication that households with low HHD receiving extension services are encouraging as it has the potential to improve their food access and subsequent improve to medium category. Related findings were also observed by Chege et al. (2018) who reported that most of the household heads who participated in extension services had their food security status improved.

4.1.3 Types of Storage Facilities use by Farmers

The predominant storage method among all the respondents (86%) was hermetic bags as shown in figure 5 below. Less than half of the respondents from low dietary diversity had used hermetic bags whereas over eighty percent from medium and low dietary diversity had used this method. 20% of all the respondents reported that they use traditional cribs for storing their maize produce. However, more than half of farmers who belong to low dietary diversity had preferred the use of this storage facility. Meanwhile there was low uptake of traditional cribs as a method of maize storage among the low and medium HDD households. Very few farmers (1.3%) have preferred the use of open ground in the houses as a storage method. Maize stored in houses were mainly preserved for very short-term period. These findings are consistent with previous research findings by Koskei et al. (2020) who reported high percentage of farmers using traditional cribs for storing grains in Kenya.

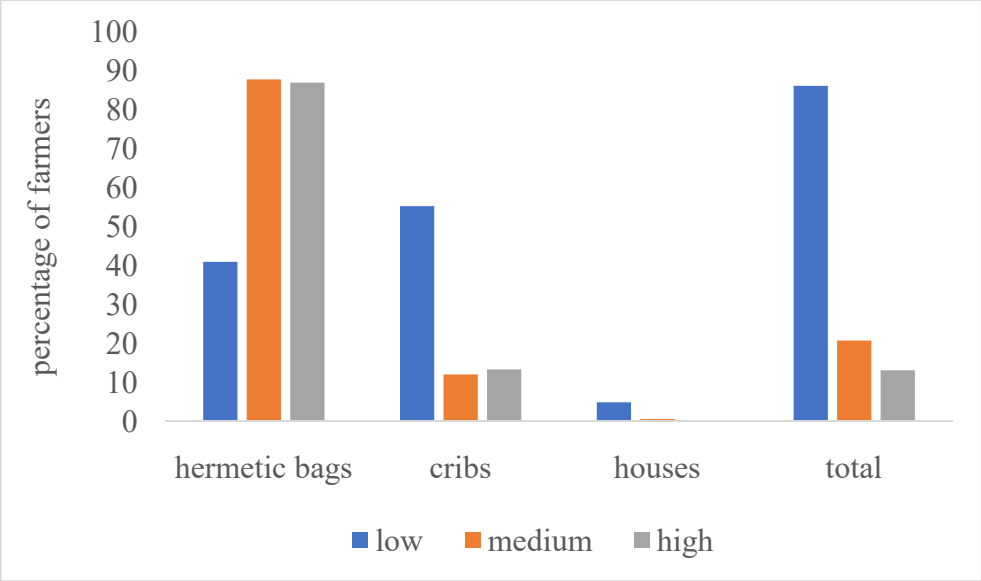

Fig 6: types of storage facilities use by farmers

Source: Author's survey data (2021)

4.1.4 Farm Crop Enterprises

Maize was the main crop enterprise grew by all the sampled households interviewed in the County as their major food crop for their livelihood, followed by other crops such as kales (77%), Irish potatoes (75%), cabbages (70%), onions (40.1%), beans (42%) and passion fruit

(7%). These crops were instantly intercropped in traditional farming system and mainly depended on rain-fed environmental conditions. Those with greater crop enterprises are more likely to have adequate dietary diversity (Mango et al., 2018).

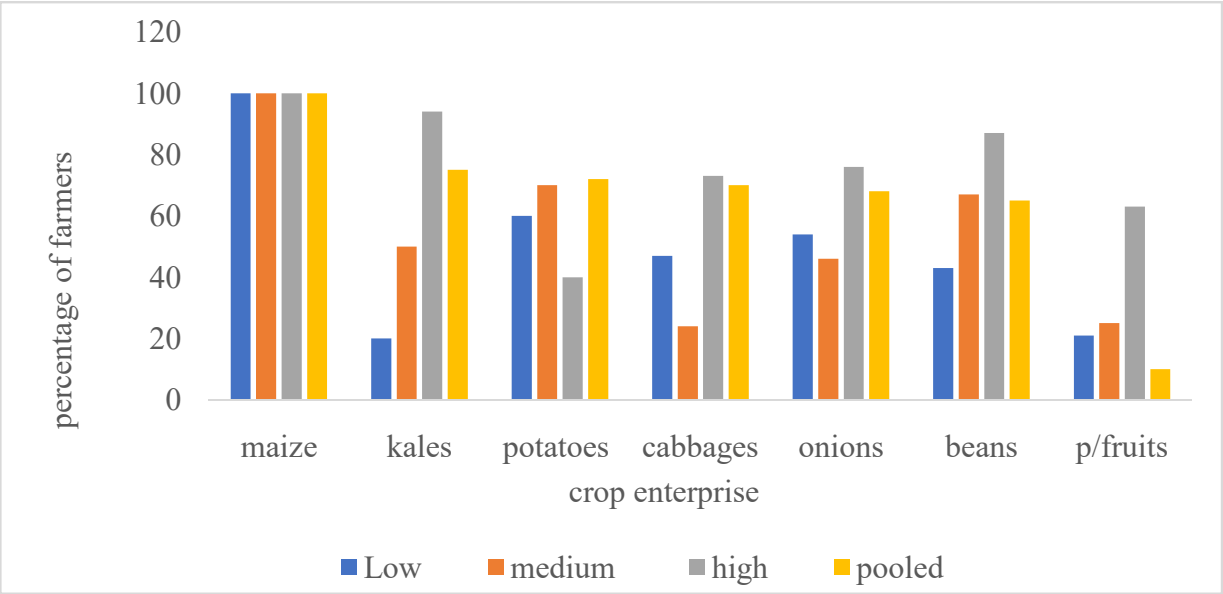

Figure 5: Farm crop enterprises in Uasin Gishu County

Source: Author's survey data (2021)

4.1.5 Household's Food Consumption Patterns

Table 4 represents the frequency of food consumption in the last 24-hours in the household across the 12 food groups, which is a snapshot of the current food diversity patterns. The findings of the study showed that all the participants (99.5%) consumed cereals inform of stiff porridge (ugali). This implied that the households' diet was predominantly based on cereals. However, consumption of this food group does not always result into a good nutritional outcome since they lack minerals and vitamin concentration. All (100%) households within low and medium HDD categories had consumed cereals, with 97.4% within the high dietary diversity consuming cereals. The findings of this study corroborate with earlier observations by Kiboi et al. (2017) who reported the dominance of cereals in Kenyans diets.

Table 4.0: Household's food groups consumption patterns

Food groups	Household Dietary Diversity Category							
	Low		Medium		High		Pooled Sample	
	N	%	N	%	N	%	N	%
Cereals	98	100	210	100	74	97.4	382	99.5
Fruits	38	38.8	22	10.5	41	53.9	101	26.3
Meat	23	23.5	48	22.9	33	43.4	104	27.8
Vegetables	80	81.6	170	8.1	67	88.2	317	82.6
Tubers	29	29.6	25	11.9	36	47.4	90	23.4
Eggs	20	20.4	12	5.7	10	13.2	42	10.9
Fish	8	8.2	8	3.8	6	7.9	22	5.7
Legumes	48	48.1	57	27.1	43	56.6	148	38.5
Milk	78	79.6	166	79.5	74	97.4	318	82.8
Oils & fats	60	61.2	157	74.8	75	98.7	292	76.4
Sweets	54	55.1	143	68.1	72	94.7	269	70.5
Miscellaneous	56	57.1	114	54.3	54	71.5	224	58.3

Source: Author's survey data (2021)

The consumption of milk was reported by 82.8% of households, with the highest (97.4%) frequency reported among households with high dietary diversity category, 79.5% and 79.6% from medium dietary diversity and low dietary diversity had consumed this food group respectively. Farmers in the study area keep livestock for both consumption and commercial purposes. Related results were also noted by earlier studies (Kurgat et al., 2019; Mukherjee et al., 2018).

About 82.6% of the households had consumed vegetables, with distribution along the three categories being 88.2% under high, 81.6% in low and 81% medium household dietary diversity categories. The main source of vitamin A was the dark green leafy vegetables. This observation is consistent with the previous research findings (Sarkar, 2014; Workicho et al., 2014).

About 23.4% of the sampled households consumed white roots and tubers, with 47.4% of households in high dietary diversity status having consumed. At the same time, small percentages of low and medium household dietary diversity categories consumed white roots and tubers at 29.6% and 11.9%, respectively. The findings indicated that the intake of protein-rich food sources was significantly low in terms of frequency for the entire sample. This corroborates

with the results of Vanessa et al. (2017) who revealed the low consumption within the same food groups.

Only 10.9% of the sampled households consumed eggs and 27.8% consumed meat. 43.4% and 13.2% of households within the high dietary diversity category had consumed meat and eggs respectively. While 22.9% and 5.7% within medium household dietary diversity category consumed meat and egg respectively. Lastly, 23.5% and 20.4% of the households within the low dietary diversity consumed meat and eggs respectively. The proportion of animal source food consumption was higher among households with high household dietary diversity status; this could be due to high income that enabled the households to purchase the expensive animal protein. This implied that households in low and medium categories have low purchasing power and could not afford the expensive meat. This finding is consistent with the previous study by Ochieng et al. (2017) who found the low consumption of these food groups among households.

The consumption of fish was very low (5.7%) across all the HDD categories in the study area. Fish are an important source of micronutrients crucial for cognitive development of children and for the health of adults. The low consumption of fish is attributed to socioeconomics characteristics in the study area like low income and distance to a water body (lake); similar findings were also reported before by Rajendran et al. (2017).

About 38.5% of the households consumed legumes, nuts and seed food group such as; lentils, beans, and peas. Low consumption of this food group as evidenced from the results of this study, limits the intake of plant proteins, vitamin A and dietary fiber which are required for growth and development especially in children and women of reproductive age (Mazunda and Droppelmann, 2012). Along the high, medium and low HDDs categories, 56.6%, 27.1% and 48.1% of the households had consumed this food group respectively; this pattern is similar with the previous report by Vanessa et al. (2017).

In this study, 76.4% of participants consumed oils (including butter and fats) food group. The distribution along the three HDD categories was 98.7%, 74.8%, and 61.2% from high, medium and low respectively. Oils and fats were used in the preparation of the food; such as baking and

frying and being added into the main dishes. The finding of this study is in line with previous observations by Akerele et al. (2017). Sugar, honey, cakes, and biscuits were all in the sweet food group, the results showed that 70.5% of respondents consumed different forms of sweets. Nearly 55.1%, 68.9%, and 94.7% of the households along the low, medium and high HHD categories having consumed this food group respectively; similar results were reported by Workicho et al. (2014).

The consumption of fruits was very low (26.3%) among all the HDD levels, with 53.9% of households in high, 10.5% from medium, and 38.8% were from low HDD category having consumed fruits. These results indicate that population being studied would categorically be subjected to the high risk of acquiring different chronic diseases due to inadequate consumption of fruits which are the source of vitamin. The possible argument for the low consumption of fruits particularly among the medium and low dietary diversity categories is that fruits are seasonal; hence must be purchased during the lean season, a pattern which most households may not financially afford. This observation is consistent with the earlier research findings by Codjoe et al. (2016). In addition, foods such as coffee, tea, local alcohol, and mixed dishes were consumed by 58.3% of the household, with 54.3% were from high, 57.1% from low, and 71.5% were from medium HDD categories. A similar condition was reported earlier by Taruvinga et al. (2013).

4.2 Factors Determining Household Dietary Diversity

As presented in Table 5 below, multinomial logit model demonstrates regression coefficients and p-values of the various factors affecting household dietary diversity. The model was significant at 1% level (0.000) and a pseudo-R-squared of 0.2084 (Table 5). Most of the explanatory variables were significant at 1%, 5% and 10% levels of probability. Medium dietary diversity (MDD) was chosen as a reference category for comparison since more than half of the sampled households fall within this category. The corresponding marginal effect of explanatory variables are shown in Table 6.

Table 5.0: MNL coefficients estimate for factors determining household dietary diversity

Variable	Low Dietary Diversity (LDD)		High Dietary Diversity (HDD)	
	Coefficients	**P-value**	**Coefficients**	**P-value**
Gender	1.384	0.000***	-0.809	0.024*
Household size	0.034	0.762	-0.147	0.243
Maize income	-1.006	0.884	0.003	0.044*
Maize yield	-0.002	0.409	-0.008	0.005**
Credit	-0.692	0.017*	0.804	0.034*
Extension	1.412	0.002**	0.064	0.909
Crop enterprise	-0.168	0.566	1.462	0.001**
Off-farm income	-0.003	0.006**	9.800	0.296
Livestock	-0.180	0.016*	0.192	0.010*
Education	0.037	0.328	0.186	0.001**
Age	0.003	0.807	0.046	0.003**
Milling/processing	-0.116	0.771	0.800	0.421
Threshing	0.061	0.623	-0.107	0.275
Meal frequency	-0.212	0.040*	-0.176	0.142
Storage	-0.070	0.838	1.424	0.000***
Market distance	-1.182	0.241	0 .037	0.945
DD knowledge	-0.369	0.195	0.841	0.012*
Base Category	Medium Dietary Diversity (MDD)			
No. of observation	384			
LR-Chi^2 (32)	159.92***			
Pseudo R-squared	0.2084			
Log likelihood	-303.72994			

Level of significance; *** 1%; ** 5%; * 10%. Dependent variable: Household Dietary Diversity (0 = Low; 1= Medium and 2= High).

Multinomial logit analysis showed that gender of the head of the household was significant and positively associated with low dietary and negatively associated with high dietary diversity. The output of the model suggests that in reference to the base category, households headed by female are more likely to improve dietary diversity by 23.1% by shifting from a low dietary diversity to a medium household dietary diversity. This can be attributed to the fact that if women control resources, they utilize them on nutritious foods for the household members; hence, it positively affects household food access, especially women and children. These findings are consistent with

the previous research findings by Lutomia et al. (2019) who reported that female-headed households have a higher probability of improving food security compared to male counterparts in Western and Eastern regions of Kenya.

Table *6*: MNL Marginal Effect for the Determining Household Dietary Diversity

Variable	**Low Dietary Diversity (LDD)**		**High Dietary Diversity (HDD)**	
	Std Error	**Marginal effect**	**Std Error**	**Marginal effect**
Gender	0.048	0.231***	0.038	-0.146*
Household size	0.017	0.097	0.014	-0.017
Maize income	0. 002	-0.012	0.001	0.034*
Maize yield	0.004	-0.046	0.003	-0.008*
Credit	0.042	-0.132*	0.041	0.113*
Extension	0.066	0.217**	0.061	0.036
Crop enterprise	0.043	-0.071	0.046	0.173**
Off-farm income	0.007	-0.006**	0.006	0.021
Livestock	0.011	-0.034*	0.008	0.028*
Education	0.006	0.001	0.001	0.002**
Age	0.002	0.008	0.002	0.005**
Milling/processing	0.060	-0.042	0.062	0.095
Meal frequency	0.015	-0.027*	0.013	-0.14
Storage	0.036	-0.055	0.036	0.166***
Market distance	0.075	-0.182	0.057	0.032
DD knowledge	0.042	-0.083	0.036	0.108*
Base Category	**Medium Dietary Diversity (MDD)**			

Level of significance; *** 1%; ** 5%; * 10%. Dependent variable: Household Dietary Diversity (0 = Low, 1 = Medium and 2 = High).

Annual maize income had a significant and positive association with high dietary diversity as expected. In regard to the base category, these results suggest that a household with annual income from the sale of maize surplus increases the likelihood of achieving a high dietary diversity by 3.4% than those who have no annual income from the sale of maize. Higher crop income typically helps improve household food security as there is more expenditure to spend on purchasing non-cereal food. Similar observations were reported earlier that on-farm income was an indication of surplus maize and found that households who sold maize were less food insecure (Mutea et al., 2019; Gitonga and Groote, 2015).

Contrary to the expectation, annual maize yield was negatively associated with high dietary diversity. With reference to the base category, annual maize production decreases the probability for a household to maintain high dietary diversity by 0.8%. This implies that households with low annual maize yield are more food insecure than those with sufficient annual maize yield. Domestic food production accounts for a major part of their consumption due to the lack of economic capacity to market goods and the engagement of farming household in off-farm activities. Similar observation was previously reported by Kimiywe (2015).

Prior to expectation, credit was positively associated with high dietary diversity and negatively associated with low dietary diversity. Reference to the base group, these results indicate that with a household that has access to credit, is more expected to increase the probability of achieving a high dietary diversity by 11.3% than a household who have no access to credit. This may be linked to the proper use of the loan and remittances by the households who have taken credit and are more likely to have sufficient food. This finding is consistent with the empirical findings of Mango et al. (2018) who reported a positive and significant impact of credit on household food security status.

Access to extension services had a significant and positive effect on low dietary diversity at 5% significant level. These results suggest that with reference to the base group, households with access to extension services increase a probability of moving from low dietary diversity to medium dietary diversity by 21.7% than households who have no access. Extension service is a vital factor in boosting food production and affirming to this, extension delivery to the smallholder farmers encourages the adoption of new innovations to increase household food production and can positively influence household dietary diversity. This corroborates with the earlier study by Kipkargat and Tuigong (2015) who observed that extension services enhanced production and indirectly improved household food security.

The regression results indicate that crop enterprise had a significant and positive association to high dietary diversity. The results depict that in comparison with the base category, households who cultivated other various crops such as fruits, kales, potatoes and beans alongside maize

increase the probability of achieving a high dietary diversity by 17.3% than households who cultivated only maize. Crop diversification enhances household diets, food security and income, thus, allowing household to purchase more consumable commodities. This result corroborates with the earlier findings by Silvestri et al. (2015) who reported that crop diversification plays a significant role in improving household nutritional status and livelihoods.

Off-farm income was significant and negatively associated with low dietary diversity and in comparison, with the base category, access to non-farm income decreases the likelihood of households to attain a high dietary diversity by 0.6%. This connotes that off-farm income can compete with on-farm income activities by reducing the family labor from farm activities. However, off-farm income may have negatively impacted on household dietary diversity by reducing higher farm's income and production, thereby affecting the household's welfare. These results comply with a previous report by Apanovich and Mazur (2019) who reported that non-farm income is a contributor to rural poverty status; affect nutritional outcome and farm income in South-Central Uganda.

The livestock holding was positively associated with high dietary diversity and negatively associated with low dietary diversity. With reference to the base category, these results suggest that for a unit increase in livestock holding, increases the likelihood of attaining a high dietary category by 2.8% and reduces the probability for a household to attain a low dietary category. Animal husbandry is a usual livelihood coping strategy that contributes directly to household food consumption patterns by providing energy via the consumption of animal products, through the sale of animals and animal products that bring forth cash, and source of manure and draft power that enhance agricultural productivity. Furthermore, livestock keeping goes beyond the explicit food supply chain but tie to cultural and social lives. The same observation was reported by Demeke et al. (2017) who noted that an increase in small and large livestock leads to an increase in nutritional and financial health as well as the food supply.

As expected, education was significant and positively associated with high dietary diversity. Compared to the base category, the more households are educated, the more they are likely to achieve a high dietary diversity at marginal effect of 0.2%. Education increases the skills and

knowledge of a person and increases the knowledge about nutritional diets. Household heads who have acquired a certain level of education could better emphasize health gain of eating nutritious food and thus spent a bigger proportion of their food budget to buy more nutritious food items relative to their uneducated counterparts. Previous study has reported the same findings (Muthini et al., 2019; Taruvinga et al., 2013).

The age of household head (in years) was significant and associated positively with high dietary diversity. Compared to the base category, these results suggest that for a unit increase in in the age of household head, increases the probability of being in the high dietary diversity by 0.5%. It is anticipated that as a farmer gets older, they acquire more skills and experience which can augment their understanding of crop varieties for their diverse diets. This entails that household heads that are old are more likely to diversify their diets than young household heads. Similarly, Gitagia et al. (2019) reported that older women were most likely to have high dietary diversity than younger women in Rongai Sub -County of Kenya.

The model output showed a negative association between low dietary diversity and meal frequency. The findings of this study suggest that, with reference to the base category, household meal intake in the last 24 hours lead to a higher probability of attaining a low dietary diversity at marginal effect of 2.7%. Taking less than the recommended minimum meals (less than three meals per day) always includes skipping meals or reducing the usual quantity of food, which is part of food insecurity coping strategy. Decreasing meal frequency signifies less expenditure on food and less food to be consumed by household members, leading to inadequate dietary diversity and malnutrition, especially in children. The findings of the study are in line with the previous report by Seguin et al. (2016) who found a negative relationship between taking breakfast, lunch and super per a week and body mass index.

Storage has established to be significant and positively associated with high dietary diversity as hypothesized. This implies that household who have stored their crops after harvest have a higher probability of attaining high dietary diversity by 16.6%. The possible explanation for this is that, the farming households who had used various modern storage facilities like hermetic bags are not associated with infestation of insects and aflatoxin contamination, hence, leading to high

food availability which in turn increase household dietary diversity. Similar observation was reported by Njoroge et al. (2019) who noted that farmers in Kenya who had used modern storage facilities did not incur postharvest losses in maize.

Dietary diversity knowledge was significant and positively associated with high dietary diversity as expected. With reference to the base category, the results suggest that, knowledge of having diverse diets increases a probability of achieving high dietary diversity by 10.8%. Food nutritive knowledge is a self-perception of the grandness of consuming balanced meals that directly affect diet quality. This means that nutritional awareness level improves knowledge about household food items and aids in choosing nutritious foods for quality health. This observation is complementary with the earlier research findings by Powel et al. (2017 who noted that dietary awareness inspires household to choose proper food consumption for good health.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The main purpose of this study was to establish the determinants of household dietary diversity among smallholder maize farmers in Uasin Gishu County of Kenya. The specific objectives were to; estimate household dietary diversity status and determine the various factors influencing household dietary diversity.

A semi-structured questionnaire survey was employed, with a multistage sampling procedure undertaken to draw 384 households. Descriptive statistics were used to estimate household dietary diversity status and socioeconomic characteristics of households; meanwhile multinomial logit model was utilized to determine factors affecting household dietary diversity. The data was analyzed using Stata version 15. The results were presented in tables and figures.

From the results, 98 participants had consumed 1-3 food groups, 210 had consumed 4-6 food groups, and 76 participants had consumed 7-12 food groups in the last 24-hour diet recall. Based on FAO methods of classifying household dietary diversity status, 25.5% households reported low dietary diversity status (LDD), 54.7% reported medium dietary diversity status (MDD) and only 19.8% of the households reported high dietary diversity status (HDD).

The mean total household size for LDD was 5.9, while for HDD and MDD were 5.8 and 5.5 respectively. The results further showed that on average, livestock holding, cultivable land size and off-farm income was significantly higher for those in HDD compared to low and medium dietary diversity status. Majority of farmers (87.8%) stored maize using the hermetic bags, while eighty percent from medium and low dietary diversity had used this method. However, more than half of farmers who belong to low dietary diversity had preferred the use of cribs storage facility. Very few farmers (1.3%) had used open ground in the houses as a storage method.
The major crop enterprises cultivated by farmers were maize (100%), kales (75%), potatoes (75%) and cabbages (70%). In addition, a chi-square test showed that 64.8% of the sampled households were males whereas half of the sampled households had knowledge on dietary

diversity. About 10.9% and 35.2% of the farmers had access to both public and private extension and credit services respectively.

The findings of the study also showed high consumption of cereals (99.5%), milk (82.8%), vegetables (82.6%), oils and fats (76.4%), sugar, honey, cakes, and biscuits (70.5%), and condiment (58.3%) in the last 24-hour. There was low consumption in the following food groups; tubers (23.4%), eggs (10.9%), fish (5.7%), legumes (38.5%), fruits (26.3%), and meat (27.8%).

In examining the factors determining household dietary diversity, multinomial logit results revealed that knowledge of dietary diversity, age, crop enterprises, livestock holding, education, storage, extension, credit and annual maize income had a significant and positive effect on household dietary diversity. Meanwhile, off-farm income, meal frequency, and annual maize yield had a significant and negative effect on household dietary diversity.

5.2 Conclusion

It is imperative to conclude that more than half of the sampled households were in medium dietary diversity, calling for immediate interventions geared towards improving household dietary diversity status.

The diet of all the households was predominantly based on cereals with inadequate vegetables, milk, sugars and condiments. On the other hand, there was a very low consumption of the protein-source food groups like legumes, fish, meat, and eggs. The study results suggest that there was an imbalance in the consumption of food groups and inadequate diets among households. However, there is need to encourage households to increase intake of other food groups like fish, diary and fruits than concentrating on the consumption of cereal based food groups.

5.3 Recommendations

5.3.1 Policy Recommendations

Based on the findings of the study, it is recommended that County government should provide nutritional training and rural education access programs to widen knowledge of households about

nutritional health gains of diverse diets. Nutritional education provides households with essential basic information necessary to prepare food. It is imperative that County government should raise awareness on dietary diversity among people through County health workers, radio and TV programs.

It is recommended that national and County governments provide affordable access to credit for poor farmers to buy fertilizers and farm equipment. This can be done through initiation of policies such as youth agriculture funds and women enterprise funds to enhance production and thus diversify their diet.

There is a need for the County government to encourage the farmers to engage in production of other crop enterprises such as kales, cabbages and potatoes. This can be done through training of farmers on intercropping method. Adequate dietary diversity goes beyond just producing sufficient maize for the household but a malleable strategy from traditional-way to nutritious-oriented farming system to meet their least standard calories requirements. Crop diversification enhances food stock in term of quantity and also improve income through sale of crops which then is used to improve household consumption patterns.

The government should continuously strengthen public extension services to enable the delivery of agricultural technologies such as hermetic bags and modern cribs to reduce postharvest losses and enhance livestock productivity by educating farmers on livestock health, feedlots, breeding and commercialization. This can be achieved by committing more human and financial resources to agricultural extension agents in the County.

5.4 Suggested Areas for Further Research

1. Since this study focused on household dietary diversity, which is not a good predictor of dietary quality, it would be paramount to carry out research along individual dietary diversity among smallholder maize farmers. This will allow for a better understanding of nutritional outcomes.
2. Further research on coping strategies adopted by households during inadequate dietary diversity would be of great importance.

REFERENCES

Abafita, J. and Kim,K-A. (2012) Determinants of household food security in rural Ethiopia: An empirical analysis. Journal of Rural Development, 37(2), 129-157.http://www.irinnews.org/coun-try/et/ethiopia.

Abass, A.B., Ndunguru, B., Mamiru, P., Alenkhe, B., Mlingi, N., and Bekunda, M. (2014). Post-harvest food loses in a maize-based farming system of semi-arid Savanah area of Tanzania. Elsevier- Journal of Stored Products Research, 57(2014), 49-57. https://doi.org/10.1016/j.jspr.2013.12.004.

Abidemi, O.A., & Adeola, O.A. (2016). Determinants of food security status of maize-based farming households in Southern Guinea savannah area of Oyo state, Nigeria. Turkish Journal of Agriculture- Food Science and Technology, 5(4), 411-417. https://doi.org/10.24925/turjaf.v4i5.411-417.534.

Abongo, G.O. (2017). Factors associated with nutritional status of children aged 6-59 months in Maikona Ward of Marsabit County. Semantic Scholar, 28-45. https://www.semanticscholar.org/.

AGRA, (2014). Establishing the status of postharvest losses and storage for major staple crops in eleven African Countries (phase II). Alliance for Green Revolution in Africa (AGRA): Nairobi Kenya.

Akerele, D., Momoh, S., &Aromolaran, A.B. (2013). Food insecurity & coping strategies in South-West Nigeria. Food Security Journal, 5(1), 407-414. https://www.researchgate.net/.

Akerele, D., Sanusi, R.A., Fadare, O.A., &Ashaolu, O.F. (2017). Factors influencing nutritional adequacy among rural households in Nigeria: How does dietary diversity stand among influencers Journal of Ecology & Nutrition, 56(2), 187-203. https://doi.org/10.1080/.

Annim, S.K., &Frempong, R.B. (2018): Effects of access to credit and income on dietary diversity in Ghana. Journal of Food Security, 25(10), 1649 -1663. https://doi.org/10.1007/s12571-018-0862-8.

Apanovich, N., Mazur, R.E. (2018): Determinants of seasonal food security among smallholder farmers in south-central Uganda. Agric & Food Security, 87(7), 7-10. https://doi.org/10.1186/s40066-018-0237-6

Bimerew, G. T., &Beyene, F. (2014). Factors influencing household food security: The case of Babile district, East Hararghe zone, Ethiopia. Journal of Development and Agricultural Economics, 6 (4), 149-158. https://www.researchgate.net/.

Chebete, A., Ruth, N., Otinga, A., Ng'etich, W., Koech, J., & Scholz, R.W. (2018): Efforts toward improving maize yields on smallholder farms in Uasin Gishu County, Kenya, through site-specific, soil-testing-based fertilizer recommendation: A transdisciplinary

approach. East African Agricultural & Forestry Journal 1-11. https://doi.org/10.1080/00128325.2018.1443413.

Chege, J., Lemba, J., & Semenya, P. (2018): Influence of agricultural extension on household food security status among smallholder farmers. Advances in Research, 14(2),1-9. 10.9734/AIR/2018/39267

Cheriyot, K.P., &Boit, K.J. (2017): Factors influencing green maize harvesting toward innovative research & knowledge for global competitiveness & sustainable development: Case study of Nandi South district. Kibabii University 2nd Interdisciplinary International Scientific Conference, June 14 – 15, 2017.

Cherop, G. (2017). Dietary Assessment and Nutritional Status of Children (6-23 Months) Consuming Local Food Recipes in Vihiga County, Western Kenya. Semantic Scholar, 78-86. Corpus ID: 209209854.https://doi.org/10.1080/03670244.2017.1281127.

Choudhury, S. (2018). An economic analysis of dietary diversification in the developing world. Adelaide Research & Scholarship, 120-137. https://doi.org/10.25909/5b3eb64a947f0.

CIMMYT, (2015): A Quarterly Bulletin of the Drought Tolerant Maize for Africa Project: Maize in Kenya. International maize and wheat Improvement Center (CIMMYT). http://www.dtma.cimmyt.org/.

Codjoe S.N, Okuta, D., Mphil& Abu, M. (2016): Urban Household Characteristics and Dietary Diversity: An Analysis of Food Security in Accra, Ghana. Food and Nutrition Bulletin, 37(2), 202-218. https://doi.org/10.1177%2F0379572116631882.

Demeke, M., Meerman, J., Scognamillo, A., Romeo, A., & Asfaw, S. (2017). Linking farm diversification to household diet diversification: Evidence from a sample of Kenyan ultra-poor farmers. ESA Working Paper No.17-01. 15-20. February 2017 Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations.

Eberwein, J.D., Shekar,M., Kakietek, J., & Walters, D.(2016): An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting. International Bank for Reconstruction and Development /the World Bank. http://www.worldbank.org/.

Eshete, T., Kumera, G., Bazezew, Y., Bereka, T.M., &Mihretie, A. (2018): Determinants of inadequate minimum dietary diversity among children aged 6-23 months in Ethiopia. Agriculture & Food Security, 7(1), 18-25. http://10.1186/s40066-018-0219-8.

FAO & ECA, (2017). Regional overview of food security & nutrition: Addressing the threat from climate variability and extremes for food security & nutrition, Accra. https://www.preventionweb.net/go/55961.

FAO & ECA, (2018): Regional overview of food security & nutrition: Addressing the threat from climate variability and extremes for food security & nutrition, Accra. http://www.fao.org/3/ca2710en/CA2710EN.

FAO, (2010). Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization of the United Nations, Rome, Italy, 10-28.

FAO, (2011). Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization of the United Nations, Rome, Italy, 5-28.

FAO, (2014): Understanding smallholder maize farmer attitudes to commercialization: The case of maize in Keya. Food and Agriculture Organization of the United Nations, Rome, 3, 50 – 61. E-ISBN 978-92-5-108279-9.

FAOSTAT, (2020): State of food security and nutrition in the world. Transforming food systems for affordable healthy diets, Rome, FAO. https://doi.org/10.4060/ca9692en.

Faridi, R., &Wadood, S. (2010). An Econometric Assessment of Household Food Security in Bangladesh. The Bangladesh Development Studies, 33(3), 97-111. www.jstor.org/stable/23339854.

Feleke, S., Kilmer, L.R., & Gladwin, H.C. (2003). Determinants of food security in Southern Ethiopia. Agricultural Economics, 33(3):351-365. https://www.researchgate.net/.

FNSP, (2017): National food and nutrition security policy implementation framework 2017-2022, Ministry of agriculture, livestock and fisheries, GoK, Nairobi, Kenya. http://www.fns.usda.gov/sites/default/files/FSGuide.pdf.

Gilbert, C.L, & Morgan, C.W. (2010). Food security: Feeding the world in 2050. Philosophical Biological Sciences, 1554 (365), 3023-3034. https://doi.org/10.1098/rstb.2010.0139.

Gitagia, Maureen Wanjiru; Ramkat, Rose Chepchirchir; Mituki, Dorothy M.; Termote, Celine; Covic, Namukolo; and Cheserek, Maureen Jepkorir. (2019) Determinants of dietary diversity among women of reproductive age in two different agro-ecological zones of Rongai Sub-County, Nakuru, Kenya. Food and Nutrition Research 63(2019). https://doi.org/10.29219/fnr.v63.1553.

Gitonga, Z.M., Groote, H.D., & Tefera., T. (2015). Metal silo grain storage technology and household food security in Kenya. International Journal of Educational Development, 43(C), 12-21. https://www.semanticscholar.org/.

Godden, B. (2004). Sample Size Formulas. Journal of Statistics, 3, 66.

Gok, (2017): National food and nutrition security policy implementation framework 2017-2022.Ministry of agriculture, livestock and fisheries, Government of Kenya, Nairobi. http://www.ascu.go.ke/.

Gujarati, D.N. (2003): Basic Econometrics, 4th edition, The McGraw-Hill Higher Education co Ltd.

Hadijah A. Mbwana, Joyce Kinabo, Christine Lambert & Hans K. Biesalski (2016) Determinants of household dietary practices in rural Tanzania: Implications for nutrition interventions, Cogent Food & Agriculture, 2:1, 1224046, DOI: 10.1080/23311932.2016.1224046.

Huluka, T.A &Wondimagegnhue, A.B. (2019). Determinants of household dietary diversity in the Yayo biosphere reserve of Ethiopia: An empirical analysis using sustainable livelihood framework. Cogent Food and Agriculture, 5:169083. https://doi.org/10.1080/23311932.2019.1690829.

IFAD, (2016). Why food and nutrition security matters for inclusive structural and rural transformation. International Fund for Agricultural Development (IFAD) Research Series. p 4-15. https://www.linkedin.com/company/ifad.

IFPRI, (2019): Assessing Africa's food & nutrition security situation. International Food Policy Research Institute (IFPRI), discussion paper 37, 2004, Washington, D.C.

IPIN, (2015): Practical. Checklists for conducting nutrition surveys Integrated Programming for Improved Nutrition (IPIN), http://www.peopleinneed.cz/ipin.

John, K.M., Demi, M., &Amegashie,P.K.(2013): Analysis of food security status of farming households in the forest Belt of the Central Region of Ghana. Russian Journal of Agricultural & Socio-Economic Sciences, 13(1):26-42. 10.18551/rjoas.2013-01.04.

Kalkuhl, M., Kornher, L., Kozicka, M., Boulanger, P., & Torero, M. (2013): Conceptual framework on price volatility & its impacts on food and nutrition security in the short-term. Foodsecure Working Paper No. 15. https://mpra.ub.uni-muenchen.de/72164/.

Kamenwa, R. (2017): State of Nutrition in Kenya. Department of Pediatrics and Child Health Aga Khan University Hospital, Nairobi, KPA Annual Conference Kisumu, 25th -29th April 2017.

KDHS, (2014). Millennium Development Indicators report in Kenya. Kenya Demographic Health Survey (KDHS), Nairobi, Kenya. https://www.dhsprogram.com.

KDHS, (2018). Demographic Health Survey, Nairobi, Kenya. https://dhsprogram.com.

Kennedy, G., Ballard, M. & Dop, M., (2011): Guideline for measuring household and individual dietary diversity. Rome, Nutrition and Consumer Protection Division. Food and Agriculture organization of the United Nations.

Kiboi, W., Kimiywe, J., &Chege, P. (2017). Determinants of dietary diversity among pregnant women in Laikipia County, Kenya. BioMed Central (BMC), 12(3), 2-8. https://doi.org/10.1186/s40795-017-0126-6.

Kimiywe, J. (2015). Food and nutrition security: Challenges of postharvest handling in Kenya. Proceedings of the Nutritional Society ,74(4), 487-495. https://doi.org/10.1017/S0029665115002414.

Kipkargat, T., &Tuigong, D. (2015). Impact of agricultural extension on food security among small-scale farmers in Wareng district, Kenya. International Journal of Agricultural Extension and Rural Development Studies, 2(1), 18-21. http://www.eajounals.org/

KNBS, (2015): Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID). http://www.knbs.or.ke/.

KNBS, (2019): Kenya 8th population and housing census report. Kenya National Bureau of Statistics (KNBS). https://t.co/1XxK6SxgMd.

Koskei, P., Bii, C.C, Musotsi, P, and Karanja, S.M. (2019). Postharvest storage practices of maize in Rift Valley and Lower Eastern Regions of Kenya: A cross-sectional study. International Journal of Microbiology, Volume 2020/ID 6109214, 1-10. https://doi.org/10.1155/2020/6109214.

Kothari, C.R. (2004): Research Methodology: Methods and Techniques. 2nd Edition, New Age

Kurgat, K.E., Keror, J.S., Yego, K.H., &Bartilol, K.M. (2019). Determinants of smallholder diary farmers milk production and supply to market in Uasin Gishu County, Kenya. International Journal of Research and Innovation in Social Sciences (IJRISS),5(3), 2454-6186. https://www.researchgate.net/publication/332413696.

Lutomia, C.K., Obare, G.A., Kariuki, I.M., &Muricho,G.S.(2019) Determinants of gender differences in household food security perceptions in the Western and Eastern regions of Kenya, Cogent Food & Agriculture, 5(1), 1694755: https://doi.org/10.1080/23311932.

Mango, N., Makate, C., &Mapemba, L. (2018): The role of crop diversification in improving household food security in Central Malawi. Agriculture & Food Security Journal, 7(7). https://doi.org/10.1186/s40066-018-0160-x.

Marechera,G., &Ndwiga,J. (2014): Farmer perceptions of aflatoxin management strategies in lower Eastern Kenya. Journal of Agricultural Extension and Rural Development. 6(12), 382-392. http://www.academicjournals.org/JAERD.

Marivoet, W., Becquey, E., &Campenhout, V.B. (2019). How well does the food consumption score capture diet quantity, quality and adequacy across regions in the Democratic Republic of the Congo (DRC). Food Security, 11:1029-1049. https://doi.org/10.1007/s12571-019-00958-3.

Mazunda, J., &Droppelmann, K. (2012): Maize consumption estimation & dietary diversity assessment methods in Malawi. International Food Policy Research Institute (IFPRI), Policy Paper No. 11, March 2012. ftp://ftp.fao.org/docrep/fao/011/x9892e/x9892e00.

Mbithi, E.M. (2018): Assessment of household land size & uses for sustainable food & livelihood security in maize farming systems: A case study of Matetani sub -location, Kangundo sub-county, Machakos County, Kenya. University of Nairobi Archives, 95, 101 – 120. http://erepository.uonbi.ac.ke/handle/11295/108905.

Mbwana, A.H., Kinabo, J., Lambert, C., &Biesalski, K.H. (2016) Determinants of household dietary practices in rural Tanzania: Implications for nutrition interventions, Cogent Food & Agriculture, 2(1): 1224046. https://doi.org/10.1080/23311932.2016.1224046.

Mekuria, W., &Mekonnen,K.(2018): Determinants of crops -livestock diversification in the mixed farming systems: evidence from central high lands of Ethiopia. Journal of Agriculture and Food Security, 60(7), 39 -48. https://doi.org/10.1186/s40066-018-0212-2

Mohajan, H.K. (2014). Food and nutrition Scenario of Kenya. American Journal of Food and Nutrition, 2(2), 28-38. DOI:10.12691/ajfn-2-2-3.

Motuma, G., Dafisa, A., & Assefa, B. (2019). Determinants of household dietary diversity in Yayu biosphere reserve, Southwest Ethiopia. Ethiopian Journal of science & Technology,12(1), 45-68. **DOI:** 10.4314/ejst.v12i1.3.

Mugisha, J., Mwadime, R., &Sebatta, C. (2017). Factors enhancing household nutrition outcomes in potato value chain in South-Western Uganda. Journal of Sustainable development, 10(3), 220-232. https://doi.org/10.5539/jsd.v10n3p215.

Mukherjee, A., Paul, S., Saha., I., Kumar, T.S., & Ghose, G. (2018). Dietary diversity and its determinants: A community-based study among adult population of Durgapur, West Bengal. Medical Sciences Journal, 11(4), 296-301. http://www.mjdrdypv.org/text.asp.

Mukhoyani, W. (2017): The role of fermented maize – based products on nutrition status & morbidity of children 6 – 59 months old in western Kenya. University of Nairobi Archives, 76 – 87. http://hdl.handle.net/11295/102209.

Mulwa, R., Rao, K.P.C., Gummadi, S., &Kilavi, M. (2015): Effects of climate change on agricultural household's welfare in Kenya. Climate Research Journal, 67(2), 87- 97. https://www.researchgate.net.

Mutea, E., Bottazzi, P., Jacobi, J., Rist, S. (2019) Livelihoods and Food Security among Rural Households in the North-Western Mount Kenya Region. Frontiers in Sustainable Food Systems, 98(3), 5-10. https://doi.org/10.3389/fsufs.2019.00098.

Muthini, D., Nzuma, J., &Nyikal, R. (2019). Farm production diversity and its association with dietary diversity in Kenya. Food Security. https://doi.org/10.1007/s12571-020-01030-1.

Mwanamwenge, M., & Harris, J. (2017): Agriculture and food systems, diets & nutrition in Zambia. Discussion Paper No: 3, IIED & HIVOS. https://www.semanticscholar.org/search.

Njagi, T., Mathenge, M., Mukundi, E., Carter, M. (2017): Maize technology bundles & food security in Kenya. The U.S Government's Global Hunger & Food Security Initiative (Feed the Future), Innovation Lab for Assets & Market Access Policy Brief, 2nd February, 2017.

Njoroge, W.A., Baoua, I., and Baributsa, D. (2019). Postharvest management practices of grains in the Eastern of Kenya. Journal of Agricultural Science, 11(3), 1916-9760. https://doi.org/10.5539/jas.

Obayelu, O.A., &Osho, F.R. (2019). How diverse are the diets of low-income urban households in Nigeria? Elsevier-Journal of Agriculture & Food Research, 100018(2), 1543-2666. https://doi.org/10.1016/j.jafr.

Ochieng, J., Afari., V., Lukumay, P.J., & Dubois, T. (2017). Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. Public Library of Science (PLOS ONE), 12(12), 101-121. https://doi.org/10.1371/.

Ochieng, J., Kirimi, L., & Mathenge, M. (2016): Effects of climate variability & change on agricultural production: The case of small- scale farmers in Kenya. Wageningen Journal of Life Sciences, 77(1), 71 -78. https://doi.org/10.1016/j.njas.2016.03.005.

Olwande, J. (2012): Smallholder maize production efficiency in Kenya. Regional Workshop on an Integrated Policy Approach to Commercializing smallholder maize production, 6th - 7th June, 2012, Nairobi, Kenya.

Onono, P.A., Wawre, N.W.H., &Ombuki, C. (2013). The response of maize production in Kenya to economic incentives. International Journal of Development and Sustainability, 2(2). 530 – 543. http://www.isdsnet.com/.

Pangaribowo H.E., Gerber, N., & Torero, M. (2013). Food and nutrition security indicators: A review. Working paper 108, Center for Development Research, University of Bonn. DOI: 10.2139/ssrn.2237992.

Powel, B., Bezner, K., & Young, S.L., (2017): The determinants of dietary diversity and nutrition: ethno nutrition knowledge of local people in the east Usambara Mountains, Tanzania. J. Ethnobiology Ethnomedicine, 23(13). https://doi.org/10.1186/s13002-017-0150-2.

Rajendran, S., Afari – Sefa, V., Shee, A., Bocher, T., Beckunda, M., Dominick, I., &Lukumay, P. (2017). Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize – based farming systems. Agriculture and Food Security Journal, 50(6), 7 – 13. https://doi.org/10.1186/s40066-017-0127-3.

Robert M. Kilonzo, Jasper K. Imungi, William M. Muiru, Peter O. Lamuka& Patrick M. Kamau Njage (2014): Household dietary exposure to aflatoxins from maize and maize products in Kenya. Journal of Food Additives &Contaminants, Part A, 31(12), 2055-2062. https://doi.org/10.1080/19440049.2014.976595.

Sarkar, S. (2014): Households' dietary diversity: A case of rural households in West Bengal, India. European Academic Research, 2(6), 5 – 9. http://www.euacademic.org/

Sawicka, B. (2019). Post-harvest Losses of Agricultural Produce. Zero Hunger. Encyclopedia of the UN's Sustainable Development Goals,1-16. https://doi.org/10.1007/978-3-319-69626-3.

Seguin, R.A., Aggarwal, A., Vermevlen, F., &Drewnowski, A. (2016). Consumption frequency of foods away from home linked with higher body mass index and low fruits and vegetables intake among adults. Journal of Environmental and Public Health, 3074241.https://doi.org/10.1155/2016/3074241.

Shee, A., Mayanja, S., and Simba, E. (2019). Determinants of postharvest losses along smallholder producers of maize and Sweet potato value chains: an ordered Probit analysis. Food Sec. 11(0), 1101-1120. https://doi.org/10.1007/s12571-019-00949-4.

Sibhatu, K., &Qaim, M. (2018): Meta – Analysis of the association between production diversity, diets & nutrition in smallholder farm households. Food Policy Journal, 77(2), 1–18. https://doi.org/10.1016/j.foodpol.2018.04.013.

Sibhatu, K., Krishna, V.V., &Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. Proceedings of the National Academy of Sciences (PNAS), 112(34), 10657-10662.https://doi.org/10.1073/pnas.1510982112.

Silvestri, S., Sabine, D., Patti, K. (2015) Households and food security: lessons from food secure households in East Africa. Agric & Food Security, 23(4), 29-38. https://doi.org/10.1186/s40066-015-0042-4.

Singh, I., Squire, L., & Strauss, J. (1986). Agricultural household models: A Survey of Recent Findings and Their Policy Implications, Center Discussion Paper, No. 474, Yale University, Economic Growth Center, New Haven, CT. http://hdl.handle.net/10419/160397.

Snapp, S.S., & Fisher, M. (2015): ''Filling the maize basket'' supports diversity & quality of household diets in Malawi. Food Security Journal, 7(1), 83 – 96. https://doi.org/10.1007/s12571-014-0410-0.

Swindale, A., &Bilinsky, P. (2006). Household dietary diversity score (HDDS) for measurement of household food access: An indictor guide, version 2. Food and nutrition Technical Assistance (FANTA). http://www.fantaproject.org/.

Taruvinga, A., Muchenje, V., &Mushunje, A. (2013). Determinants of rural household dietary diversity: The case of Amatole and Nyandeni districts, South Africa. International Journal of Development and Sustainability (ISDS, 4(2),2233-2247. http://www.isdsnet.com/ijds.

Tefera, T., Mugo, S., and Likhayo, P. (2011). "Effects of insect population density and storage time on grain damage and weight loss in maize due to the maize weevil Sitophilus

zeamais and the larger grain borer Prostephanustruncatus," African Journal of Agricultural Research,10(6),2249–2254. http://www.academicjournals.org/AJAR.

Torheim, L.E., Quattara, F., Diarra, M.M., Thiam, F.D., Barikmo, I., Hatloy, A., &Oshaug, A. (2004): Nutrient adequacy and dietary diversity in rural Mali: Association and Determinants. European Journal of Clinical Medicine, 58(4), 594-604. https://doi.org/10.1038/sj.ejcn.1601853.

UASIN County, (2013): Gishu County integrated development plan

UNICEF, (2020): Global nutrition report: Action on equity to end malnutrition. United Nations Children's Fund (UNCEF). https://campaigns.savethechildren.net/grid.

Vanessa, O., Santellano, E., & Garrido, A. (2017). Dietary diversity in rural households: The case of indigenous communities in Sierra Tarahumara, Mexico. Journal of Food and Nutrition, 5 (2), 86-94. http://pubs.sciepub.com/jfnr/5/2/3.

Wafula, B.P., Nyantika, D.K., Ekisa, T.G., &Mabaya, D.M. (2018): Influence of type of input subsidies on maize production in Trans Nzoia West sub- County, Trans Nzoia County, Kenya. International Journal of Current Innovations in Advanced Research, 6(1), 57 -66. https://www.semanticscholar.org/search.

Wakweya, F. (2010): Does off-farm income compete with farm income: Evidence from Malawi. Norwegian University of Life Sciences. 25 -30.

Wambua, S., Birachi, E., Gichangi, A. *(2018):* Influence of productive resources on bean production in male- and female-headed households in selected bean corridors of Kenya. *Agric & Food Secur*ity**,** 85(7). https://doi.org/10.1186/s40066-018-0236-7.

Wamunga, W.F., Mukabane,D., &Wakhu.D. (2015). "Sustainable Household Food Security in Moiben, Uasin Gishu County, Kenya." Food Studies: An Interdisciplinary Journal 6 (1): 27-38. https://doi.org/10.18848/2160-1933/CGP/v06i01/40521.

WFP, (2008): Food consumption analysis Calculation and use of the food consumption score in food security analysis. United Nations World Food Program (WFP), February 2008. http://vam.wfp.org/.

WFP, (2015): Technical guide note: Food consumption score nutritional quality analysis (FCS-N). United Nations World Food Program, Food Security Analysis, (VAM), Rome. http://wfp.org/policy-resources.

WHO, (2010): Indicators for assessing infant & young child feeding practices Part 2 measurement, World Health Organization, Geneva

Woodridge, J.M. (2015). Introductory econometrics: A modern approach, 5th edition. Nelson education.

Workicho, A., Belachew, T., Feyissa, G.T. *(2016):* Household dietary diversity and Animal Source Food consumption in Ethiopia: evidence from the 2011 Welfare Monitoring Survey. *BMC Public Health*, 1192 (16),3-11. https://doi.org/10.1186/s12889-016-3861-8.

World Bank, (2018): The World Bank Annual Report. International Bank of Reconstruction & Development (IBRD), Washington Dc.http://hdl.handle.net/10986/30326.

World Bank, (2019): Global Economic prospective. International Bank of Reconstruction & Development (IBRD), Washington Dc. https://www.worldbank.org/.

APPENDICES

Appendix 1: Multinomial logistic regression results

Table 1: MNL coefficients estimates for the factors determining HDD

Predictor variables	**Low Dietary Diversity (LDD)**			**High Dietary Diversity (HDD)**	
	B	Sign	value	Sign	p-value
Intercept	β_0	-0.167	0.898	-5.365	0.001
Gender	β_1	1.384	0.000***	-0.809	0.024*
Household size	β_2	0.034	0.762	-0.147	0.243
Maize income	β_3	-1.006	0.884	0.003	0.044*
Annual maize yield	β_4	-0.002	0.409	-0.008	0.005**
Credit	β_5	-0.692	0.017*	-0.804	0.034*
Extension	β_6	1.412	0.002**	0.064	0.909
Crop enterprises	β_7	-0.168	0.566	1.462	0.001**
off-farm income	β_9	-0.003	0.006**	9.800	0.296
Livestock	β_{10}	-0.180	0.016*	0.192	0.010*
Education	β_{11}	0.037	0.328	0.186	0.001**
Age	β_{12}	0.003	0.807	0.046	0.003**
Threshing	β_{13}	-0.116	0.771	0.800	0.145
Drying practices	β_{14}	0.061	0.473	0.107	0.275
Meal frequency	β_{15}	-0.212	0.040*	-0.176	0.142
Storage	β_{17}	0.070	0 .838	-1.424	0.000***
DD knowledge	β_{20}	-0.369	0.195	0.841	0.012*
Base Category	Medium Dietary Diversity (MDD)				
No. of observation	384				
LR-Chi-squared (40)	159.92***				
Pseudo R-squared	0.2084				
Log likelihood	-303.72994				

Level of significance; *** 1%; ** 5%; * 10%. Dependent variable: Household Dietary Diversity (1= Low 2= Medium 3= High).

Table 2. MNL Model Marginal effects

Variable	Low Dietary Diversity (LDD)		High Dietary Diversity (HDD)	
	Marginal effect	Std. Err.	Marginal effect	Std.Err.
Gender	0.231***	0.048	-0.146*	0.038
Household size	0.097	0.017	-0.017	0.014
Maize income	-0.012	0. 002	0.034*	0.001
Annual maize yield	-0.046	0.004	-0.008**	0.003
Credit	-0.132*	0.042	0.113*	0.041
Extension	0.217**	0.066	0.036	0.061
Crop enterprises	-0.071	0.043	0.173**	0.046
Dependents	-0.048	0.024	0.046	0.020
off-farm income	- 0.006**	0.007	0.021	0.006
Livestock	-0.034*	0.011	0.028*	0.008
Education	0.001	0.006	0.002**	0.001
Age	0.008	0.002	0.005**	0.002
Threshing	-0.042	0.060	0.095	0.062
Drying practices	0.006	0.013	0.010	0.010
Meal frequency	-0.027*	0.015	-0.14	0.013
Storage	0.055	0.036	-0.166***	0.036
DD knowledge	-0.083	0.042	0.108*	0.036
Base Category	Medium Dietary Diversity (MDD)			
No. of observation	384			
LR-Chi-squared (32)	159.92***			
Pseudo R-squared	0.2084			
Log likelihood	-303.72994			

Level of significance; *** 1%; ** 5%; * 10%. Dependent variable: Household Dietary Diversity (1= Low 0= Medium 2= High). Source: author's own survey (2021)

Table 3: Hausman test for the Independence of Irrelevant Alternatives (IIA) assumption.

	chi2	df	P>chi2
Low	20.848	21	0.468
Medium	24.907	21	0.251
High	14.849	21	0.83

Appendix 2. Multicollinearity test results

Table 4: Variance of inflated factor (VIF) for the explanatory variables used to model the determinants of household dietary diversity

Variables	VIF
Gender	1.13
Age	1.11
Education level	1.07
Household size	2.97
Land size	1.06
Maize income	2.31
Annual maize yield	2.53
Off-farm income	1.10
Livestock holding	1.16
Crop enterprise	1.10
DD knowledge	1.10
Credit	1.07
Extension	1.22
water access	1.03
Threshing	1.05
Drying	1.02
Storage	1.15
Meal frequency	1.09
Mean VIF	**1.43**

Source: author's own survey (2021)

Appendix 3: Heteroscedasticity test:

Table 4: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Chi2(1)	2.40
Prob>chi2	0.1210

Appendix 4: Questionnaires

University of Nairobi

Questionnaire ID: _____

Farmers' Questionnaires

Determinants of Household Dietary Diversity among Smallholder Maize Farmers in Uasin Gishu County, Kenya

Household survey questionnaire, February 2020

Introduction:

This questionnaire will be used to interview smallholder maize farmers' household head or family members aged above 18 years who participated in decision-making in the household.

The purpose of the study was to establish the determinants of household dietary diversity among smallholder maize farmers. The specific objectives were to estimate household dietary diversity status and determine the various factors affecting household dietary diversity of smallholder farming households. Only farmers who are currently engaged in subsistence maize farming will be interviewed. Information collected is purely for research and academic purpose and your views will be treated confidential neither to be linked to you in any way. Kindly note that your participation is voluntary and you are free to withdraw at any point or fail to answer any of the questions you feel uncomfortable with. If you agree to participate, the survey will take about less than forty-five (45) minutes, we are therefore kindly asking for your consent to be part of the study.

General Information

Enumerator's Name: _____

Name of the Farmer: _____

Date of Interview: _____

County: _____Sub-county: _____Location: _____

Sub-location: _____Village: _____

No	Section 1: Household Characteristics	Codes
1	Name of the respondent	
2	Sex of the respondent	[ ] 1 = Male [ ] 0 = Female
4	Age of household head (in years)	
5	Highest education of household head (in years of schooling)	
6	What is the size of the household?	
7	Number of household members under 15 and above 64 years	
11	How many years have you engaged in subsistence maize farming?	

Section 2: Food Consumption

Please describe the food that was eaten or drank yesterday during the day or night by any member of the household and exclude food purchased and eaten outside the home.

Food source code: 1- Own production 2- Purchase 3. Others _____

No	Household's types of food consumed	Unit (Bowls/kgs /liters)	Unit price (Ksh)	Source (s) of food (refer to the code)	Codes
1	**Cereals** (corn/maize, rice, wheat, sorghum, millet e.g. bread, noodles, porridge. ugali, Gethuri, & other grain products.)				[ ] 1 = Yes [ ] 2 = No
2	**White root & tubers (White** potatoes, white yam, white cassava or any other foods made from roots)				[ ] 1 = Yes [ ] 2 = No
3	**Vitamin A rich vegetables & Tubers** (Pumpkin, carrot, sweet potatoes, red sweet pepper & other locally available vitamin A rich vegetables)				[ ] 1 = Yes [ ] 2 = No
4	**Dark green leafy vegetables (**cassava leaves, kale & wild forms)				[ ] 1 = Yes [ ] 2 = No
5	**Other vegetables** (Tomatoes, onion, eggplants & other locally available vegetables)				[ ] 1 = Yes [ ] 2 = No
6	**Vitamin A rich fruits** (Ripe mango, ripe papaya, ripe avocado & fresh juice made from these fruits)				[ ] 1 = Yes [ ] 2 = No
7	**Other fruits (**Wild fruits				[ ] 1 = Yes [ ] 2 = No

	&juice made from theses fruits)				
8	**Organ meat** (Liver, kidney, or other organ meats or blood-based foods)				[ ] 1 = Yes [ ] 2 = No
9	**Flesh meats** (Beef, pork, lamb, goat, rabbit, chick & duck or other birds & insects)				[ ] 1 = Yes [ ] 2 = No
10	**Eggs** (Eggs from chicken, duck, ostrich & any other egg)				[ ] 1 = Yes [ ] 2 = No
11	**Fish & seafoods** (Fresh or dried fish or shellfish)				[ ] 1 = Yes [ ] 2 = No
12	**Legumes, nuts & seeds** (Dried beans, dried peas, lentils, nuts, degu, seeds, & peanut butter)				[ ] 1 = Yes [ ] 2 = No
13	**Milk & milk products** (Milk, cheese, yoghurt or other milk products)				[ ] 1 = Yes [ ] 2 = No
14	**Oils & fats** (Oils, fats or butter added to food or used for cooking)				[ ] 1 = Yes [ ] 2 = No
15	**Sweets** (Sugar, honey, sweetened soda, or sweetened juice drinks, sugary foods such as chocolates, cookies & cakes)				[ ] 1 = Yes [ ] 2 = No
16	**Spices, condiments & beverages** (Black pepper, salt, hot sauce, coffee, tea, alcoholic drinks)				[ ] 1 = Yes [ ] 2 = No

No	Section 3: Farm Characteristics	Codes
1	Do you own a plot for faming maize?	[ ] 1 = Yes [ ] 0 = No
2	How was the land owned or accessed for use?	[ ] 1 = Inherited [ ] 2= Purchased [ ] 3 = Cooperative [ ] 4 = Others
3	What size of maize farm do you possess (acres)?	[ ] 1= < 2 acres [ ] 2= > 2 but less than 11 acres
4	What is the quantity of maize you produced in a year?	Quantity (kgs)
5	How much do you earn in a year from the sale of maize?	Ksh
6	How much do you incur as cost of selling maize?	Ksh

Section 4: Off- farm earnings

Alongside on farm activities or during on- season or off - season, has your household engaged in any of the listed income generating activities as alternative sources of income? [ ] 1 = Yes [ ] 0 = No. If your answer is **yes**, please answer the questions in the table below.

Household member codes: 1. Head 2. Spouse 3. Son 4. Daughter 5. Others (specify)

No	Description of the source	Codes	Household member (refer to the codes)	Frequency	Monthly income/unit (Ksh/kgs)	Annual income (Ksh)
1	Part time job in other farms?	[ ] 1 = Yes [ ] 0 = No				
2	Running petty business?	[ ] 1 = Yes [ ] 0 = No				
3	Gifts/ food aid	[ ] 1 = Yes [ ] 0 = No				
4	Permanent farm worker?	[ ] 1 = Yes [ ] 0 = No				
5	Remittances from relatives or friends	[ ] 1 = Yes [ ] 0 = No				
6	Non –agricultural casual worker?	[ ] 1 = Yes [ ] 0 = No				
7	Salaried government employment?	[ ] 1 = Yes [ ] 0 = No				
8	Others (specify)					

Section 5: Access to credit

1. Did you have access to credit in the last farming season? [ ] 1 = Yes [ ] 0 = No

1a. If **Yes,** what was the source of credit? [ ] 1 = Farm group [ ] 2 = Microfinance [ ] 3 = other self-help group [ ] 4 = Banks [ ] 5 = Friends/relatives [ ] 6 = others (specify)

2. What kind of credit did you go for: 1. [ ] Consumption credit 2. [ ] Production credit 3. Others (specify) _____

3. What was the size of the credit? Ksh _____

4. Did you get credit on time? [ ] 1 = Yes [ ] 0 = No

4a. If No, what constrained your access to credit? 1. [ ] Tedious administrative procedures 2. [ ] Financial institution attributes 3. [ ] Lack of collateral 4. [ ] Delay/default in previous loan 5. Others (specify) _____

5. What was the effect of the credit on agricultural yield? _____

_____

_____

Section 6: Access to extension services

1. Did you have access to extension services in the last farming season? [ ] 1 = Yes [ ] 0 = No
2. If Yes, how often? 1. Once a month 2. Once every three months 3. Once a year
3. Do you have access to market information? [ ] 1 = Yes [ ] 0 = No
4. If yes, what is the source of information? [ ] 1 = Farmers in the village [ ] 2 = Mass media [ ] 3 = Extension agents [ ] 4 = Local NGOs [ ] 5 = International NGOs [ ] 6. Social media [ ] 7 = Others (specify) _____
5. What distance do you travel to the nearest market (Km)? _____

Section 7: Own farm production and on-farm Income Sources

No	Crops	Quantity produced (in Kgs or Numbers)	Quantity sold (in Kgs or Numbers)	Unit price (Ksh)	Total Income per year (Ksh)
1	Cows				
2	Sheep				
3	Goats				
4	Poultry				
5	Donkeys				
6	Pigs				
7	Rabbit				
8	Cereals				
9	Vegetables				
10	Fruits				
11	Cash crops				
12	Others (Specify)				

Section 9: Post-harvest practices

1. How many days do you sundry your maize? .....

2. Methods use for drying

   [ ] 1 = by stoking [ ] 1 = dry on the ground [ ] 3= others (specify)…….

3. Processing/Millings
   [ ] 1 = Traditional processing [ ] 2 = Posho milling [ ] 3 = others (specify) ……..

4. Sorting and cleaning practices of maize

   [ ] 1= after cobs removed [ ] 2= sort & select before cobs removed [ ] 3=others (specify)…….. ……

5. Maize storage practices
   [ ] 1= Traditional granaries [ ] 2= improved granaries [ ] 3 = others (specify) ……

6. Are you aware about Aflatoxins contamination?
   [ ] 1 = Yes [ ] 0 = No

7. How do you mill/thresh your maize flour?
   [ ] 1 = Manual threshing [ ] 2 = motorized threshing [ ]

8. Do you experience postharvest losses?
   [ ] 1 = Yes [ ] 0 = No

Section 10: Dietary diversity knowledge

1. Do you have knowledge about the health benefits of consuming different food groups?
   [ ] 1 = yes [ ] 2 = No

2. How many meals does household takes per day in the last 24-hours? .....
   1. Do you have access to clean water?
   [ ] 1 = yes [ ] 2 = No