

**EFFECTS OF CHANGING WEATHER PATTERNS ON HOUSEHOLD FOOD
SECURITY IN BUKIRO SUB COUNTY MBARARA DISTRICT**

BISHOP STUART UNIVERSITY



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MASTER OF SCIENCE IN CLIMATE CHANGE
AND FOOD SECURITY**

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Declaration

Declaration

I, John Francis Nuwasasira, declare that the work contained in this dissertation is my original and has been done by me under the supervision of my supervisors. I also declare that this work has never been submitted for any award of a degree/diploma/certificate to any Institution of higher learning,



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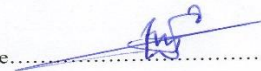
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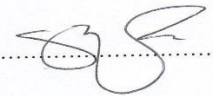
This is to confirm that, this thesis for the award of the Degree of Master of Science in Climate Change and Food Security of Bishop Stuart University was prepared under our supervision.

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Date.....07/09/2024

Dedication

This dissertation is dedicated to my parent Mrs Topista Bakainaga who offered the initial spirit to be self-determined. To my wife Mrs Agnes Tusingwire for all the love, comfort, support, and encouragement to complete the master's degree program in time. To our children Edith, Jude and Maria for family support and encouraging me to pursue science education up to master's level.

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The Research Ethical Committee of Bishop Stuart University for approving my research, and to the University at large for allowing me to pursue my studies.

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List of Acronyms

CO	-	Carbon monoxide
FAO	-	Food and Agricultural Organization
GoU	-	Government of Uganda
IPCC	-	Intergovernmental Panel on Climate Change
MAAIF	-	Ministry of Agriculture Animal Industry and Fisheries
NAPA	-	National Adaptation Program of Action
NEMA	-	National Environment Management Authority
UBoS	-	Uganda Bureau of Statistics
UN	-	United Nations
WFP	-	World Food Programme

Abstract

Changing weather patterns and their variables are already negatively impacting food security by damaging crops, reducing yields, and increasing the prevalence of pests and diseases. These pests and diseases contend with crops for sunlight, water, and nutrients, further diminishing agricultural yields and creating issues for crops that were previously unexposed to these threats. Climate-related disruptions in food distribution and transportation, both internationally and domestically, have a substantial impact on not just safety and quality but also access to food. Prolonged dry spells followed by heavy and stormy rains cause interruptions in food production and transportation, reducing farmers' ability to get their grains to market and potentially affecting food prices. The study examined the effects of changing weather patterns on food security in smallholder households in Bukiro Sub County, Mbarara District. The objectives of the study were to a) establish the effects of changing weather patterns on food security among households) establish the coping strategies towards effects of changing weather patterns on food security by the smallholder households and c) propose the mitigation and adaptation strategies towards the effects of changing weather patterns on food security among households in Bukiro Sub County. This study assessed farmers' perceptions of effects of changing weather patterns on food security and their coping strategies, mitigation and adaptation strategies towards effects of changing weather patterns in smallholder households in Bukiro Sub County, Mbarara District. A sample of 100 smallholder farmers were randomly selected from four parishes of Bukiro sub county and studied using questionnaire and observations. key informants were also conducted with six technical workers and three opinion leaders

The research utilized quantitative and qualitative approaches of data collection. . software STAT 26 and Ms excel version 2016 were used to do data analysis. Quantitative data collection focused on gathering numerical data collected through structured questions and used to aggregate data and generate statistics based on respondents' opinions and/or perceptions. Qualitative data collection involved use of interviews to capture in-depth information that was not captured through the questionnaires. The study incorporated descriptive statistics to present respondents' opinion in the study regarding addressing the research questions. The study utilized quantitative and qualitative methods of data collection and analysis where information was obtained using questionnaires surveys on 100 smallholder farmers and interviews on key informants (9). The collected qualitative data was analysed using Statistical Package for the Social Sciences 26, presented in frequency tables, graphs and charts, and interpreted accordingly while narrative analysis method was used to analyse the qualitative data. The study

found out that changing weather patterns through its variables specifically heavy and stormy rains, late onset of rains, and prolonged dry spells had significant effects on food security. The perceived effects of changing weather patterns established were drying up of water sources (83.8%), decreased land for crop growing (82.4%), reduction in crop yields (77.7%), drying of pastures for animals (67.4%), drying of crops (58.1%), and occurrence of crop and livestock pests and diseases at 56.6%. Also, the perceived weather changing variabilities were late onset of rains (60.1%), prolonged dry spells (17.6%) and heavy and stormy rains (22.3%). From the study findings, farmers clearly perceived that changing weather patterns had negative effects on smallholders' agricultural production systems, impacting negatively on food security. The study findings revealed that changing weather patterns, specifically the parameters of heavy rains and storms, had a significant effect on food accessibility. Households that experienced heavy rains and storms faced difficulties in accessing food. The study findings also revealed that changing weather patterns, specifically late onset of rains and heavy rains and storms, had a significant effect on food stability in Bukiro sub county. Findings further established that changing weather patterns, specifically late onset of rains, had a significant effect on food utilisation in Bukiro sub county. Households that experienced it utilized the food they had due to uncertainties on how the rains would last and their intensity to cause need to grow crops. The study concluded that late onset of rains and heavy rains and storms are the changing weather patterns with the most significant threat to food security in Bukiro Sub County. The study recommended that weather resistant crops should be grown to minimize crop damages that come with unexpected changing weather patterns to improve food production. The study further recommended that people should increase on climate smart practices, ecological land use management practices and improved post-harvest handling technologies as a mitigation measure to heavy and stormy rains because few smallholder farmers were using them. The researcher also recommended effective capacity building to strengthen the most vulnerable groups in agricultural production, who are usually the smallholder farmers, with requisite knowledge and information necessary for weather change mitigation and adaptation.

CHAPTER ONE:

1.0 Introduction

The Chapter contains the study problem (food insecurity) from a national situation (Uganda). The study investigated food insecurity threat in Uganda—focusing on Bukiro sub county, Mbarara District in southwestern Uganda. The study linked climate change as a cause of food insecurity in the study area, centring on the effects of changing weather patterns on food availability, farmers coping strategies, analysed the effects of changing weather patterns and identified the study gaps the weaknesses that form grounds for the knowledge gap. This chapter presents the background of the study, statement of the problem, purpose of the study, research objectives, research questions, and scope of the study, significance of the study. It also presents the conceptual framework.

1.1 Background

Climate refers to the average weather conditions of a place as determined by the temperature, precipitation, and humidity over thirty years (Danandeh Mehr *et al.*, 2020). Climate change refers to a situation of how weather patterns change over decades or longer and it takes place due to natural and human influences. Intergovernmental Panel on Climate Change (IPCC, 2014) defines ‘‘climate change’’ as ‘‘a change in the state of the climate that can be identified (for example using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer’’. Changing weather patterns occur when there is an extended period of months or years of extended periods of too much rain with hail and windstorms causing destructions or when a region notes deficiency in its water supply whether surface or underground water (FAO, 2015a) (Kabubo-Mariara *et al.*, 2015). IPCC defines drought as ‘‘a period of unusually dry weather that persists long enough to cause problems such as crop damage and water supply shortages’’. Generally, drought occurs when a region receives consistently below average precipitation and prolonged sunshine and can have a substantial impact on the ecosystem and agriculture of the affected region (Meza *et al.*, 2021). For example, subsistence farmers are more likely to migrate during periods of prolonged sunshine because they do not have alternative food sources (Sorgho *et al.*, 2020). Because there were more hot days than cold days and more days without rain than days with rain and any rainfall that is less than 1mm is considered no rainfall at all for agriculture.

According to (FAO, 2015a), food security always refers to a state or condition when all people at all times have physical, economic and social access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The same author refers to food availability refers as sufficient quantities of food of appropriate quality, supplied through domestic production or imports, including food aid , and outlines the four pillars of food security as: availability, access, utilization and stability and defines food accessibility as one's ability to access sufficient resources (entitlements) to enable him or her get the right foods for a nutritious diet; food stability is a situation where there is presence of food at all times in terms of availability, access and utilization; and utilization as the adequate utilization of food through adequate diet, clean water, sanitation and healthcare to reach a state of nutritional wellbeing where all physiological needs are met.

Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality(Brown *et al.*, 2015) for example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery and resulting spikes in food prices after. Increasing temperatures can contribute to spoilage and contamination. Environmental changes, including climate change and water scarcity threaten global agricultural production, food security, and health. There is evidence that environmental change will reduce the yields of both crops, fisheries, and livestock. For example,(Ziska *et al.*, 2016)indicated that Changes in the frequency and severity of prolonged dry spells, and heavy and stormy rains could pose challenges for farmers and ranchers and threaten food safety.(Ziska *et al.*, 2016) Overall, changing weather patterns could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as had been done in the past. The effects of changing weather patterns also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology. More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially heavy and stormy rains and prolonged dry spells can harm crops and reduce yields. Many weeds, pests, and fungi thrive under warmer temperatures and wetter climates, which compete with crops for light, water, and nutrients reduce agricultural yields- and eventually food security(Hatfield *et al.*, 2014).The ranges and distribution of weeds and pests are likely to increase

with climate change. This could cause new problems for farmers' crops previously unexposed to these species. Heat waves, which are projected to increase under climate change, could directly threaten livestock. (*Ibid*) Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production. Prolonged dry spells may threaten pasture and feed supplies. Prolonged dry spells reduce the amount of quality forage available to grazing livestock. increase the prevalence of parasites and diseases. Any climate-related disturbance to food distribution and transport, internationally or domestically, may have significant impacts not only on safety and quality but also on food access. For example, the food transportation system in the United States frequently moves large volumes of grain by water. In the case of an extreme weather event affecting a waterway, there are few, if any, alternate pathways for transport. Prolonged dry spells immediately followed by heavy and stormy rains results in disruptions of food transport.(Ziska *et al.*, 2016),Transportation changes such as these reduce the ability of farmers to transport their grains to food markets and can affect food prices.

(D'Odorico *et al.*, 2018) revealed that the world is experiencing rising demands for food, stemming from three key forces: increasing human population; rising meat and dairy consumption with growing affluence; and biofuel consumption while (Jensen & Orfila, 2021) indicated that the cost of food imports and factory farming are increasing, and world food security is at a crossroads. In October 2009, during a High-Level Expert Forum in Rome, FAO predicted that the world population by the year 2050 would reach 9.1 billion, thirty four percent higher than it was in 2009 which would necessitate increased food production (net of food used for biofuel) by seventy percent (Mottaleb *et al.*, 2021). (Apanovich & Mazur, 2018) indicated that effects of climate changed posed a threat to food security as the planet warms, rain fall patterns will shift, while extreme weather events like drought, floods and forest fires will be more frequent affecting agriculture productivity and food security, and (Masson-Delmotte *et al.*, 2019) revealed that in some countries, yields from rain-fed agriculture could fall by 50 percent by 2030.

The food insecurity threat global situation is no different from Africa. In sub-Saharan Africa, extreme changing weather patterns already impede people's ability to grow food and rear livestock, and pastoralists and Agro pastoralists will need to adapt to changes in water regimes to maintain their food security and well-being(FAO, 2018. (Songok *et al.*, 2011), in their studies found that Sub-Saharan Africa is vulnerable to climate change, as multiple biophysical, political,

and socioeconomic stresses interact to heighten the region's susceptibility and constrain its adaptive capacity; and (Sorgho *et al.*, 2020) indicated that higher increases in temperature in sub-Saharan Africa has caused changes in rainfall intensity while (Tschakert *et al.*, 2010) revealed that there are increased incidences of extreme events such as droughts. However, they did this at higher levels and there is need for it to be done at lower local levels to show how such changing patterns affect the small holder farming households. Felt and expected impacts include shortened or disrupted growing seasons, reductions in the area suitable for agriculture, and declines in agricultural yields in many regions of sub-Saharan Africa posing a threat to food security (Masson-Delmotte *et al.*, 2019).

In Zimbabwe, (Mugandani *et al.*, 2012.) revealed that the warming trends render land increasingly marginal for agriculture, which poses a major threat to its heavy dependence on rain-fed agriculture and climate sensitive resources while (Kabubo-Mariara, 2014) revealed that in Kenya, extreme changing weather patterns undermine food production affecting crop and livestock systems both directly posing serious threats to food shortage, water, and energy.

(FAO, 2014), indicated that Uganda's food security is still not the best compared to the rest of the world and sub-Saharan Africa and nearly 1.4 million people are food insecure and (Ssewanyana & Kasirye, 2010a) indicated that Ugandans were experiencing food insecurity in terms of calorie intake, and according to (Namugumya *et al.*, 2020) Uganda has registered increased undernourishment since the early 2000s and the hope of achieving the United Nations Millennium Development Goal (MDG) hunger target by 2015 was minimal, and that calls for researchers to come in and assess the effects of climate change and propose their mitigation and adaptation measures.

(Connolly-Boutin & Smit, 2016) indicated that due to predominantly decline in food production and diversity at household level, especially in agriculture-dependent rural areas has made nearly half of households food insecure in Uganda, (Mbolanyi *et al.*, 2017) stated that food patterns in Uganda, especially within the cattle corridor are often characterized by very low levels of harvest, small quantities stored per growing season, and short periods before depletion and a small number of meals taken by several households per day. (Fraser, 2009.) also indicated that Since agriculture is the main source of household income, crop failure due to changing weather patterns leaves the

affected smallholder farmers unable to buy sufficient food for households hence a vicious cycle of food insecurity, and this was supported by (Mayanja *et al.*, 2015) that as such, incidences of poverty, famine, and hunger, are abundant in such areas.

(FAO, 2015a), pointed out that 25.5% of the population in Uganda is undernourished, four in every ten persons (38%) in Uganda were food energy deficient, and 9% of these consume one meal a day (Uganda Bureau of Statistics, 2016). There is evidence in Uganda that average temperatures have increased by as much as 1.4⁰C since the 1960s (McSweeney *et al.*, 2010). (Hepworth & Goulden, 2008) indicated that up to 4.3⁰C change in average temperatures by the 2080s is possible and a temperature rise of that magnitude would have disastrous consequences for Uganda.

With 80% of Uganda's population dependent on agriculture as their major source of livelihood, (Koesaryani *et al.*, 2018) revealed that drought effects of climate change have had far reaching consequences on agriculture production in Uganda by disrupting growing seasons, reducing areas suitable for agriculture, and general declines in agricultural yields posing a real and serious threat to the food security of about 80% of Ugandans who depend on rain fed agriculture, and (Sridharan *et al.*, 2019) indicated that there is need for adaptation options needed to be explored and planned for and these included modified resource management, introduction of new varieties and changes in husbandry techniques that may sustain crops and industries.

1.2 Statement of the problem

Changing patterns in climate are already affecting Land resources, crops, livestock, fisheries, biodiversity and human health. Climate associated morbidity renders people inactive and reducing work force for food production; Extreme weather changes can be devastating, potentially leading to the loss of crops, livestock, and even human lives. Such events can force displacement and exacerbate famine, hunger, and poor nutrition in areas where people are unable to grow or access sufficient food (FAO, 2014). (Brown *et al.*, 2015) Changing patterns in climate are already affecting Land resources, crops, livestock, fisheries, biodiversity and human health. Climate associated morbidity renders people inactive and reducing work force for food production; Extreme weather changes can be devastating, potentially leading to the loss of crops, livestock, and even human lives. Such events can force displacement and exacerbate famine, hunger, and poor nutrition in areas where people are unable to grow or access sufficient food (FAO,

2014)(Brown *et al.*, 2015) Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality. (Brown *et al.*, 2015) stated that the translates from climate to the environment, the productive sphere, sand economic dimensions, bringing a range of additional risks on availability of food, on access to food and utilization of food, as well as on the stability of these characteristics for both farm and non-farm households. At the household level, climate change effects may reduce income level and stability, through effects on productivity, production costs or prices. The research thought to prove if this was also true in the research area. Extreme events, especially heavy and stormy rains and prolonged dry spells can harm crops and reduce yields. Many weeds, pests, and fungi flourish in warmer temperatures and wetter climates, competing with crops for light, water, and nutrients reduce agricultural yields- and eventually food security, therefore this research also sought to establish if such information is also true in the research area. According to Uganda Climate Action prolonged dry spells were known as the most challenging climate hazards to food security in Uganda through its negative impacts on agricultural production as indicated by (Mfitumukiza *et al.*, 2020a), and (Nuwagaba & Namateefu, 2013) noted that southwestern region has been devastated by the effects of changing weather patterns. Climate change is expected to significantly affect food security at global, regional, and local levels. It can disrupt food availability, restrict access to food, and impact food quality. Consequently, this study was to establish the effects of changing weather patterns on food security and the coping strategies, mitigation and adaptation practices employed by farmers to develop approaches that ensure sustainable food production.

Such variations can drive sales of productive capital, such as cattle, which reduces long-term household productive capacity. At national level, exposure to climate risks can trigger shocks on agricultural production and food availability, with risks of market disruptions, effects on supply and storage systems, as well as increases in agricultural commodity prices (food and feed), affecting accessibility and stability of food supplies for the entire population, particularly in countries with significant shares of the population spending a large part of their income on food. The research too thought to prove if this was true in the research area. According to Uganda Climate Action Report (Irish Aid Uganda, 2016), Uganda is a landlocked country in east Africa, approximately 236,040 square kilometers in size, with a population of approximately 41 million which is expected to grow to over 93 million in the 2040s. Agriculture as its the main economic

sector accounts for 25% of its Gross Domestic Product (GDP) and employs 70% of the labour force. As Uganda's economy depending highly dependent on natural resources, makes it vulnerable to the impacts of changing weather patterns. Agriculture, which accounts for over 40% of Uganda's GDP, employs 80% of the labor force and supplies 85% of exports, is primarily rain-fed, making it vulnerable to changing weather patterns. The effects of higher average temperatures and more frequent and severe climatic changes in Uganda are seen primarily in the reduction in food security, decline in the quantity and quality of water and degradation of ecosystems, and negative impacts on health, settlements, and infrastructure. Yet, farmers receive little or no relevant information to help them cope with effects of changing weather patterns. Extreme events, especially heavy and stormy rains and prolonged dry spells can harm crops and reduce yields. Many weeds, pests, and fungi flourish in warmer temperatures and wetter climates, competing with crops for light, water, and nutrients reduce agricultural yields- and eventually food security, therefore this research also sought to establish if such information is also true in the research area. According to Uganda Climate Action, prolonged dry spells were known as the most challenging climate hazards to food security in Uganda through its negative impacts on agricultural production as indicated by (Mfitumukiza et al., 2020a), and (Nuwagaba & Namateefu, 2013) noted that southwestern region has been devastated by the effects of changing weather patterns. Climate change is expected to significantly affect food security at global, regional, and local levels. It can disrupt food availability, restrict access to food, and impact food quality. Food production is the initial creation of food and occurs through the cultivation of crops and livestock as well as foraging, fishing, hunting outside of cultivated systems and the relationship of each to changing weather patterns. Crop production forms the foundation of food availability, providing calories and nutrients for human consumption, as well as feed for animals that contribute to food supplies. At the same time, crop production is vulnerable to changing weather patterns. This study was to assess the effects of changing weather patterns on food security and the coping strategies, mitigation and adaptation practices employed by farmers to develop approaches that ensure sustainable food production. (Brown *et al.*, 2015) reported that all aspects of food security including food availability, accessibility and stability are potentially affected by changing weather patterns. And prolonged dry spells were identified by (Mfitumukiza *et al.*, 2020b) as the most challenging climate hazards and food security threat in Uganda through its negative impacts on agricultural production and that most of the population depending on agriculture for subsistence, the immediate

effect of changing weather patterns is on food availability and accessibility, income, and livelihoods in general. (Nuwagaba & Namateefu, 2013) noted that south western region has been devastated by the effects of changing weather patterns. However, these studies have been carried out on a regional context in Uganda for example Southwestern, Central, Eastern and Karamoja regions,

1.3 General Objective of the study

The general objective of the study is to examine effects of changing weather patterns on food security among households in Bukiro Sub County, Mbarara District and propose mitigation and adaptation strategies towards impacts of Changing weather patterns in the study area.

1.4 Specific Objectives: The specific objectives of the study are:

1. To establish the effects of changing weather patterns on food availability among households in Bukiro Sub County.
2. To establish the causes of changing weather patterns in Bukiro Sub County.
3. To determine the coping strategies of households towards changing weather patterns on food security among households in Bukiro Sub County.
4. To determine mitigation and adaptation strategies to mitigate effects of changing weather patterns for sustainable food security.

1.5. General Research question

Under what circumstances are small holder farmers able to effectively adapt to effects of changing weather patterns in the study area?

Other research questions

1. What are the effects of changing weather patterns on food security among households in Bukiro Sub County?
2. What are the effects of changing weather patterns on food stability among households in Bukiro Sub County?
3. What are the effects of changing weather patterns on food utilization among households in Bukiro Sub County?
4. What the coping strategies employed by farmers during the period of food scarcity?

5. what are the mitigation strategies for changing weather patterns to improve food availability for smallholder households?

1.6 Scope of the study

The scope of this study capture information of the geographical location, time scope, content, significance and conceptual framework of the study.

1.6.1 Geographical scope

The study was carried out in Bukiro Sub County found in Mbarara District in the southwestern farmlands and cattle range lands located at latitude -0.60467 and longitude 30.64851. The sub county is famous for crop growing with bananas as the leading food crop grown supplemented by millet, cassava, sorghum, sweet potatoes and maize and vegetables. Coffee is grown as a cash crop. It is believed that drought is affecting these crops. Bukiro Sub County borders with Rwanyamahembe Sub County in the East, Bubaare Sub County in the South, Sheema district in the West and Rubindi Sub County in the North. The Sub County is pre-dominantly occupied by the Banyankole who speak Runyankole. Bukiro Sub County was selected as area of study because of its location in the cattle corridor with semi-arid characteristics which include high rainfall variability and periodic late onset rains/droughts making it vulnerable to climate change, long dry spells/prolonged sunshine, and no previous research on effects of changing weather patterns on food availability has been conducted there.

1.6.2 Content scope

The study examined effects of changing weather patterns on food security among households in Bukiro Sub County, Mbarara District. This was achieved by finding out the effects of prolonged sunshine, less rains and other changing weather events on food accessibility establishing the effects of changing weather patterns on food stability and exploring the effects of changing weather patterns on food utilization among households in Bukiro Sub County. It also investigated the coping strategies and determinants to the coping strategies by the studied communities.

1.6.3 Time scope

The study paid attention to effects of changing weather patterns on food security in Bukiro Sub County considering the period 2017 to 2021. This period was chosen because of the persistent changing weather patterns in Uganda for the past 5 years in which prolonged dry spells have

generally outweighed rainfall due to its semi-arid characteristics of high rainfall variability and periodic late onset of rains/droughts as it is in the cattle corridor and vulnerable to climate change.

1.7 Significance of the study

The revelations of this study will be used in contributing to the development of policy advice and recommendations on weather change impacts and adaptation in the study area to improve food security, accessibility, and availability to the livelihoods of the small-scale farmers.

The study contributes to the stock of knowledge on the existing literature concerning effects of changing weather patterns on food availability and associated adaptation measures in rural areas where prolonged sunshine, less and late onset of rains are a challenge for food availability and access, providing reference for future researchers who wish to investigate more in areas with similar situations.

The results of study will be helpful to Mbarara district production department to train the small household farmers on the effects of changing weather patterns, coping strategies, and mitigation and adaptation strategies for the impacts of changing weather patterns.

1.8 Conceptual framework

The framework is an illustration of the relationship between the independent variable changing weather patterns measured through duration/period of prolonged dry spells and heat intensity as conceptualised by (Ogunrinde, *et al.* 2020) the dependent variable “food availability” is measured through food accessibility, food stability and food utilization as conceptualised by (Jägerskog, *et al.* 2012) The moderating variables considered in this study were government policy, extension services, levels of education, gender, level of income and, availability of support systems and services. These variables play a key role in determining how individuals and communities can cope with the impacts of changing weather patterns and maintain the functioning of their socio-economic systems (Robeyns, 2005).

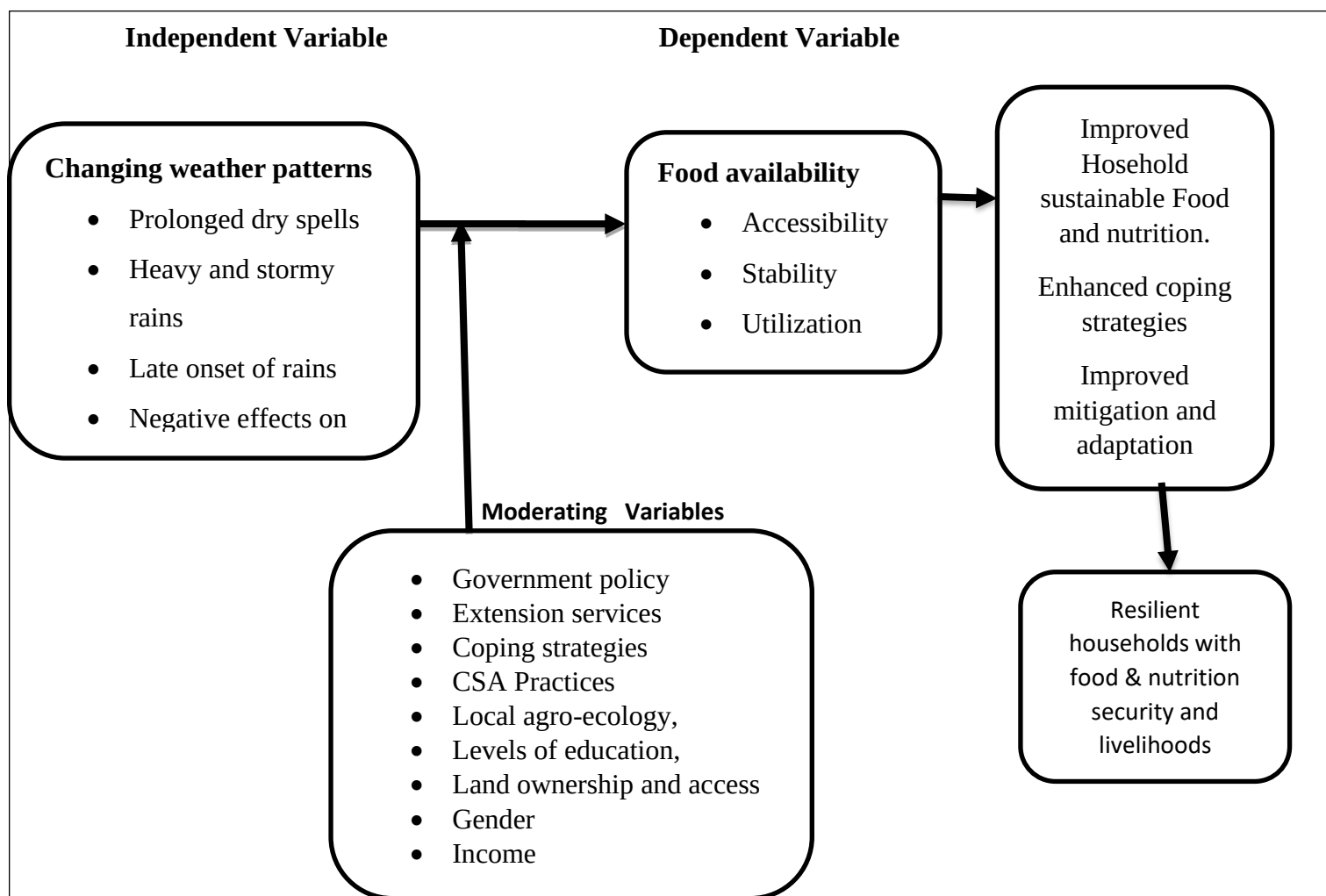


FIGURE 1: CONCEPTUAL FRAMEWORK

The effects of changing weather patterns on food availability and accessibility depend on levels of vulnerability and the capacity of the households and communities to respond (Atube *et al.*, 2021) changing weather patterns coping strategies are likely to be more limited for resource-constrained people, like those whose livelihoods are heavily dependent on natural resources (Mfitumukiza *et al.*, 2020b). Coping response varies depending on the prevailing ecological and socio-economic conditions: these may include local Agro-ecology, levels of education, gender, income, availability of support systems and services (Mfitumukiza *et al.*, 2020a) These play a key role in determining how individuals and communities are able to cope with the impacts of changing weather patterns like drought and maintain the functioning of their socio-economic systems (Robeyns, 2005). The framework above was adopted from the scholars mentioned because it has tested measurements.

CHAPTER TWO: LITERATURE REVIEW

2.1 Theoretical review

The study was guided by the Sustainable Livelihoods Theory advanced by Chayanov in the 1920s. The theory assesses how and why individuals or household units make their decisions (Farrington *et al.*, 1999a). It focuses on the household's ability to sustainably provide for itself within the complex system of its environment (Scoones, 1998). The theory seeks to better understand how people make a living and how successful their chosen strategies are, given the capitals they access and control (Farrington *et al.*, 1999b). This was examined in the context of food availability, accessibility, stability, and utilization.

(Robert, *et al.* 1992) described livelihoods as comprising of people, their capabilities, and their means of living, including food, income and assets. According to the livelihoods' theory/model, households exist in both natural and social environments, each with its own risks and uncertainties that individuals, households and communities must negotiate to reduce their vulnerability and improve their welfare (Valdivia & Quiroz, 2001). Livelihoods models include household resources (capital), human capabilities (agency) and institutions. The theory investigates how capitals and agency are combined into activities that combine to create livelihood strategies within the natural and social structures in which the household exists, and such, understanding how households successfully navigate these obstacles is important for those trying to alleviate food insecurity and poverty in their households (Valdivia & Quiroz, 2001).

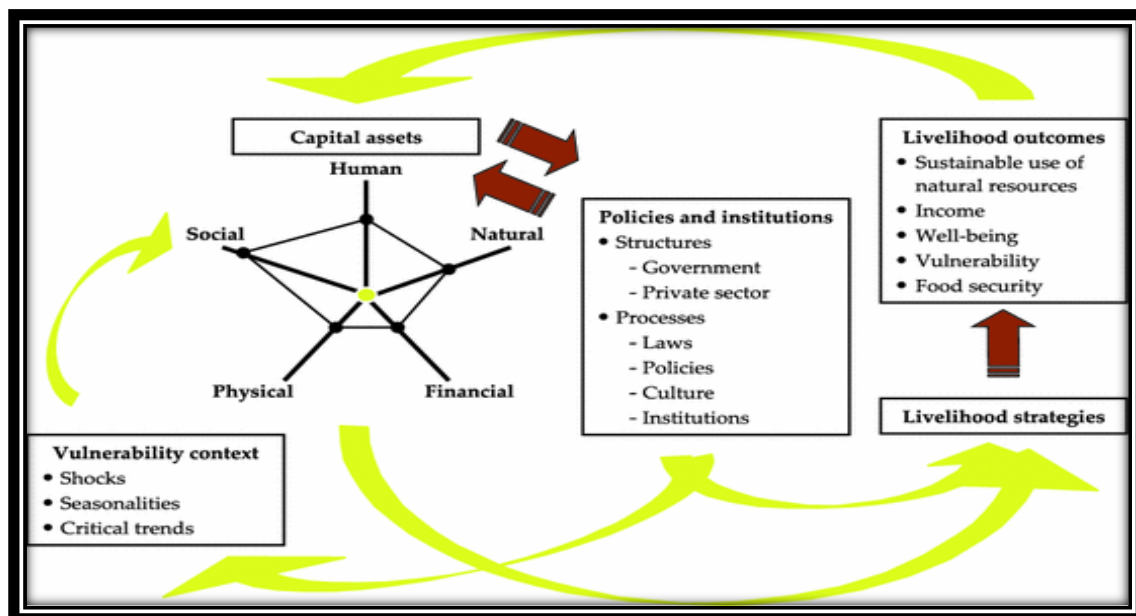


FIGURE 2: THE SUSTAINABLE LIVELIHOODS FRAMEWORK.

This theory is relevant to this study in a way amid changing weather patterns like during prolonged dry spells, households must look for coping mechanisms on how to alleviate threats of food insecurity caused by changing weather patterns and alleviate poverty in their households, that communities take advantage of opportunities available to change their lives. Additionally, the existence of changing weather patterns also provides an opportunity for communities to make a living and adopt strategies for improving their quality of life in a sustainable manner for example by growing drought resistant crops and adopting drought mitigation measures like irrigation and improve on their quality of life through sustainable food security.

According to Food and Agriculture Organisation of United Nations report on Climate change and food security: risks and responses(FAO, 2015a) extreme weather events Under climate change, the frequency and intensity of some disasters such as droughts, floods and storms could increase, with an adverse impact on livelihoods and food security. Climate-related disasters have the potential to destroy crops, critical infrastructure, and key community assets therefore deteriorating livelihoods and exacerbating poverty. Under warming trends, glacial melt could accelerate, and the melt season would begin earlier in the year. In addition, climate change could affect all dimensions of food security and nutrition in complex ways. On food production, Changes in climatic conditions have already affected the production of some staple crops, and future climate change threatens to exacerbate this. Higher temperatures will have an impact on yields while changes in rainfall could affect both crop quality and quantity; for Food access, Climate change could increase the prices of major crops in some regions. For small-holder farming households, lower agricultural output would also mean lower income and the poorest people who already use most of their income on food would have to sacrifice additional income to meet their nutritional requirements. As for food utilization, Climate-related risks affect calorie intake, particularly in areas where chronic food insecurity is already a significant problem. Changing climatic conditions could also create a vicious cycle of disease and hunger while Nutrition is also likely to be affected

by climate change through related impacts on food security, dietary diversity, care practices and health.

(Charles Boliko, 2019) argued that global level, climatic shocks impacting areas of global importance for food supplies can have remote impacts through effects on; supply flows and food price spikes, with increased market volatility; impacts on bilateral contracts and/or import/export behaviors, with disruption of trade patterns. Food price volatility is likely to be exacerbated by climate change. Trade is expected to play a major role in adjusting to climate-change-driven shifts in agricultural and food production patterns. Recent experience indicates that climate change effects on food price volatility are greatly influenced by domestic policies, with export bans contributing to price fluctuations. Ultimately, global markets will not be accessible to the poorest countries and the poorest populations without sufficient purchasing power. At national level, exposure to climate risks trigger shocks on agricultural production and food availability, with risks of market disruptions, effects on supply and storage systems, as well as increases in agricultural commodity prices (food and feed), impacting accessibility and stability of food supplies for the entire population, particularly in countries with significant shares of the population spending a large part of their income on food. This triggers macro-economic effects for countries for which agriculture is an important part of GDP and/ or constitutes an important source of employment. Climatic risks can also hinder agricultural development by discouraging investments. At the farm/household level, climate change impacts may reduce income level and stability, through effects on productivity, production costs or prices. Such variations can drive sales of productive capital, such as cattle, which reduces long-term household productive capacity lowering incentives to invest in production systems, often with negative impacts on long-term productivity, returns and sustainability which brings effects on household capacity and the impacts of various types of weather anomalies on farm income indicates that the impacts are greatest for the poorest farmers(Charles Boliko, 2019)

(Ministry of internal Affairs. GoU, 2016) indicated that as a landlocked country, Uganda's regions: the mountain regions, lowlands, and the cattle corridor differ in their vulnerability and adaptive capacity. Agriculture is the main economic sector, accounting for over 25% of its Gross Domestic Product (GDP) and employing over 70% of the labour force. Uganda faces several developmental constraints, including high population growth (3.3%), post-conflict conditions in the north, soil

erosion and degradation, that increasing variability in rainfall and rising temperature will present an additional stress on development in the country, especially with its high dependency on rain-fed agriculture. Rising temperatures and shifting or increasingly unpredictable rainfall patterns can reduce the amount of agricultural land, shorten growing seasons, hamper crop production, undermine the (ground) water resources and alter the occurrence and distribution of pests.

According to Office of the Prime Minister (OPM, 2014) the estimated value of the effects caused by rain-fall deficit conditions in Uganda in 2010 and 2011 amounts to 2.8 trillion Shillings (US\$ 1.2 billion). This amount was equivalent to 7.5 percent of the country's gross domestic product (GDP) in 2010, which provides a measure of the magnitude or relevance of the rainfall deficits for Uganda's economy. Three types of effects were identified: (i) damage in the form of death of livestock and crop production failure (ii) losses in the production of goods and services, and (iii) higher costs or prices for goods and services. Most changing weather effects are production losses and higher costs, rather than the value of destroyed physical assets. Damage and losses from the 2010-2011 rainfall deficit appear to be much greater than those from the 2005-2007 drought (the last severe drought), although a full comparison is hindered by data availability.

According to (El Bilali *et al.*, 2020) Climate change will reduce food access through negative impacts on both food prices and rural livelihoods, food supply shortfalls, due to negative impacts of changing weather patterns on yields and production, would increase food prices. Increases in food prices would affect millions of low-income people that live in areas that are already affected by high rates of hunger and poverty, such as South Asia and Sub-Saharan Africa are faced with a range of that climate risks, which include rapid and uncertain changes in rainfall and temperature patterns that threaten food production and could lead to an increase in food prices and food insecurity.

(Ssewanyana & Kasirye, 2010) stated the national average for food intake in financial year 2005/06 was 1190 kcal/person/day. In the Karamoja, Acholi, and Lango sub-regions, over 85 percent of the population was considered food insecure. Historically, these areas have faced acute and chronic food insecurity due to conflict, insecurity, and changes in weather patterns particularly frequent droughts (Ibid). In recent years, Uganda has experienced cyclical (within a range of 10 to 12 years), frequent and severe droughts and limited rainfall in most parts of the country, especially the northern and western parts which were seriously affected. This has made the regions food insecure

(GoU, 2015) Stability of food supply will be impacted by changes in seasonality, increased variance of ecosystem productivity, increased supply risks and reduced supply predictability, issues that may also have large impacts on supply chain costs and retail prices (FAO, 2008). Although the climate change patterns in some areas of the world will have positive effects on agricultural production (Reidsma *et al.*, 2009) but the negative impacts of these changes will be so severe in hot and dry areas (Parry *et al.*, 2004). (Gregory *et al.*, 2005) also indicated that in developing countries the rise in temperature and the decrease in rainfall have been more severe while (Sivakumar *et al.*, 2005) indicated the frequency and intensity of the occurrence of rare climatic phenomena (drought, heat, coldness and flood) will also be intensified as well as (IPCC, 2014) which indicated that they will take toll on crop production.

(Thompson & Scoones, 2009) stated that Climate change is commonly recognized to have major implications for food security and livelihoods. (Songok *et al.*, 2011) revealed that in sub-Saharan Africa, extreme weather changes like drought already impede people's ability to grow food and rear livestock, and pastoralists and Agro-pastoralists will need to adapt to changes in water regimes in order to maintain their food security and well-being while (Niang, *et al.* 2014) stated that due to its largely adverse effects on African agriculture and livelihoods, climate change has negative impact on food security. (El Bilali *et al.*, 2020), argued that Climate variability and change will have far reaching consequences for smallholder farmers in sub-Saharan Africa, the majority of whom depend on agriculture for their livelihoods, rural populations will suffer from the increase of food prices as well as the negative impacts of climate change on their sources of income and livelihoods strategies relating to agriculture and that agricultural production loss implies the loss of income for farmers and of revenues for countries. The most dominant and widespread changing weather pattern due to climate change is drought, which is frequently observed to be on the increase. For example, Uganda experienced seven droughts' episodes between 1991 and 2000 that severely affected the agricultural sector leading to famine, malnutrition, low production and productivity of crops and animals.

The prolonged drought of 1999/2000 caused severe water shortage, leading to loss of animals, low production of milk, crop failure and food insecurity, increased food prices, and a general negative effect on the economy (Mukasa *et al.*, 2020) On the other hand, heavy and stormy rains also have negative effect on crop production and water resources; heavy and stormy rains lead to destruction

of crops, landslides, soil erosion water logging destroying crops and reducing agricultural production and productivity. It also pollution of drinking water sources leading to outbreaks of waterborne diseases such as cholera, typhoid, and dysentery due to poor sanitation which also affects food utilisation (Gabiri *et al.*, 2020). Climate change has been found to have an impact on food safety, particularly on incidence and prevalence of food-borne diseases. Increased climate variability, increased frequency, and intensity of extreme events as well as slow ongoing changes will affect the stability of food supply, access, and utilization. climate change will impact livelihoods and income of small-scale food producers and also, through food price increases and volatility, the livelihoods of poor net food buyers, constraining these populations to reduce their food consumption in quantity and quality, and also likely to reduce health expenditures with potential effects on nutrition(FAO, 2015a) Also (WFP, 2012) in its report indicated that Changing weather patterns conditions could also create a vicious cycle of disease and hunger. (Walker *et al.*, 2018) indicated that Climate change causes changes in vegetation type, crop types and varieties, forest resources, soil conditions, and water levels and this has great effects on food security, nutrition, and livelihoods of small holder farmers, also (Akwango *et al.*, 2017) cited that drier conditions and prolonged dry spells, late on set of rains frequently affecting agricultural productivity and causing food insecurity. In addition, (Berman *et al.*, 2015) stated in his study that climate change reduces on the socio-economic development of the country by impacting infrastructure, health, and livelihoods negatively.

(FAO, 2015b) indicated that climate change would impact the livelihoods and income of small-scale food producers and also, through food price increases and volatility, the livelihoods of poor net food buyers, restricting access to food. Climate change has been found to have an impact on food safety, particularly on incidence and prevalence of food-borne diseases. Increased climate variability, increased frequency, and intensity of extreme events as well as slow ongoing changes will affect the stability of food supply, access, and utilization. The effects of prolonged dry spells on food availability and accessibility depend on levels of vulnerability and the capacity of the households and communities to respond to adverse impacts of changing weather patterns. According to (Mfitumukiza *et al.*, 2020b) Changing weather patterns coping strategies are likely to be more limited for resource-constrained people, for example, those whose livelihoods are heavily dependent on natural resources, (Robeyns, 2005) further revealed that these capabilities play a key role in determining how individuals and communities are able to cope with the impacts

of drought and maintain the functioning of their socio-economic systems. (Trærup & Mertz, 2011); (Tambo & Abdoulaye, 2013) revealed that In reaction to changing weather patterns in shorter growing seasons, some farmers in Tanzania and Nigeria are shifting to drought tolerant crops and fast-maturing varieties in order to adapt to shorter growing seasons, These shifts are sometimes aided by extension, or communication and support among farmers as cited (Hesselberg & Yaro, 2006) demonstrating the important role of higher-level structures and processes. (Thomas *et al.*, 2007) stated that in South Africa, a short-term adaptation strategy to dry spells is to shift from cropping to livestock management, while this strategy is effective in reducing reliance on crops that may fail due to lack of rain. One of the shift's outcomes is therefore having a negative impact on natural capital. Other changes in farming practices due to changes in rainfall include increasing planting distances in response to soil moisture deficits, introducing short-maturing varieties of maize in response to reduced rainfall at the end of the growing season, and the construction of stone bunds to curb soil erosion caused by more intense rainfall(*Ibid*). Many risk management and diversification strategies are not new to African households who have traditionally dealt with climate variability impacts through, for example, (seasonal) migration, combining multiple crops and or cultivars, diversifying livestock herds, and utilizing the complementarities between crop cultivation, livestock and trees(Thornton & Herrero, 2014). Farmers can adapt to shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and adjusting planting dates (Jaleta *et al.*, 2020) Such agronomic management decisions can be informed by detailed crop growth modelling results, which showed, for example, for Zimbabwe that a moderate delay in planting to avoid early-season dry spells can be beneficial (Rurinda & Jairo, 2014). Burney (2011) found that solar-powered drip irrigation significantly increased household income and nutritional intake, particularly during the dry season.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter provides descriptive account of the methods that were used in the study to address the research objectives and the research questions. It provides information on the steps and the procedure used to generate data during the research process. It also details data processing and presentation to answer the central research objective which shaped and guided the study.

3.1 Location of Study area

This study was conducted in the four parishes (Bukiro, Nyanja, Nyarubungo and Rubingo) of Bukiro Sub County found in Mbarara District in the southwestern farmlands and cattle range lands located at latitude -0.60467 and longitude 30.64851. The area was selected for study because of its high potential for food production in the Mbarara District which was attributed to its good soils but under threat of massive soil degradation and the area experiences high/intense weather events and variability, Ministry of water and environment, (MoWE, 2020). Bukiro Sub County lies on the North-western part of Mbarara District and covers an area of 261 km² with a population of 32,323. The study was conducted in the whole sub county covering all its four parishes of Bukiro, Nyanja, Nyarubungo and Rubingo.

The sub county was famous for crop growing with bananas as the leading food crop grown supplemented by millet, cassava, sorghum, sweet potatoes and maize and vegetables. Coffee is grown as a cash crop. It was believed that prolonged was affecting these crops. Bukiro Sub County bordered with Rwanyamahembe Sub County in the East, Bubaare Sub County in the South, Sheema district in the West and Rubindi Sub County in the North. The Sub County was predominantly occupied by the Banyankore who speak Runyankore. The Sub- County has one main river, a tributary of River Rwizi emanating from Buhweju running through Nyakambu swamp along the Western part. Bukiro Sub County has dry seasons with scattered rainfall from May to August each year. The Sub- County receives an average annual rainfall of 1200 mm, with seventy five percent of the rainfall falling during the long rain season which is at its peak between late August and late December, while twenty five percent falls during the short rains between March and May. The annual mean maximum and minimum temperatures range between 26 and 30 and 14 and 22 °C, respectively (UBOS, 2012)..

Table 1: Average monthly weather data: 1991 - 2021 for Bukiro sub county

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	21.7 °C (71.1) °F	22.5 °C (72.5) °F	22 °C (71.5) °F	20.9 °C (69.6) °F	20.7 °C (69.2) °F	20.9 °C (69.6) °F	21.2 °C (70.2) °F	20.9 °C (69.6) °F	20.7 °C (69.3) °F	20.5 °C (68.9) °F	20.1 °C (68.2) °F	20.7 °C (69.2) °F
Min. Temperature °C (°F)	16.6 °C (61.9) °F	17.2 °C (63) °F	17.1 °C (62.8) °F	16.5 °C (61.8) °F	16.2 °C (61.2) °F	16 °C (60.8) °F	16 °C (60.7) °F	16.2 °C (61.1) °F	15.8 °C (60.5) °F	16 °C (60.7) °F	15.8 °C (60.4) °F	16 °C (60.9) °F
Max. Temperature °C (°F)	27.1 °C (80.7) °F	28.1 °C (82.6) °F	27.2 °C (80.9) °F	25.8 °C (78.4) °F	25.5 °C (77.8) °F	26.2 °C (79.1) °F	26.9 °C (80.4) °F	26.3 °C (79.4) °F	26.2 °C (79.1) °F	25.7 °C (78.2) °F	25 °C (77) °F	25.6 °C (78.1) °F
Precipitation / Rainfall mm (in)	39 (1)	43 (1)	74 (2)	93 (3)	72 (2)	28 (1)	15 (0)	51 (2)	74 (2)	107 (4)	109 (4)	68 (2)
Humidity (%)	63%	59%	66%	75%	73%	61%	54%	62%	69%	73%	77%	71%
Rainy days (d)	7	7	12	15	12	5	3	8	13	17	17	12

		January	February	March	April	May	June	July	August	September	October	November	December
avg. Sun		10.2	10.3	9.7	8.9	9.1	10.0	10.4	9.9	9.8	9.4	9.1	9.7
hours													
(hours)													

The month of maximum warmth in a year is February. The average temperature during this period reaches up to 22.5 °C (72.5) °F, with 10.3 making it the hottest time of the year. This is followed by March and July, with average temperature of 22 °C (71.5) °F and 21.2 °C (70.2) °F respectively. During the month of November, there is a notable drop in temperature, with an average low of approximately 20.1 °C (68.2) °F, making it the coolest time. The month with the lowest rainfall is July with 15mm whereas the one with highest rainfall is November with 104mm and variation in precipitation between the months with the lowest and highest levels of rainfall is 94 mm/ 4 inches. It is noteworthy that October and November had the highest number of rainy days, amounting to 17 each thus making them the wettest, whereas the month with the least rainfall is July, experiencing only 3 wet days. Making it the driest.

In terms of relative humidity, the month that exhibits the highest level is November with a percentage of 77. Conversely, July has been recorded as having the lowest amount of relative humidity at only 54.

3.3 Research design

The research used cross-sectional study design. A cross-sectional study is a type of research design in which data is collected from many different individuals at a single point in time (Saunders *et al.*, 2007). The design utilized quantitative and qualitative approaches of data collection. Quantitative data collection focused on gathering numerical data collected through structured questions and used to aggregate data and generate statistics based on respondents' opinions and/or perceptions. Qualitative data collection involved use of interviews to capture in-depth information that was not captured through the questionnaires. The study incorporated descriptive statistics to present respondents' opinion in the study regarding addressing the research questions.

3.4 Study population

Information was obtained from smallholder farmers in Bukiro Sub County with a total of a population of 32,323 and key informants from Mbarara District Local Government Environment and Natural Resources department, Mbarara District Officials: Production and Marketing Officer and District Agricultural officer, District Natural Resource Officer, District Forestry Officer, District Environment Officer and at sub county level such as the Sub county chairperson, sub-county chief, Sub county Agriculture officer, Sub county Community Development Officer (CDO) of Bukiro Sub County. Data was generated through the use and administration of questionnaires and interview guides which was thematic to collect data to address the research questions.

3.5 Sample size

An exploratory survey was conducted in the structure using a structured questionnaire to collect data from 126 households. This sample size was determined from the total population of households in the study area using the formula proposed by Yamane (1967) below.

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

Where n = Sample size, N = Total population of households in the sub-county, and e = error tolerance (was set at 10%).

$N = 32323 / 1 + 32323(0.1)^2 = 99.7$. this was approximated to the nearest whole number which is 100.

The survey household were randomly picked from the four parishes of Nyanza, Nyarubungo, Bukiro and Rubingo which make up Bukiro sub county.

TABLE 2: SAMPLE SIZE

Small holder farmers	100
Key informants (local and district officers and leaders)	9

3.5 Sampling techniques

Sampling is a process of extracting a portion of the population from which generalization to the population can be made(Ahuja, 2000), Uganda was stratified into districts, zeroing on Mbarara

District; and the district was further stratified into Sub counties, zeroing onto Bukiro sub county, and down to Parishes and up to households. Random sampling was adopted to give probabilistic chances of smallholder farmers being selected as respondents.

On the other hand, purposive sampling was used to collect data from key informants (CDO of Bukiro Sub County, the Mbarara District Production Officer, Agricultural officer, and Environmental Officer. Their views were key in supplementing on the information collected from farmers in households in Bukiro Sub County. Purposive sampling was used to select these key informants because these are professionals and have skills in farmers' mobilization and skilling in climate-smart agriculture for enhanced resilience! The two female professionals (COD and Agriculture Officer) are instrumental in reaching out to the females engaged in agriculture.

3.6 Data collection methods

Data was collected using a variety of methods such as questionnaire surveys; key informant interviews; observations; and household survey and details of the methods are presented". A survey is one of the tools used in the collection of research data (Postlethwaite, 2005).

3.6.1 Interviews using structured Questionnaire.

Questionnaire surveys are a technique for gathering statistical information on the following parameters: the attributes, attitudes, or actions of a population by a structured set of questions. Questionnaire surveys provided a relatively cheap, quick, and efficient way of obtaining large amounts of information from a large sample of people. The surveys were carried out using both open and closed ended questions. Semi-structured questionnaires were used to collect data from farmers in Bukiro Sub County. Research assistants were recruited and trained on data collection using the structured questionnaires and equipped with skills to collect reliable data. The research assistants conducted interviews on the small holder farmers while Interviews on key informants were conducted by the researcher to obtain data from key informants. An interview refers to an oral interaction or discussion between an interviewer and the respondents(Jamshed, 2014). In detail, face to face interviews between the researcher and the key informants were conducted and through the interaction, more other questions were asked outside the set questions hence more information was obtained. The prepared set of questions translated in local language provided the

framework for conducting the interviews to avoid deviations from respondents. Interviews were used because they eliminate response errors since it is interviewer who controls the interview process.

3.7 Data collection tools

3.7.1 Interview guides

These were used to obtain data from key informants. This was because they could ask more probing questions to dig deeper so that more information can be revealed through the interviews. An interview guide is a list of topics or questions that the interviewer hopes to cover during an interview (Atkins & Wallace, 2015). The interviews lasted for between 30 minutes and One hour to avoid suspicion by the respondents.

3.7.2 Structured Questionnaires

A questionnaire is defined as a survey instrument intended to self-administered questions (Azurah Mohd Roni *et al.*, 2020). Semi-structured questionnaires were used to collect data from smallholder farmers in Bukiro Sub County. The questionnaires were administered by the research assistants and filled data into the questionnaires and the researcher collected them at agreed upon schedules. (Schaeffer & Dykema, 2010) stated that questionnaires were preferred because they gave respondents freedom to answer sensitive but true questions.

3.8 Data quality control

Verification and confirmation of data collection tools were done by the study supervisors prior to field application to confirm that they would generate the needed information. Recruiting and training of the of research assistants on research tools was done to ensure collection of valid and reliable information. Pre-tested of the questionnaires on 20 smallholder farmers and 2 key informants was conducted to layout the research tools for validity and reliability. Both male and female research assistants were recruited so that the female approached female respondents on food matters, to diffuse suspicion from the male respondents and some of the issues can be shared in interview session if a female interacts with a female in an interview session as proposed by (Gill *et al.*, 2008)

3.9 Data analysis

3.9.1 Quantitative data analysis

The data collected was summarized using descriptive statistics. Data from questionnaires was entered into Microsoft Excel to generate statistics. Data analysis involved coding, editing, data entry, and monitoring of the whole data processing procedure. Data was entered into Microsoft excel version 20 then exported to SPSS 26 software for analysis. Data was exported to STATA 17 for advanced statistical analysis. Descriptive statistics such as frequencies, percentages and charts were used to present statistical illustrations of the research variables. Statistical tools, including Chi square tests were used to evaluate associations of different variables with food availability constructs.

3.9.2 Qualitative data analysis

This was done using the narrative analysis as a method to interpret research participants' interview responses, and other text or visual data. Completed answers generated from interviews were cross checked for completeness, accuracy, uniformity, and comprehensiveness. The interview guide was used to check the feedback from the respondents, noting the relationships between the given answers and asked questions. Additionally, data was categorized according to themes generated from the research questions. Primary data collected like interviewees' responses were analysed for content and found patterns were discussed in line with the research objectives to establish areas of convergence and divergence. The analysis involved listing and summarizing data in compilation sheets of developed themes as according to (Bryman, 2006) who indicated that the themes and sub-themes emerge from the repeated statements by the respondents in the text, which are later applied to the data. Best quotes were reported according to the study objectives.

3.10 Ethical considerations

Written informed consent were sought from the study participants by providing a consent form to the participants who were then be given time to read its contents explaining the reason for being selected and why the research is being done. Where s/he did not understand the researcher explained. Summarised information about the purpose of the study, voluntary participation, benefits, and freedom to withdraw from the study at any time without any consequences, risks and discomforts were included on the consent form and presented to the respondent before interviews session. When read and understood and the respondents accepted to sign it as a way of accepting

to participate then s/he was interviewed. Measures to ensure confidentiality and privacy regarding participants' identity protection and protection of information given were provided on the information sheet for them to make informed decisions regarding participation or exclusion from the study.

The confidentiality and privacy of respondents was further be ensured by not revealing their names or identities at any stage of reporting of the research findings. The principal researcher assured the study respondents of total confidentiality and assurance that the study was only and purely for academic purpose.

The study happened when Covid 19 was still prevalent. In effort to observe the Standard Operating Procedures, respondents wore face masks and maintained safe distance of 1.5 m during interview sessions. And the researcher always wore a face mask during data collection and carried with himself hand sanitizers such that he was not deemed a health threat regarding covid 19 spread.

Ethical Clearance for this study was obtained from the Research Ethical Committee of Bishop Stuart University, Kakoba Mbarara.

3.11. Research limitations

The limitations of the research included limited money that delayed the data collection process, rains that disturbed the data collection too as access to some of the areas was cut off due to blockage of roads. Some of the respondents couldn't be in their households thus were not interviewed.

CHAPTER FOUR: RESULTS

4.1.0. Introduction

This chapter presents the results of the survey. The data collected from the field was analysed and differentiated using different methods and are detailed in tables, graphs, and pie charts below.

4.1.1 Response rate

Questionnaires were tools used to collect data from respondents. 100 questionnaires were distributed to the respondents and 100 were returned representing 100% response rate. Key informants were also interviewed. Out of the targeted 16, Nine (09) were interviewed which is 62% representation. 100% for small holder farmers and 62% for key informants responded in the interviews respectively sufficient and above the recommended response rate of 50% for humanity studies according to (Pielsticker & Hiebl, 2020)

4.1.2 Socio-demographic Characteristics of respondents

TABLE 3: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF SMALLHOLDER FARMERS

Characteristics		Frequency (percent)
Gender	Males	37 (37)
	Females	63 (63)
Age	18-36	68 (68)
	37-54	29 (29)
	≥55	3 (3)
Education	No formal education	2 (2)
	Primary	78 (78)
	Secondary	19 (19)
	Tertiary	1 (1)
Marital status	Married	87 (87)
	Divorced	11 (11)
	Divorced	2 (2)
Family members	1-4	61 (61)
	5-8	19 (19)
	≥ 9	20(20)

Occupation	Farming	87(87)
	Business	13 (13)
Size of land owned. (in hectares)	<1 ha	2 (2)
	1-3 ha	95 (95)
	>3 ha	2 (2)
	>8 ha	1 (1)
Crops grown.	2 crops (beans & bananas)	41 (41.0)
	3 crops (maize, beans, g.nuts)	2 (2)
	4 crops (Bananas, Maize, Beans & g.nuts)	16 (16)
	4 crops (Bananas, Millet, beans, & gnuts)	16 (16)
	All crops	25 (25)

Source: Field data, 2022

Table 3 shows that of the 100 smallholder farmers in Bukiro Sub County enrolled into the study, the majority were females, 63.% (n = 63) aged 18-36 years, 68% (n = 68), held primary level of education, 78% (n = 78), were married, 87% (n = 78) and with 1-4 family members in the household, 61% (n = 61). Besides, the majority were solely involved in farming, 87% (n = 87). Majority (95%) owned 1-3 acres of land while 13% had other businesses. Farmers grew bananas, beans, millet, maize, g/nuts and every household grew at least more than one crop with majority 41.0% (n =41) growing bananas, beans, 16% (n = 16) grew bananas, maize, beans and g/nuts, 16% (n= 16) bananas, millet, beans and g/nuts, 2% (n = 2) grew maize, beans and g/nuts and 25% (n= 25) grew all the crops.

Table 4: Socio-demographic Characteristics of Key informants

Name	Gender	Age bracket	Level of Education
1. Sub county Agriculture Officer	Female	36-54	University degree
2. District production and marketing officer		35-54	University degree
3. District Environment Officer	Male	36-54	University degree
4. District Agricultural Officer	Male	36-54.	University degree
5. CDO Bukiro Sub county	Female	36-54	University degree
6. District Forestry officer	Male	36-54	University degree

7. Chairperson LC3 Bukiro Sub County	Male	>54	Certificate
8. Sub county chief Bukiro sub county	Male	>54	University degree
9. District Natural resources Officer	Male	36-54	University degree

Source: Field data, 2022

Table 4 shows that of the 9 key informants (7 males and 2 females) enrolled into the study and included the District Production and Marketing officer, District Agriculture Officer, Sub county Agriculture officer, District Environment officer, District Forestry officer, Sub county Community Development Officer, sub county chief and sub county LC3 Chairperson were males (7 out of 9), aged 36-54 years (8 out of 9) with a university degree (7 out of 9) have worked and resided in the area for more than 8 year.

TABLE 5: ASSOCIATION BETWEEN DEMOGRAPHIC CHARACTERISTICS AND FOOD AVAILABILITY

Characteristics		Food availability (N = 100)		p-value
		Yes (n = 34)	No (n = 66)	
Gender	Male	32(86.5)	5(13.5)	<0.001
	Female	3(4.8)	60(95.2)	
Age	18-36	17(25)	52(75)	<0.001
	37-54	16(52.9)	13(47.1)	
	≥55	1(50.0)	1(50.0)	
Education	Never went to school	3(100.0)	0(0.0)	<0.001
	Primary	17(21.8)	61(78.2)	
	Secondary	13(81.3)	3(18.7)	
	Tertiary	0(0.0)	3(100.0)	
Marital status	Married	33(37.1)	56(62.8)	<0.001
	Divorced	4(57.0)	3(43.0)	
	Divorced	4(100.0)	0(0.0)	
Family members	1-4	20(31.3)	44(68.7)	<0.001
	5-8	13(81.3)	3(18.7)	
	≥9	0(0.0)	20(100.0)	

Occupation	Farming	33(37.9)	54(62.1)	<0.001
	Business	2(15.4)	11(84.6)	

Source: Field data 2022

The table above show the relationships between the different demographic characteristics of the respondents and food availability. The demographic characteristics considered were gender, age, education level, marital status, number of family members and occupation.

4.1.3 Understanding Changing weather patterns and its variabilities.

From data analysis it was discovered that the smallholder farmers understood climate change from two perspectives. The majority (78%) understood it as a period of rain and prolonged dry spells while the others (22%) understood as a time of Plenty of food and hunger, as presented in the figure 4 below.

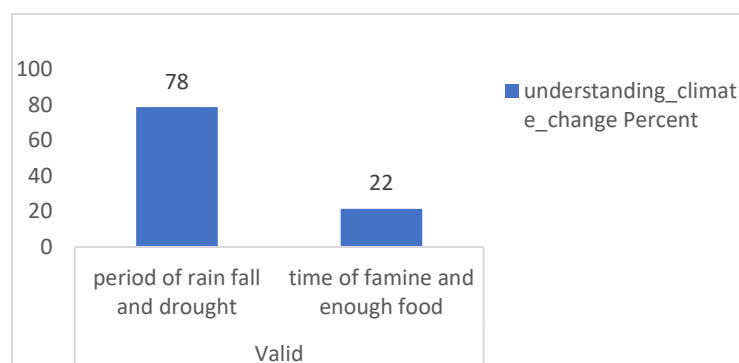


FIGURE 4: UNDERSTANDING TERM CLIMATE CHANGING WEATHER PATTERNS BY FARMERS.

Source: Field data

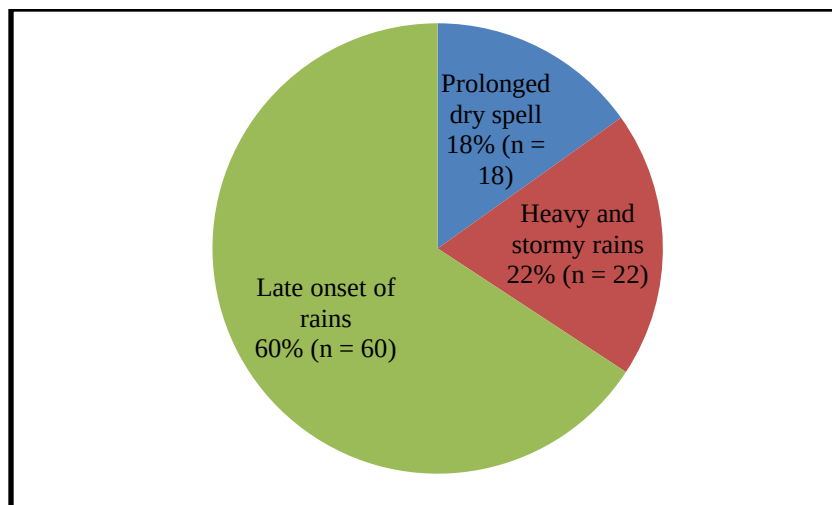


FIGURE 5: WEATHER CHANGING PATTERN VARIABILITIES.

Source: Field data

Figure 5 above shows results on the questions of the variabilities of changing weather patterns experienced in the research area by farmers. From the analysis, 60% of the respondents identified late onset of rains, prolonged dry spells was responded to by 18% while 22% responded to heavy and stormy rains.

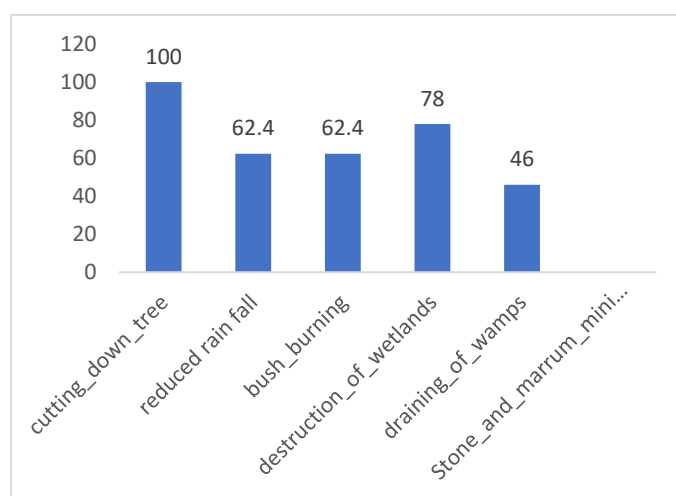


FIGURE 6: CAUSES OF CHANGING WEATHER PATTERNS.

Source: Field data 2022

Figure 6 above shows the causes of changing weather patterns in Bukiro sub county reported by farmers. cutting down of tree was indicated as the major cause of changing weather patterns by

all the respondents (100%) reported, followed by destruction of wetlands (78%), bush burning at 62.4%, draining of swamps at 54% while no one reported stone and marram mining as a cause. Some percentage (62.4%) reported reduced rainfall a cause of changing weather patterns although it is a variable of changing weather patterns.

4.1.4: Understanding food security.

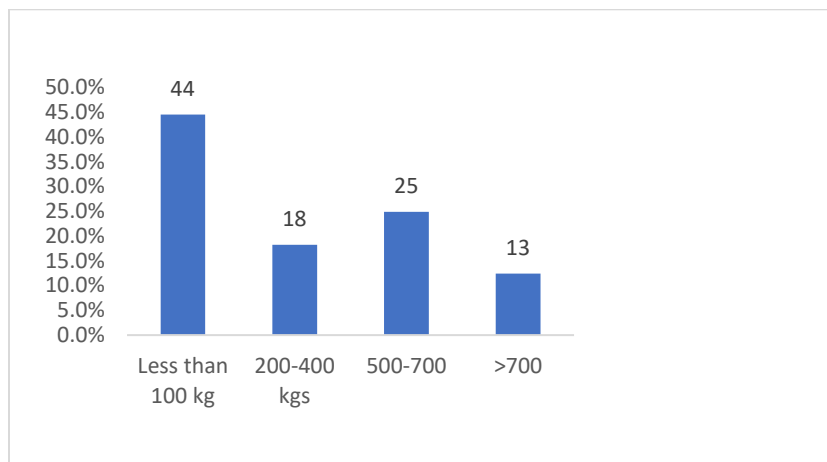


FIGURE 7: HARVEST QUANTITY PER SEASON

Source: Field data

Figure 7 above gives general seasonal harvest quantities for the respondents where majority (44%) harvested less than 100kg, 18% of the respondents harvested 200-400kg, 25% of the respondents harvested 500-700kg and 13% harvested more than 700kg.

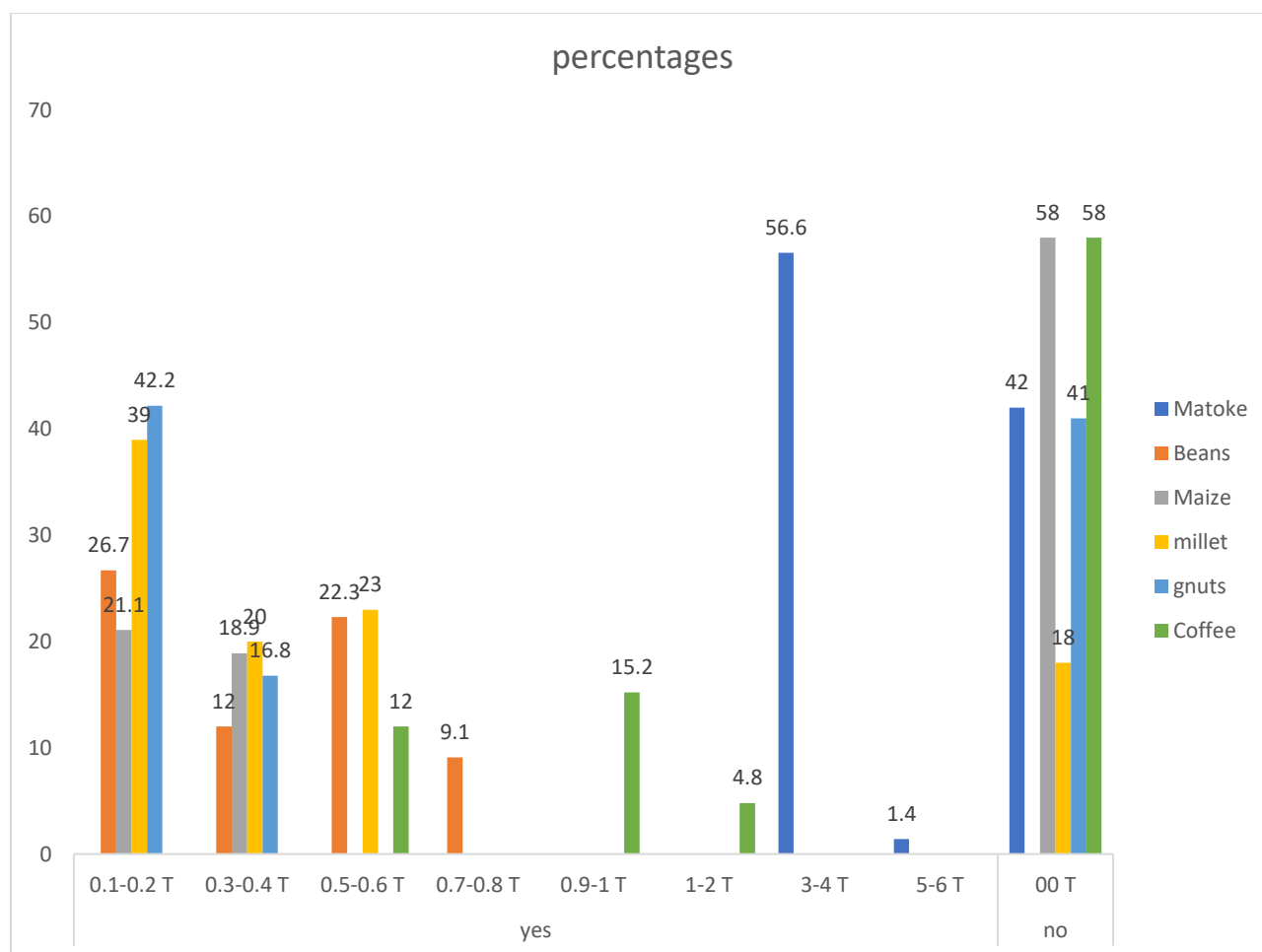


FIGURE 8: ANNUL CROP HARVESTS FOR FARMER HOUSEHOLDS.

Source: Field data

Figure 8 above shows the annual harvested quantity for each crop grown. Beans grown by (100%) of the respondents yielded between 0.1-0.8 Tonnes, with the majority of the respondents growing it (27%) harvesting between 0.1-0.2 Tonnes, followed by those who harvested between 0.5-0.6 tonnes at 22%, then 12% harvesting 0.2-0.3 tonnes and 9% harvesting 0.7-0.8 Tonnes. Millet produced by 82% of the respondents yielded between 0.1 to 0.6 tonnes, bananas between 3-6 tonnes, G/nuts yielded between 0.1 to 0.4 tonnes, and maize with a range between 0.1 to 0.4 tonnes.

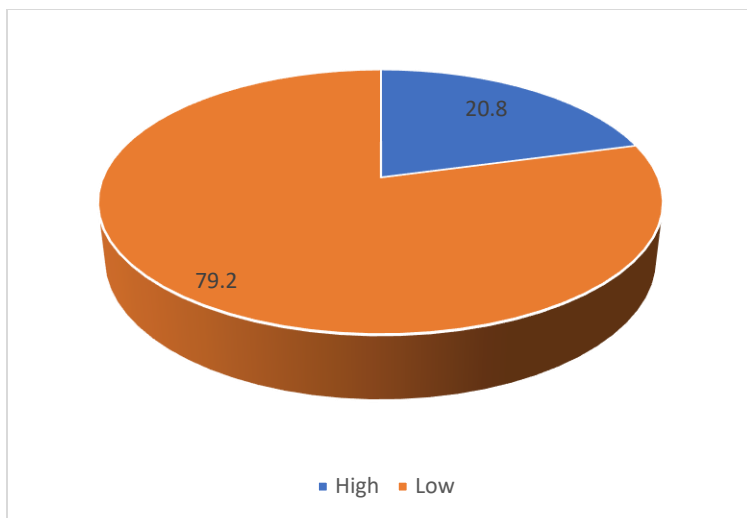


FIGURE 9: RATING OF FOOD ACCESSIBILITY DURING PROLONGED DRY SPELLS

Source: Field data 2022

Figure 9 above shows results on food accessibility rating during prolonged dry spells, whereby the majority of the respondents (79.2%) indicated a low accessibility to food while minority (20.8%) indicated high accessibility to food during the prolonged dry spells.

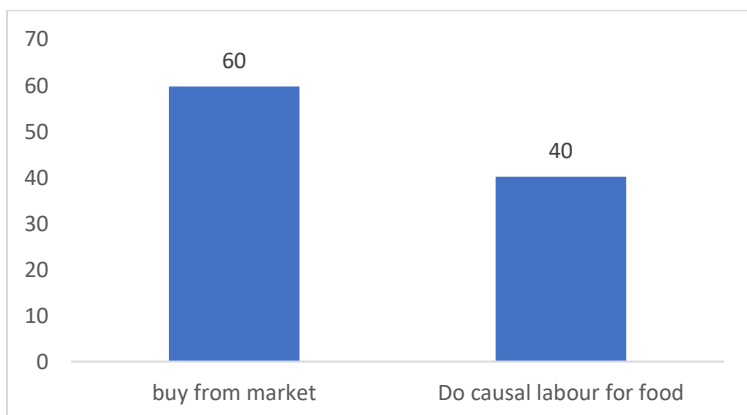


FIGURE 10: ACCESS TO FOOD DURING PROLONGED DRY SPELLS

Source: Field data 2022.

On how they get food during the prolonged dry spells, results from the analysis indicated that the majority of the farmers (60%) buy from the markets while the rest (40%) indicated that they do casual labour to be able to get food as illustrated in figure 10 above.

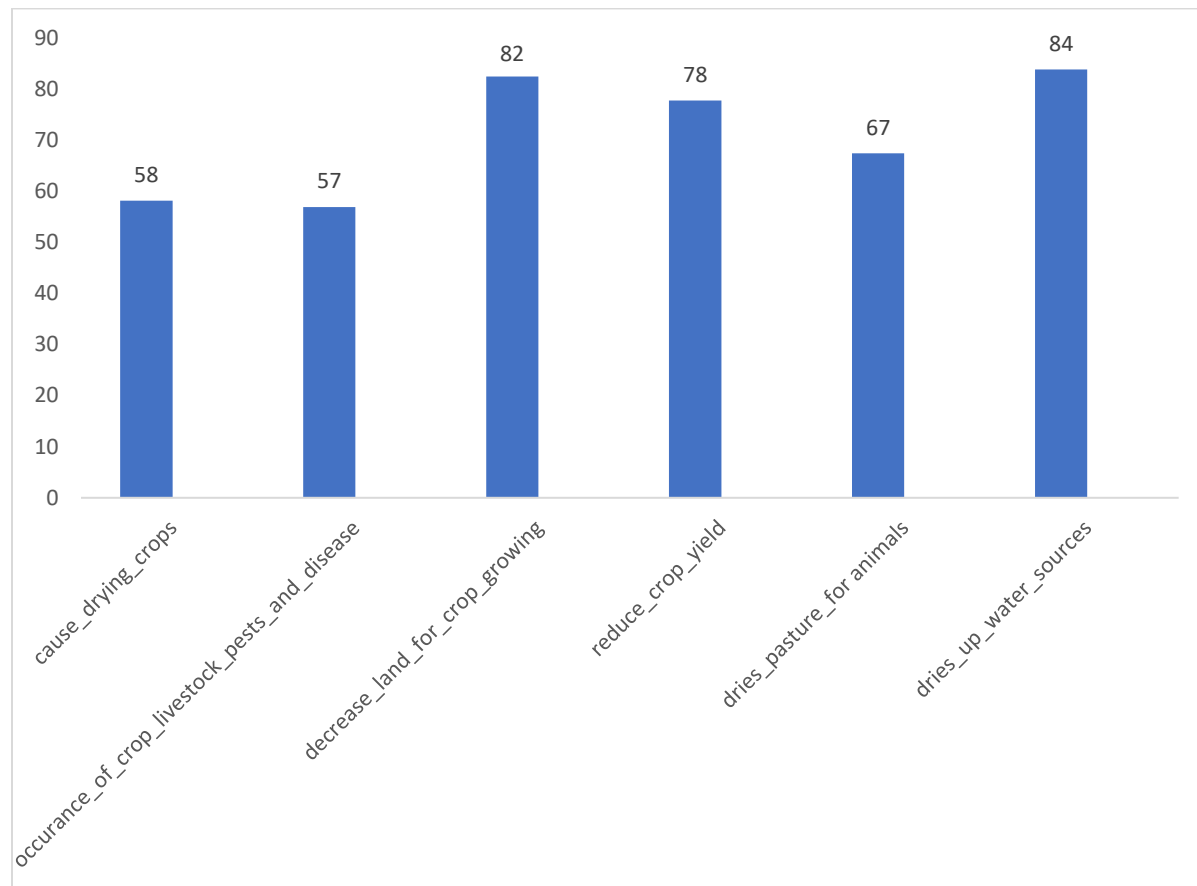


FIGURE 11: EFFECTS OF CHANGING WEATHER PATTERNS ON FOOD AVAILABILITY

Source: Field data 2022

On the question about how changing weather patterns affect food production results as presented in figure 11, majority of the respondents (84%) indicated that changing weather patterns caused drying up of water sources followed decreased land for crop growing 82.4%, reduction in crop yields 78%, drying of pastures for animals (67%), drying of crops at 58%, and occurrence of crop and animal pests and diseases at 57%. clearly indicating that changing weather patterns were affecting smallholders' agricultural production.

TABLE 6: ASSOCIATION OF CHANGING WEATHER PATTERNS AND FOOD STABILITY

Weather patterns		Food stability		p-value
		Yes	No	
Prolonged dry spell	No	62(75.6%)	20(24.4%)	<0.001
	Yes	18(100.0%)	0(0.0%)	
Heavy and stormy rains	No	58(74.3%)	20(25.7%)	<0.001
	Yes	22(100.0%)	0(0.0%)	
Late onset of rains	No	23(100.0%)	0(0.0%)	<0.001
	Yes	57(74%)	20(26%)	

Source: Field data, 2022

TABLE 7: ASSOCIATION OF CHANGING WEATHER PATTERNS AND FOOD UTILIZATION

		Food utilization		p-value
		No	Yes	
Prolonged dry spell	No	37(45.1%)	45(54.9%)	<0.001
	Yes	18(100.0%)	0(0.0%)	
Heavy and stormy rains	No	55(70.5%)	23(29.5%)	<0.001
	Yes	0(0.0%)	22(100.0%)	
Late onset of rains	No	10(32.2%)	21(67.8%)	<0.001
	Yes	46(66.7%)	23(33.3%)	

Source: Field data, 2022

4.1.5 Mitigation measures and coping strategies for the effects of changing weather patterns on food availability

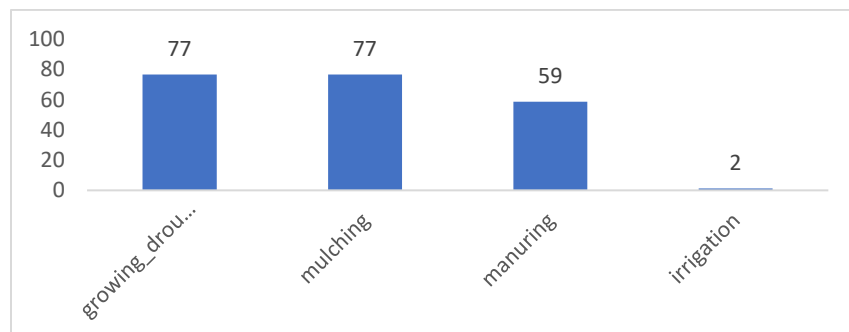


FIGURE 12: MITIGATION MEASURES FOR FARMERS ON THE EFFECTS OF PROLONGED DRY SPELLS

Source: Field data

From the analysis of data on the Mitigation measures used by small holder farmers to mitigated effects of prolonged dry spells as presented in figure 12 above, 77% grew drought resistant crops which stood the effects of high temperatures and little water available in the soils, 77% mulched their gardens especially banana plantations to conserve the soil water and prevent loss of their soils through soil erosion, while 59% applied manure to ensure soil fertility is maintained to enable their crops yield even with little rains that fell and , 2 % irrigated their crops to compensate the little rains received and support their crops to overcome they effects of prolonged dry spells.

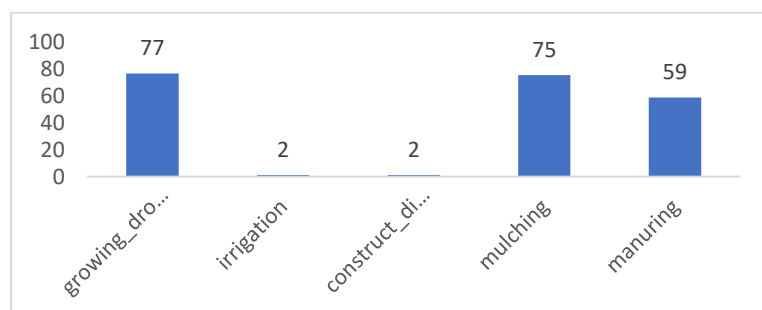


FIGURE 13: MITIGATION MEASURES FOR FARMERS ON THE EFFECTS OF DELAYED RAINS

Source: Field data

Figure 13 above shows results on mitigation strategies for delayed rains. The research indicated that the farmers grew drought resistant crops as responded to by 77%, Mulched their crop fields by 75%, constructed, applied manures in their gardens by 58.7%, dug water ditches by 2% and irrigation of crops by 2%.

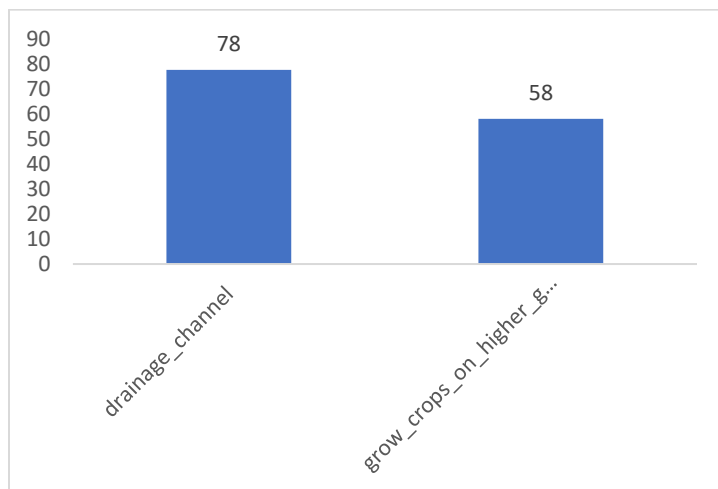


FIGURE 14: MITIGATION MEASURES FOR FARMERS AGAINST THE EFFECTS OF HEAVY AND STORMY RAINS

Source: Field data

Figure 14 above shows the mitigation measures used by the smallholder farmers to compact the effects of heavy and stormy rains. The results revealed that digging of drainages channels and

growing crops on raised ground were the main mitigation measures employed by smallholder farmers at percentages of 78 and 58 respectively.

4.1.6. Coping strategies for food insecurity by small holder farmers

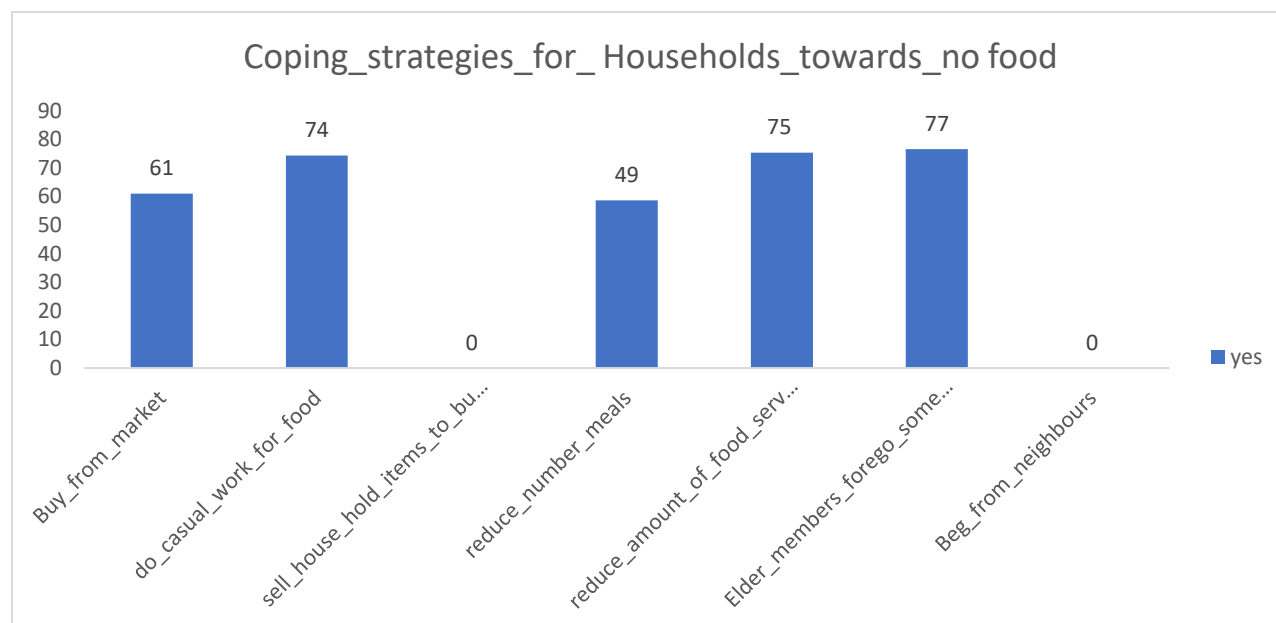


FIGURE 15: COPING STRATEGIES EMPLOYED BY FARMERS AGAINST FOOD INSECURITY IN HOUSEHOLDS.

Source: Field data

Figure 15 above displays results on the coping strategies employed by smallholder farmers when they have little or no food in their households which revealed that foregoing some meals to ensure the children get enough to eat was the main coping strategy employed by the majority at 77% , followed by those who did causal labour for food at 75%, then those who bought from the markets (61%), those reducing on the number of the meals consumed per day at 59%, and no one indicated begging food from their neighbours.

4.1.7. Results from key informants

TABLE 8: QUALITATIVE RESULTS FROM KEY INFORMANTS.

Key Informants	Effects of changing weather patterns on Accessibility	Effects of changing weather patterns on Stability	Effects of changing weather patterns on Utilization
KII_1_ District Production Officer	Food accessibility is heavily and negatively affected by changing weather patterns as bad weather leads to bad or poor harvests because crops dry and fail to yield during the longer dry seasons and that when rains are heavy, banana plantation are destroyed, crop gardens along the hill slopes are washed away down the valleys.	Very bad. It destroys people's crops, banana plantations, washes away people's gardens along mountain slopes to valley, and floods those crops in the wetlands, leading to poor harvests. It also affects access roads to markets where farmers can buy food. Prices increase for foods in the villages and markets. these the affect stability of foods in a community.	The way people use food depends on how much they have. People with plenty of food eat more and those with little food eat less. But during prolonged dry spells there is not enough food that can be eaten to realize full utilization by the body. During heavy rains, harvest get rotten during drying. These are usually thrown away causing a negative effect on the way farmers utilize their food. So food utilization is affected negatively by bad weather
KII_2_ Sub County	Food accessibility is heavily and negatively affected by	In markets very few people take there	Food utilization depends on the

Agriculture officer	changing weather patterns. Bad weather leads to bad or poor harvests because crops dry and fail to yield during the longer dry seasons. When rains are heavy, banana plantation are destroyed, crop gardens along the hill slopes are washed away down the valleys. The crops in wetlands are flooded and rotten and all in all harvests become very poor, negatively affecting food availability and accessibility.	food produce for sale which leads to price increase due to low quantities of foods in markets, people walk long distances looking for work to get food or money to buy food so when the weather conditions change or become bad, the stability of food is very much affected negatively.	situation, for example during too much rain, there are a lot of storage diseases and aflatoxins are too much in the grains due to rotting that happens during drying as a result of little sunshine. Some crops get rotten in the gardens. When these are eaten by household members, they are likely to get food poisoning and diseases. This affects the way the body uses the food eaten and usually the food is not used as expected by the body.
KII_3_ District Agriculture Officer	Access roads to farmer gardens and markets are cut off due to destruction/blockage of roads/pathways by rain run offs. Food prices increase when there are poor harvests making it difficult for the poor households to access food even if it were there on the market.	With poor harvests due to harsh weather conditions, the food stability is very poor or even not there. People sometimes go without eating food in a day. The prices increase for	The utilization of food is negatively affected as people eat poor quality foods, some eat partially rotten grains due to poor harvest handling brought about by heavy rains and end up suffering

	There are outbreaks of pests and diseases that affect farmers crops and livestock and this reduces the yield affecting food accessibility. in gardens and stores	foods and most households eat few meals or less food.	from health problems due to aflatoxins. Others eat few meals which are not enough for their body to function properly. So, food utilization is generally bad in bad weather conditions.
KII_4_ LC3 Chairperson	The crops in wetlands are flooded by rain run offs and get rotten and all in all harvests become very poor, negatively affecting food availability and accessibility. Changing weather patterns leads to low production of food in the area. Families get little food due to poor harvests. Some families sell their properties to access food in markets. So, it is very badly affected	Prolonged dry spells lead to drying of crops in gardens and poor harvests. Water well dries up and those with cows get very little or no milk, so food stability is very much affected by the changing weather patterns. Some people move from the families to look for food in other areas	In most cases changing weather patterns affect food utilization negatively. People eat less, which is not enough for their bodies to utilize maximally. People eat little because the food is not there due to poor harvests as a result of weather conditions, it means that the food is not enough and cannot be utilized as it should be.
KII_5_ Environment Officer	The effect is very bad. Heavy rains with hailstorms destroy people's gardens, rain ran offs cause soil erosion, wash away	Changing Weather Patterns affects the production and yield of crops, and this	Many farmers lose their crops in the garden due to heavy rains or prolonged dry

	people's crops very badly reducing yields and these bring hunger due to poor harvests. People go without food during prolonged dry spells as their crops dry in gardens causing total destruction of harvests which negatively affects food availability and accessibility.	negatively affects the stability of food in the sub county.	spells, making people get less harvest to utilize for their food requirement. And is very bad. Some ware grains get rotten and are thrown away reducing the amount of food available for utilization. It causes malnutrition related diseases like marasmus, stomach infections like ulcers. Generally it affects food utilization negatively
KII_6_Sub County Community Development Officer	Changing weather patterns negatively affect food stability. Bad weather like prolonged sunshine kills and dries crops causing hunger and too much rain destroys gardens and makes crops rotten in the gardens with poor yields and harvests, food stability is affected negatively. They cause Poor- and low-quality harvests. And worse is that a hungry family is violent family so	If there are low yields, then there is also instability in food supplies to the households. The food requirements are not met.	People get little food to eat when their harvests are poor. Some go without some meals, affecting the bodily food requirements. This means there is no enough food to use by farmers.

	changing weather patterns also bring domestic violence.		
KII_7_sub county chief	There are poor harvest due to prolonged dry spells which causes famine. But also, when the rains are too much, crops get rotten in garden and on the compounds without drying and are thrown away reducing the food available for a home. These abrupt changings really bring hunger	In markets foods become very few and rare, so changing weather patterns negatively affect the stability of food in the sub county. There is also increase in prices.	Some families eat the rotten grains. Some don't have enough to eat. These things cannot allow a home to have enough harvest to meet their food requirements.
KII_8 District Natural Resources Officer	Prolonged droughts lead to drying of crops in gardens and poor harvests. Water well dries up those with cows get very little or no milk, so food accessibility is very much affected by the changing weather patterns. Some people go away from their families to look for food in other areas. Also natural ecosystems are destroyed leaving no place to gather natural foods.	When weather patterns change a lot, the stability of food in highly affected stable weather conditions brings food stability as enough food is produced and harvested. But changing weather pattern leads to poor harvests due to destruction of crops by heavy rains or drying of crops by long dry seasons even outside Bukiro. The foods that come	1. People lack what to eat, and less food eaten then poor health. When people don't eat enough food, their bodies are not satisfied. Households skip their meals and as a result deficiently diseases due to poor meals as a result of Changing weather patterns which affect production.

		into our markets from outside reduces in quantities increasing prices or even some households fail to get food completely due to reduce income.	
KII_9 District Forestry Officer	It causes Famine due to drying of crops during prolonged dry spells. rotting of crops due to heavy rains destruction of gardens by stormy and heavy rains, washing away of planted crop by rain offs and also plant and animal disease accuracies increases which reduces yields.	Average rainfall and sunshine lead to food stability, Heavy rains, and prolonged drought lead to food instability. Too little rain leads to food instability	

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the discussion of the study findings by comparing with previous related studies and makes conclusions and recommendations basing on the findings in chapter four. The chapter then provides suggestions for further studies basing on the gaps and limitations in the findings. The chapter is also organized in chronological order of the research objectives.

5.1 Understanding changing weather patterns.

Smallholder farmers understood changing weather patterns from two dimensions as presented in figure 5. (1) as periods of prolonged dry spells and heavy rains. As stated by farmers by periods of prolonged dry spells, it meant that farmers sometimes they experience somehow extended periods of sunshine and faced a deficiency of water limiting agriculture production, and at some other times they experienced extended periods of heavy rains favoring agricultural [production, and (2) as periods of famine and plenty of foods which also correlates well with the first understanding because it is during the periods of prolonged dry spells that agricultural production is affected resulting into famine, and also it is in periods of availability of rains that farmers get plenty of foods. This understanding by farmers correlated to the description of changing weather patterns by (FAO, 2015a) which indicated that changing weather patterns occur when there is an extended period of months or years of extended periods of too much rain with hail and windstorms causing destructions or when a region notes deficiency in its water supply whether surface or underground water.

The farmers also had knowledge on variabilities of changing weather patterns (figure 3). The variabilities reported by the small holder farmers and affecting their food security were prolonged dry spells, late on set of rains and heavy and stormy rain fall. The farmers reported that they experienced Prolonged drought too as a weather variability immediately after planting resulting into germination failures, crops wilting and drying up partially or completely affecting the yield and quality of the crop harvests. They also indicated Late on set of rains as a weather variability which delayed timing for planting, delaying planting, germinating resulting into dwindling growth which result into poor and low yields. Furthermore, farmers reported experiencing heavy and stormy rains, a variability which caused extreme rain runoff washing away their crop garden, causing physical damage to the crops and causing rotting of crops in the fields. These variabilities

affect agricultural productivity posing a big threat to food security. This result is in line with (Apanovich & Mazur, 2018) who indicated that these variabilities posed a threat to food security, and that as the planet warms, rainfall patterns will shift, while extreme weather events such as prolonged dry spells, floods, and forest fires will become more frequent, impacting agricultural productivity and food security.

From the findings of the research, farmers also had knowledge on causes of changing weather patterns in their areas and the caused mentioned by the farmers include cutting down of trees, destroying wetlands, drainage of swamps, bush burning, sand and marram mining as presented in figure 7. They also had knowledge on variabilities of changing weather patterns (figure 6). These variabilities affect agricultural productivity as well as food security as described by (Apanovich & Mazur, 2018), who indicated that effects of changing weather patterns posed a threat to food security, and that as the planet warms, rain fall patterns will shift, while extreme weather events like drought, floods and forest fires will be more frequent affecting agriculture productivity and food security.

Effects of changing weather patterns on food availability, accessibility stability and utilization. among households in Bukiro Sub County

Agriculture production and productivity is fundamental to food security and from table 3, the research revealed that majority of the respondents were solely doing agriculture as their occupation while few were doing some other business. And also land ownership and accessibility is an important resource for agricultural production which the research found that it is owned in small sizes by the majority described in table 3 which affects production and food accessibility. The research revealed that there were low seasonal and annual yields to ensure all year around food accessibility for households as illustrated in in figures 8 and 9. However, all these were as a result of effects of changing weather patterns not only causing physical damage to crops and livestock but also affecting the food production systems. The effects revealed by the research are discussed in detail below.

Drying of crops, pastures and water sources: The scourge that comes because of high temperatures for small holder farmers is the drying of crops, pastures and water resources. Agriculture production and productivity is fundamental to food security however this in most cases is affected by changing weather patterns and its variabilities which pose a threat to food security. From figure 11, the farmers reported that there were drying of crops, pastures and water sources due to prolonged dry spells in relation to its time of set in, longevity and intensity. The drying of these resources is due extreme evapotranspiration that occur because of increased temperatures and reduced humidity during daytime and limited agriculture water supply in the soils. Drying of water sources exposes the livestock especially cattle and goats which get dehydrated and die because of extreme high heat stress during daytime. Furthermore, the farmers reported that the drying of water resources limited local fishing reducing some farmers' income and nutrition. This aligns with (Ziska *et al.*, 2016) who noted that changes in the frequency and severity of prolonged dry spells, heavy rains, and stormy weather could present challenges for farmers and ranchers, potentially threatening food security. They also pointed out that shifting weather patterns might complicate crop cultivation, livestock rearing, and fishing, making it difficult to maintain previous methods and locations. The effects of changing weather patterns should be assessed alongside other growing factors influencing agricultural production, such as variations in farming practices and technology. Extreme temperatures and precipitation can hinder crop growth. This also agrees with (Brown *et al.*, 2015) who noted that climate variation is expected to impact food security at global, regional, and local levels by troublemaking food availability, restricting access to food, and affecting food quality. They highlighted that anticipated rise in temperatures, alterations in precipitation patterns, more frequent extreme weather events, and decreased water availability could result in reduced agricultural productivity, disruptions in food delivery, and higher food prices.

Changing weather patterns affected agricultural production and productivity negatively resulting into seasonal and annual yields through its effects as described in figure 12 as the research revealed that drying of crops before maturity, increasing disease and pest incidences that attach and destroy crops and animals, drying up of pastures for animals, decreasing land for agriculture and drying up of water sources affecting the productivity of livestock, reducing their productivity and yields and this made the available food low and its accessibility difficult throughout the year. Findings further revealed that heavy and stormy rains had a significant association with food accessibility

among households in Bukiro Sub County as the heavy rains destroyed crops and the crops grown by a household in Bukiro Sub County were predominantly Matooke, millet, maize, and legumes like beans and ground nuts as described in table 3, limited people from harvesting and blocked peoples' access to markets to buy food, which limits food accessibility. Interviews from key informants as presented in table 8 under effects of changing weather patterns on food accessibility, agreed with these finding by indicating that changing weather patterns affected food availability and accessibility negatively by drying crops in gardens caused by prolonged dry spells, washing away of crops by rain runoffs, and rotting of crops in low lands caused by flash flooding from heavy rains, destruction of crops by heavy and stormy rains, and also these findings are in line with what (El Bilali *et al.*, 2020a) stated that climate change will reduce food access through negative impacts on both food prices and rural livelihoods, food supply shortfalls, due to negative impacts of changing weather patterns on yields and production, would increase food prices (Mbolanyi *et al.*, 2017) who stated that food patterns in Uganda, especially within the cattle corridor were often characterized by very low levels of harvest, small quantities stored per growing season, and short periods before depletion and a small number of meals taken by several households per day. but they remain the major sources of daily food consumption.

Reduction of yields: Changing weather patterns affected agricultural production and productivity negatively resulting into reduction or total failure of yield and these leads to low seasonal and annual yields. This reduction in yields in terms of quantity and quality is because of drying of crops before maturity due to early onset of prolonged dry spells which reduce growth or cause crop retardation because of limited agricultural water in the soils, Reduced and poor yields are also because of increasing disease and pest incidences that attach and destroy crop and livestock. Reduction in quantity also occurs because of decreasing land for agriculture due to soil erosion, water logging emanating from heavy and stormy rains. Heavy rains too destroy crops physically, cause rotting of crops in the fields and limiting people from harvesting their crops which reduces quantitative and qualitative yields. The decreased and poor-quality harvests reduce available and accessible nutritious foods required by households in right quantities and at all times. This is consistent with (El Bilali *et al.*, 2020b) , who reported that climate change will decrease food access by adversely affecting both food prices and rural livelihoods. This will lead to food supply shortages due to the adverse effects of changing weather patterns on yields and production, subsequently driving up food prices. It also corresponds with (Mbolanyi *et al.*, 2017), who noted

that food practices in Uganda, particularly in the cattle corridor, are marked by very low harvest levels, minimal quantities stored each growing season, short storage durations, and a limited number of daily meals consumed by many households. Additionally, it agrees with (FAO, 2014), which indicated that extreme weather events contribute to increased famine, hunger and malnutrition in regions where people cannot produce or access enough food. Furthermore, the reduction in the harvested yields force households to reduce on their daily food rations, reduce number of meals per day which reduces their bodily food requirements for a healthy life. Also, the low yields are of poor quality due to rotting of crops in the gardens, pest and disease infestations and poor harvesting and post harvesting handling, which introduces aflatoxins into the ware grains and animal products which in turn lead food poisoning. These affect the quality and nutrient values of the food consumed by the households leading to food related problems like malnutrition-based diseases like stomach pains, ulcers, poisoning that affect the well-being of households and whole community. This is in agreement with (WFP, 2012), which noted that climate change affects food safety, particularly by increasing the incidence and prevalence of food-borne diseases. It also impacts livelihoods and income and contributes to food price increases and volatility. This, in turn, diminishes the purchasing power of poor net food buyers, forcing them to cut back on both the quantity and quality of their food consumption.

Furthermore Changing weather patterns affected production of these crops by drying crops in the fields, increasing the occurrences and incidences of crop and livestock diseases and pests, drying up pastures for livestock, reduces land for crop production as presented in figure 12 resulting into low and poor quality yields threatening farmers' food security, which is in line with (Ziska et al., 2016)'s findings that indicated that Changes in the frequency and severity of prolonged dry spells, and heavy and stormy rains could pose challenges for farmers and ranchers and threaten food safety. This finding also partly agrees with (Sivakumar *et al.*, 2005) and(IPCC, 2014) who highlighted that in developing countries, the rise in temperature and the decrease in rainfall have been more severe and moreover the frequency and intensity of the occurrence of rare climatic phenomena (prolonged dry spells, heat, coldness and flood) will also be intensified and therefore take toll on crop production, and also agree with (Niang *et al.*, 2014) who observed that due to its largely adverse effects on African agriculture and livelihoods, climate change has negative impact on food security but also with (Hatfield *et al.*, 2014) who indicated that the ranges and distribution of pests are likely to increase with climate change. This could cause new problems for farmers'

crops previously unexposed to these species. Heat waves, which are projected to increase under climate change, could directly threaten livestock.

Occurrence/outbreak of pests and diseases: Changes and variabilities in changing weather patterns come with a threat of pest and diseases outbreaks for both crops and livestock. Farmers reported to have been army worm a common pest of maize whose spread has been attributed to changes in weather patterns especially prolonged dry spells. Furthermore, the farmers reported foot and mouth disease posing a challenge to livestock farmers due to heavy rains with cause water logging in farmers affecting their lives. Banana bacterial wilt a common disease in banana plantations was also attributed to changes in weather patterns. Farmers growing beans a major delicacy in the area reported rot, black and dry spots of leaves/anthracnose and lepidoptera species affecting their crop, while the tomatoes growers reported late blight as a major disease disturbing them during rainy times. With diseases and pests attacking and destroying the farmers crops and livestock, their food security is threatened. This range of diseases reported by farmers distributed randomly across the sub county was related to change in weather patterns by farmers and agrees with (Hatfield *et al.*, 2014) who suggested that climate change is likely to broaden the ranges and distribution of pests, potentially introducing new challenges for crops that were previously not affected by these species. The results from increased pest and diseases occurrence also make farmers to consumed poor quality grains infected with aflatoxins introduced into crops and livestock products by pests and diseases leading to nutrition related diseases and challenges, and this also aligns with (WFP, 2012), which found that climate change affects food safety by raising the incidence and prevalence of food-borne diseases, as well as affecting livelihoods and income. Additionally, it contributes to food price increases and volatility, which diminishes the purchasing power of poor net food buyers and forces them to reduce both the quantity and quality of their food consumption.

The study findings revealed that changing weather patterns had a significant association with food stability in small holder farmers' households in Bukiro Sub County. Households that experienced late onset of rains 21 (67.8%) experienced food instability, and this is because changing weather patterns disrupted planting preparations, led to late planting affecting seasonal crop harvests due to early dry spells. Most of the crops grown in the area are annual in nature, purely rain fed, and a delay in onset of rains translated into low seasonal and annual crop harvests as presented in figures 8 and 9 respectively. Low yields leads to food instability. This finding concurs with (OPM,

2012) which contended that food crops are greatly affected by the changes in weather patterns like prolonged dry spells and less rains since most of them are annual in nature and depend greatly on the seasonal availability of rains and any absence of rains directly translates into either their destruction or reduced production and productivity.

The study findings also revealed that heavy and stormy rains had a significant association with food stability among small holder farmers' households in Bukiro Sub County. This was due to its destructive nature to the crop through breaking down of crops like bananas, carrying of crops from the gardens by rain runoffs, and flash floods that crop rotting and dying of crops before reaching maturity. In most cases, heavy rains and storms destroy banana and coffee plantations, and coffee which are the major cash crops in the area which are the major cash crops in the area and other crop farms leading to poor and low yields. This implied that both food production was affected negatively and food purchasing power is greatly reduced, thereby causing food instability. Also based on the findings from the study that seasonal and annual yields were low described in figure 8 and 9 respectively and that some of these same yields were for either home food consumption or sale to generate income which led food instabilities in most homes.

In addition as presented in table 8 under effects of changing weather patterns on food stability, results from the key informant interviews, also indicated that Food stability is heavily and negatively affected by changing weather patterns through drying of crops during the longer dry seasons, drying of water sources and pastures leading to less milk production, destruction crops by heavy rains like banana plantation are destroyed, washing away of crop gardens along the hill slopes, down the valleys, the crops in wetlands are flooded and rotten leading to overall poor and low harvests and yields increasing food instability. Furthermore, they revealed that there were few foods being brought to markets which increased due to poor harvests but also due to blockage of access roads. They also revealed that some families sell their household properties to buy food, yet food prices increase in the villages and markets during harsh changing weather patterns which in turn increased food instability. This concurred with (El Bilali *et al.*, 2020), who argued that Climate variability and change will have far reaching consequences for smallholder farmers in sub-Saharan Africa, the majority of whom depend on agriculture for their livelihoods, that rural populations will suffer from the increase of food prices as well as the negative impacts of climate

change on their sources of income and livelihoods strategies relating to agriculture and that loss in agricultural production implied the loss of income for farmers.

Results in Table 6 show that of the 100 smallholder farmers recruited in the study, food availability was significantly influenced by all the weather change patterns ($p < 0.05$). Specifically, majority households that experienced late onset of rains had their food supply unstable, 74% ($n = 57$) or dry spell, 100%, $n=23$ experienced food stability ($p < 0.001$). Almost all the key informants disagreed. One study participant said:

Weather changing affects the production and yield of crops and this affects negatively the stability of food in the sub county. In markets very few people bring their food price increase due to low quantities of foods in markets, people walk long distances looking for work to get food or money to buy food so when the weather conditions change or become bad, the stability of food is very much affected negatively (KII, Agricultural Extension worker)

Another responded: KII_3 also indicated that Food stability is affected negatively, and food becomes scarce, the food prices increase, food in the markets reduce and most families go with one meal a day or others just boil porridge and spend a day on it. While KII_6 also said that bad weather conditions destabilized food availability, food stability becomes poor with less food in markets and the prices become high. Some people travel long distances to look for food by doing casual labour. When food is not stable in homes there are quarrels and fighting

It was also indicated from KII_5 that low harvests due to harsh weather conditions, the food stability is very poor or even not there. The prices increase for foods and most households eat few meals or less food. In markets foods become limited and rare evidence that weather changes negatively affect the stability of food in the sub county

KII_7 also in his response indicated that changing weather patterns affect the stability of food very badly. With poor harvests, very little food is brought to markets and those who brought it, they sold it expensively like those days, beans and posho are very expensive due to poor harvests even in areas where they were usually gotten, they were not there. He also indicated that when weather patterns change the stability of food is highly affected and stable weather conditions brings food stability as enough food is produced and harvested. He emphasized that negative changing weather

pattern leads to poor harvests due to destruction of crops dry heavy rains or drying of crops by long dry seasons even outside Bukiro. The foods that come into our markets from outside reduces in quantities hiking prices or even some households fail to set food completely due to reduced income.

The study finding revealed that changing weather patterns have negative effects on food utilization in smallholder housed. Seasonal and annual crop harvest quantities (Figure 8 and 9) were low in most households, yet these harvests are for both food and income generation. With low harvested quantities, this put the house at risks of consuming low food quantities, as well as getting little to sell income to purchase other foods need for a healthy family but not produced by the households, that in turn exposed these households to risks of malnutrition related hazards. Also, information from key informants in table 8 under effects of Changing weather patterns, revealed that Changing weather patterns affected food utilization in the sub county as it caused shortages in crop harvests which affected negatively the required for daily food needs of households. This force households to reduce on their daily food rations, reduce number of meals per day which reduces their bodily food requirements for a healthy life. It also revealed that changing weather patterns leads to poor quality harvests due to rotting in the gardens, pest and disease infestations and also poor harvesting and post harvesting handling, which introduce aflatoxins into the ware grains and animal products which in turn lead food poisoning. These affect the quality and nutrient values of the food consumed by the households leading to food related problems like malnutrition-based diseases like stomach pains, ulcers, poisoning that affect the well-being of households and whole community. This agreed with (WFP, 2012) which stated that Climate change had been found to have an impact on food safety, particularly on incidence and prevalence of food-borne diseases, livelihoods, and income, and also through food price increases and volatility, reducing food purchase power of poor net food buyers, constraining them to reduce their food consumption in quantity and quality. This also agreed with (IFPRI, 2009) which revealed that changes in rainfall patterns and total annual rainfall amounts are also expected less than changes in temperature and that regardless of changes in rainfall, changes in temperature are likely to have significant implications for food security, and human health.

Information from interviews concurred. One study participant KII_2 said that the utilization of food is negatively affected as people eat poor quality of foods, some eat grains affected with

aflatoxins due to poor harvest handling and end up suffering from intestinal problems. Others eat few meals which are not enough for their bodies. So, food utilization is generally bad in bad weather conditions. As for KII_3 he indicated that the way people use food depends on how much they have. People with plenty food eat more and those with little food eat less. In most cases Changing weather patterns affect the production and productivity of food thus affecting food utilization negatively in the long run. In addition KII_6 indicated that bad weather conditions lead to poor harvest; people eat less food or even bad food like rotten seeds and that Changing weather patterns affected food utilization negatively. Children get malnourished and suffer from deficiency diseases due to poor utilization of food.

5.3 Adaptation and Mitigation measures for the effects of changing weather patterns on food availability in Bukiro Sub County

From the discussions above, it is clear that changing weather patterns to some extent had negative effects on food security of smallholder households in Bukiro sub county. However, the smallholder households who were affected by changing weather patterns still also had some adaptation and mitigation measures that they were employing against the effects of changing weather patterns as described in figures 14, 15, and 16, and therefore had some level of food access though it was low (figure11).

The mitigation strategies that were being used depended on the variables of the changing weather changing experienced in the study area. For prolonged dry spells as presented in figure 14, farmers grew drought resistant crops that would stand heat stress and still give some yields like millet and ground nuts, early maturing crops like beans that could escape the adverse effects of prolonged dry spells and made farmers get some yields. Also, farmers mulched and applied organic manures in the banana and coffee plantations to reduce water losses during the dry spells and also enhance soil fertility, which in turn helped in realizing some harvests that would generate both food and income in case of bananas and income in case of coffee during the dry spells. Also, there was irrigation though to a smaller extent.

For late on set of rains as described in figure 14, it was less or more like during dry spells, and this also concurs with (IPCC, 2014) which stated that farmers could adapt to shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and

adjusting planting dates. In the times of heavy and stormy rains (Figure 15) smallholder farmers dug drainage channels to drain the flash floods in gardens in the lowlands. Others grew crops on raised ground e.g., on hill slopes while other farmers grow crops with erect stems such as maize which need long rains to yield well but also could withstand rain run offs and not get destroyed. These strategies helped the small holder farmers to have some harvests from their gardens and therefore some level of access to food. Also, farmers grew more than one crop to spread the risks and reduce the effects of Changing weather patterns on food availability and accessibility as described in table 3. They also used some mitigation methods such as growing crops in valleys, near and in swamps and wetlands which naturally retain water for long periods. All these adaptation and mitigation methods aimed at reducing the effects of changing weather patterns on production and productivity to ensure food security was achieved. These findings agree with (Trærup & Mertz, 2011) and (Tambo & Abdoulaye, 2013) whose studies in Tanzania and Nigeria respectively revealed that farmers are shifting to drought tolerant crops and fast-maturing varieties in order to adapt to shorter growing seasons and prolonged dry spells, and also with (Burney, 2011) who in their studies on Sub Saharan Africa found irrigation a significantly increased household income and nutritional intake, particularly during the dry season. It also concurs with (IPCC, 2014) report, which indicated that Farmers could adapt to shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and adjusting planting dates.

5.4 Coping strategies

According to the results of the research, smallholder farmers in Bukiirro sub county utilize a number of coping strategies whenever there is shortage of food and these strategies included buying food items from markets, doing cause labour for food, cutting back on meal frequencies consumed per day, reducing on food rations served on the table and elder members of the households foregoing some meals to ensure the children get enough food. The coping strategies that the farming households apply provide significant insight into daily operations of these households. The smallholders used these strategies consistently. changing to less favorite products, cutting back on meal frequencies, and giving feeding to their kids a priority. Those strategies are some of the drastic coping behaviors that point to the area's severe level of food insecurity. And these strategies in broad terms, indicate that the agricultural households' adaptability and perseverance in the face of food destitution is

strong. This is in agreement with (Jaleta *et al.*, 2020) who indicated that many risk management and diversification strategies are not new to African households who have traditionally dealt with climate variability impacts through, for example, (seasonal) migration, combining multiple crops and or cultivars, and utilizing the complementarities between crop cultivation, livestock and tree and also with (Thornton & Herrero, 2014) who indicated that farmers can adapt to shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and adjusting planting dates

5.5 Conclusions

The research from its findings concluded that:

1. The research was conducted to establish the effects of changing weather patterns on food security among small farmer households in Bukiro sub county and from its findings, the research made the following conclusions. The farmers had expanding knowledge on changing weather patterns and their effects on the households' food security. From the study, all farmers agreed with the certainty of changing weather patterns. The variabilities identified by the farmers in Bukiro sub county were prolonged dry spells, heavy and stormy rains, and late onset of rains. The study also established that changing weather patterns had both direct and underlying effects on both crop and livestock production, which are back bones of food security.
2. The Changing weather patterns have significant negative effect on food availability, accessibility, stability and utilization among smallholder households in Bukiro Sub County through its effects on agricultural production and productivity by disrupt planting preparations by late onset of rains, destroying gardens, blockage of access roads by heavy and stormy rains, drying of crops, pastures and water sources by prolonged dry spells leading low and crop production and productivity and therefore increased household food insecurity major effect was drying up of water sources, decreased land for crop growing and animal rearing in the area, drying of pastures for livestock, drying of crops, increases occurrence of crop and animal pests and diseases and decrease in crop and animal yields among others clearly indicating that changing weather patterns were affecting smallholders' agricultural production process.

3. Farmers already knew the different variables of Changing weather patterns and their effects, and they employed different adaptation and mitigation measures to reduce effects of changing weather patterns on agricultural production depending on the different weather patterns with mulching, application of manures, growing drought resistant crops, mixed cropping, and digging of trenches as the main adaptation and mitigation measures adopted to counter the effects of changing weather patterns.
4. Farmers had adapted to different coping strategies towards food insecurity which included buying from the markets, doing casual labour for food, reducing on the number of the meals consumed per day, reduction on amount of food served per meal, and foregoing some meals by the elders to ensure the children get enough to eat.

5.6 Recommendations

1. There is need for effective capacity building by government and other stakeholders to strengthen the most vulnerable small holder farmers in agricultural production with requisite knowledge and information necessary for mitigating the effects of changing weather patterns such as embracing climate smart agriculture practices, Sustainable land use management practices, appropriate farming systems, and proper post-harvest handling technologies.
2. Investment on modern agricultural technology, infrastructure and early warning systems by government and other stakeholders to enable farmers get access to appropriate and proper information, technologies, and practices necessary for climate change adaptation and mitigation technologies to be able to cope with effects of climate change.
3. Sensitization on protection and importance of environment, ecosystems and natural resources need to be conducted by government and concerned stakeholders to create awareness about the dangers and adverse effects of their destruction to help in mitigating the negative effects of changing weather patterns while improving on food production and security.

5.7 Areas for Further study

- Longitudinal study could be done on effects of changing weather patterns on food security on the same area of this study and/or other areas.

- A similar study could be conducted in other sub counties or rural settings since they were outside the study scope.
- A study on seasonal changes in weather patterns and their effects on food security can be conducted in the same area.

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APPENDICES

Appendix 1: Questionnaire for farmers in Bukiro Sub County

BISHOP STUART UNIVERSITY

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Dear Respondent,

I am **John Francis Nuwasasira**, a student at Bishop Stuart University conducting masters’ academic research on **“Effects of changing weather patterns on household food availability in Bukiro Sub County, Mbarara district”**. You have been identified and selected to participate in

this study because you are a resident smallholder farmer; and I am therefore seeking for your consent to be interviewed and all the interview details will be kept confidential. Do you accept to be interviewed? If YES, Proceed with interview. If NO, get to the next respondent.

Section A: Background Characteristics (Bio-data) of Respondent

1. How old are you?

- a) <18 []
- b) 18-36 []
- c) 37-54 []
- d) >54 []

2. What level of Education do you hold?

- a) Never went to school []
- b) Primary []
- c) Secondary []
- d) Tertiary []

3. What is your marital status?

- a) Single []
- b) Married []
- c) Divorced []
- d) Widow/widower []
- e) Others (Specify).....

4. How many members make up your family?

- a) 1-4 []
- b) 5-8 []
- c) >8 []

5. What other occupation/job do you earn income from?

.....

Section B: Understanding food accessibility in Bukiro Sub County.

6. Do you own land?

- a) Yes []
- b) No []

7. How did you acquire that land?

a) Through inheritance []

b) Bought it []

c) Both []

d) Others (specify).....

8. What is the size of your land?

a) 1-3 acres []

b) 4-8 acres []

c) 9+ acres []

9. Do you practice agriculture on that land?

a) Yes []

b) No []

10. (i) What types of crops do you commonly grow on your land?

(a) Bananas []

(b) Maize []

(c) Beans []

(d) Millet []

(e) G/nuts []

(f) Peas []

(g) Other (specify).....

ii) For what purposes do you use the food produced on your land? Tick all mentioned

a) Consumption

☐

b) Sale

☐

11. If you do not own land, where else do you practice agriculture from?

a) Rented land []

b) Swamps/wetlands []

c) Near river banks []

d) Near lake shores []

e) Others (specify).....

12. Which agricultural methods do you use?

a) Mixed cropping []

- b) Crop rotation []
- c) Communal []
- d) Any other (Specify).....

Section C: Understanding weather changing pattern effects on household food availability in Bukiro Sub County.

13. (a) What is your understanding of changing weather patterns?

.....

.....

.....

13(b) What changing weather patterns do you experience in your area? Tick all alternative methioned.

- (1) Prolonged dry spells []
- (2) Heavy and stormy rains []
- (3) Late on set of rains []

14(a) what do you think were the causes of the changing weather patterns in your area? Tick all all alternative methioned.

- (i) Cutting down of tree []
- (ii) Poor farming methods []
- (iii) Reduced rain fall []
- (iv) Bush burning []
- (v) Destruction of wetlands []
- (vi) Draining of swamps []
- (vii) Stone and sand mining []
- (viii)

15. How does changing weather patterns affect production of food in your household?

- a) Causes drying of crops []
- b) Increases occurrences of crop and livestock pests and disease []
- c) Reduces land acreage for crop growing []
- d) Reduces crop yield []
- e) Dries up water sources.

f) Dries up pasture for animals.

Section D: Effects of changing weather patterns on food accessibility in Bukiro Sub County.

16 i) How much in quantity (in kilograms) do you produce from your agricultural crops per season during dry spells?

- a) Less than 100 kg b) 200-400 kgs
- c) 500-700kgs d) above 700 kgs

ii) How do you rate your access to food for your household during the time of prolonged dry spells?

- a) High b) Low

iii) How do you access food for your household when prolonged dry spells affect your crop production?

- a) Do casual labour for food [] b) Buy from market [] c) Get from well-wishers []
d) Humanitarian aid []

18. Provide the current quantity records of food productivity changes (in tons) for the following food crops in relation to changing weather patterns in Bukiro Sub County.

Crops	2017		2018		2019		2020		2021	
	Tons per acre	Total number of tons produced	Tons per acre	Total number of tons produced	Tons per acre	Total number of tons produced	Tons per acre	Total number of tons produced	Tons per acre	Total number of tons produced
Matooke										
Beans										
Maize										
Millet										
G/nuts										

Section E: Effects of changing weather patterns on food stability in Bukiro Sub County.

19. How is your food stability affected by prolonged dry spells?

.....

.....

.....

Section F: Effects of drought on food utilization in Bukiro Sub County.

20 How is your food utilization affected by prolonged dry spells?

.....

.....

.....

Section G: Mitigating the effects of changing weather patterns on food availability in Bukiro Sub County.

21. In your efforts as a farmer to ensure food availability, what do you do in times of:

i) Prolonged dry spells?

- a) Irrigation []
- b) Grow drought resistant crop varieties []
- c) Mulching []
- d) Manuring []
- e) Construct ditches for rain water harvesting
- f) Others (specify).....

.....

ii) Delayed rainfall?

- a) Irrigation []
- b) Grow drought resistant crop varieties []
- c) Mulching []
- d) Manuring []
- e) Others (specify).....

.....

iii) Heavy and stormy rains?

- a) Dig drainage channels []
- b) Grow crops on higher grounds eg hill tops []
- c) Others (specify).....

22. What do you when you do not have enough food in your?

- (a) Buy from the market from my savings
- (b) Do casual work for food
- (c) Sell household items to buy food.
- (d) Reduce on the number of meals per day.
- (e) Reduce the amount of food served per head.
- (f) Beg from neighbours
- (g) Elder members of the household forego some meals.

Thank you for your time.

Appendix 2: Interview guide for Mbarara District Officials

BISHOP STUART UNIVERSITY

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Dear Sir/Madam,

I am **John Francis Nuwasasira**, a student at Bishop Stuart University conducting a masters academic research titled **“Effects of drought on household food availability in Bukiro Sub County, Mbarara district”**. You have been identified and selected to participate in this study and I am therefore seeking for your co-operation because it is necessary for the success of the study and the information given will be treated with maximum confidentiality and used for academic purposes only. Tick in the boxes or fill in the blank spaces provided.

Your cooperation is highly valued and appreciated.

Section A: Biographic data of respondents

1. Gender
 2. Age group
 3. Education level
 4. Time (in years) working with Mbarara District’s Environment Department.
 5. In your opinion, explain the effect of changing weather patterns on food accessibility by the population in Bukiro Sub County.
 6. Share your thoughts on the effect of changing weather patterns on food stability by the population in Bukiro Sub County.
 7. What do you think are the effects of changing weather patterns on food utilization by the population in Bukiro Sub County?
- End. Thank you very much.