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Effects of Changing Weather Patterns on House Hold Food Security in Bukiro Sub County Mbarara District

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Abstract

The study examined the effects of weather changing patterns on food security in smallholder households in Bukiro Sub County, Mbarara District. The objectives of the study were to a) assess the effects of weather changing patterns on food accessibility among households; b) assess the effects of weather changing patterns on food stability; c) determine the effects of weather changing patterns on food utilization and d) determine the mitigation measures for the effects of changing weather patterns on food security among households in Bukiro Sub County

The study utilized quantitative and qualitative methods of data collection and analysis where information was obtained using questionnaires surveys on 346 smallholder farmers and interviews on key informants (10). The collected data was analysed using Statistical Package for the Social Sciences 26, presented in frequency tables and charts and interpreted accordingly.

The study findings revealed that weather changing patterns, specifically the parameters of heavy rains and storms had a significant effect on food accessibility($p<0.05$). Households that experienced heavy rains and storms faced difficulties in accessing food. The study findings also revealed that weather changing patterns, specifically late onset of rains and heavy rains and storms had a significant effect on food stability in Bukiro sub county($p<0.05$). Findings further established that weather changing patterns, specifically late onset of rains had a significant effect on food utilisation in Bukiro sub county ($p<0.05$).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 so as to minimize crop damages that come with unexpected weather changing patterns to improving 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: Introduction

Overview

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 south western Uganda. The study linked climate change as a cause of food insecurity in the study area, centring on the effects of weather change patterns on food availability, farmers coping strategies, analysed the effects of drought 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.

Background

Climate refers to the average weather conditions of a place as determined by the temperature, precipitation and humidity over thirty years (Danandeh et al. 2020) [1]. 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, [2]. The Intergovernmental Panel on Climate Change (IPCC 2007) [3] 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'. Weather change patterns occur when there is an extended period of months or years of extended periods of too much rains with hail and wind storms causing destructions or when a region notes deficiency in its water supply whether surface or underground water (Kabubo-Mariara 2015) [4]. IPPC 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, weather change patterns occur 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) [5]. 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) [6]. 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 (2017) [7], food security 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.

D'Odorico, et al.,(2018) [8] 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 and Orfila 2021) [9] 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) [10]. (Apanovich and Mazur 2018) [11] 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 (IPCC 2019) [12] 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 weather change 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 in order to maintain their food security and well-being(Stavi et al. 2021; FAO 2018) [13,14]. (Connolly-Boutin and Smit 2016; Songok et al 2017) [15], 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) [6] indicate that higher increases in temperature in sub-Saharan Africa has caused changes in rainfall intensity while (Tschakert et al. 2010) [16] revealed that there are increased incidences of extreme events such as droughts and floods and Reich et al.(2001) showed that climate change increases desertification. 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 (IPCC 2015) [17].

In Zimbabwe, (Mugandani et al. 2012) [18] 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 2015) [4] revealed that in Kenya, extreme weather changing patterns undermine food production affecting crop and livestock systems both directly posing serious threats to food shortage, water, and energy. In Mauritania, as indicated by (UN 2010) [19] 500,000 people cannot access and maintain their food consumption basket.

FAO,(2014) [20], 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 and Kasirye 2010) [21], indicated that Ugandans were experiencing food insecurity in terms of calorie intake, and according to Namugumya,et al., (2020) [22] 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.

(Barrett 2010) [23] 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,while (Mbolanyi, et al 2017) [24] 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) [25] also indicated that Since agriculture is the main source of household income, crop failure due to weather changing 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) [26] that as such, incidences of poverty, famine and hunger, are abundant in such areas.

UN FAO (2015)[20], indicated 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) [27]. According to the Global food security index report (2015), Uganda scored 79 out of 109 of food affordability. There is evidence in Uganda that average temperatures have increased by as much as 1.40C since the 1960s (McSweeney et al. 2010) [28]. (Hepworth and Goulden 2008) [29] 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, (Koesharyani et al. 2018) [30] 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) [31] there is need for adaptation options need 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.

Statement of the Problem

(IPCC 2015) [17] reported that all aspects of food security including food availability, accessibility and stability are potentially affected by changing weather patterns. And drought was identified by (FAO et al., 2015; (Mfitumukiza, Mbolanyi, and Egeru, 2017) [32] as the most challenging climate hazards and food security threat in Uganda through its negative impacts on agricultural production. (Gitz et al. 2016) [33] Indicated that most of the population depending on agriculture for subsistence, the immediate effect of weather changing patterns is on food availability and accessibility, income, and livelihoods in general, but did not indicated its effects on smallholder farming holds, leaving a gap that needs to filled thus the need for this study, also (Nuwagaba and Namateefu 2013) [34] noted that south western region has been devastated by the effects of drought. However, these studies have been carried out on a regional context in Uganda for example South Western, Central, Eastern and Karamoja regions, but not on weather changing patterns and not at lower levels like Sub County which creates a knowledge gap. There are limited number of studies that have been conducted on by (Twongirwe et al. 2019a; Simtowe et al. 2019; Atube et al. 2021) [35-37] that focused attention on the direct relationship between weather changing patterns like drought and food security in Uganda but these did not document any studies in Bukiro sub county, rather focused on other areas such as Isingiro District (Twongyirwe et al. 2019a) [35], Kanungu district (Patterson et al. 2017) [38] creating a knowledge gaps on effects of weather changing patterns on food security in Bukiro sub county in Mbarara district which called for this study to be conducted to establish the effects of weather changing patterns affect food security in Bukiro Sub County, Mbarara District.

Purpose of the Study

The purpose of this study is to improve food security, access and availability to the livelihoods of the small-scale farmers by contributing to the development of policy advice and recommendations on weather change impacts and adaptation in the study area.

Objectives of the Study

The general objective of the study is to examine effects of weather changing patterns on food availability among households in Bukiro Sub County, Mbarara District.

Specific Objectives

The specific objectives of the study are to: 1) Assess the effects of weather changing patterns on food accessibility among households in Bukiro Sub County. 2) Assess the effects of weather changing patterns on food stability among households in Bukiro Sub County. 3) Determine the effects of weather changing patterns on food utilization among households in Bukiro Sub County, and 4) Propose mitigation strategies to mitigate effects of weather changing patterns for sustainable food availability and accessibility.

General Research question

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

Other research questions

1. What are the effects of weather changing patterns on food accessibility among households in Bukiro Sub County?
2. What are the effects of weather changing patterns on food stability among households in Bukiro Sub County?
3. What are the effects of weather changing patterns on food utilization among households in Bukiro Sub County?

What are the mitigation strategies for changing weather patterns to improve food availability for smallholder households.

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.

Geographical scope

The study was carried out in Bukiro Sub County found in Mbarara District in the south western 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, BubaareSub 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 weather changing patterns on food availability has been conducted there.

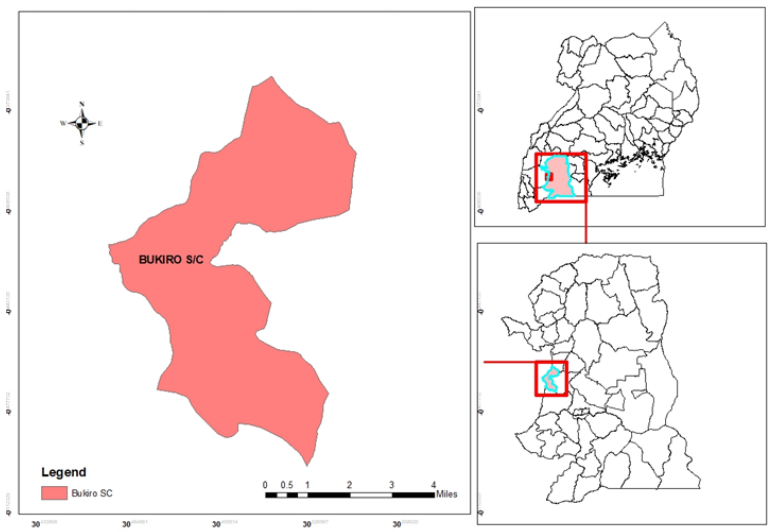

Figure 1: Map of Uganda showing location of Bukiro District

Content scope

The study examined effects of weather changing patterns on food availability 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 weather changing patterns on food stability and exploring the effects of weather changing 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.

Time scope

The study paid attention to effects of drought on food availability in Bukiro Sub County considering the period 2017 to 2022. This period was chosen because of the persistent weather changing 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 located in the cattle corridor and vulnerable to climate change.

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, access 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 weather changing 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.

Conceptual Framework

The framework is an illustration of the relationship between the independent variable weather changing patterns measured through duration/period of prolonged dry spells and heat intensity as conceptualised by (Ogunrinde et al. 2020) [39] the dependent variable “food availability” is measured through food accessibility, food stability and food utilization as conceptualised by (Jägerskog, A., Jønch Clausen 2012) [40]. 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 are able to cope with the impacts of weather changing patterns and maintain the functioning of their socio-economic systems (Robeyns 2005) [42].

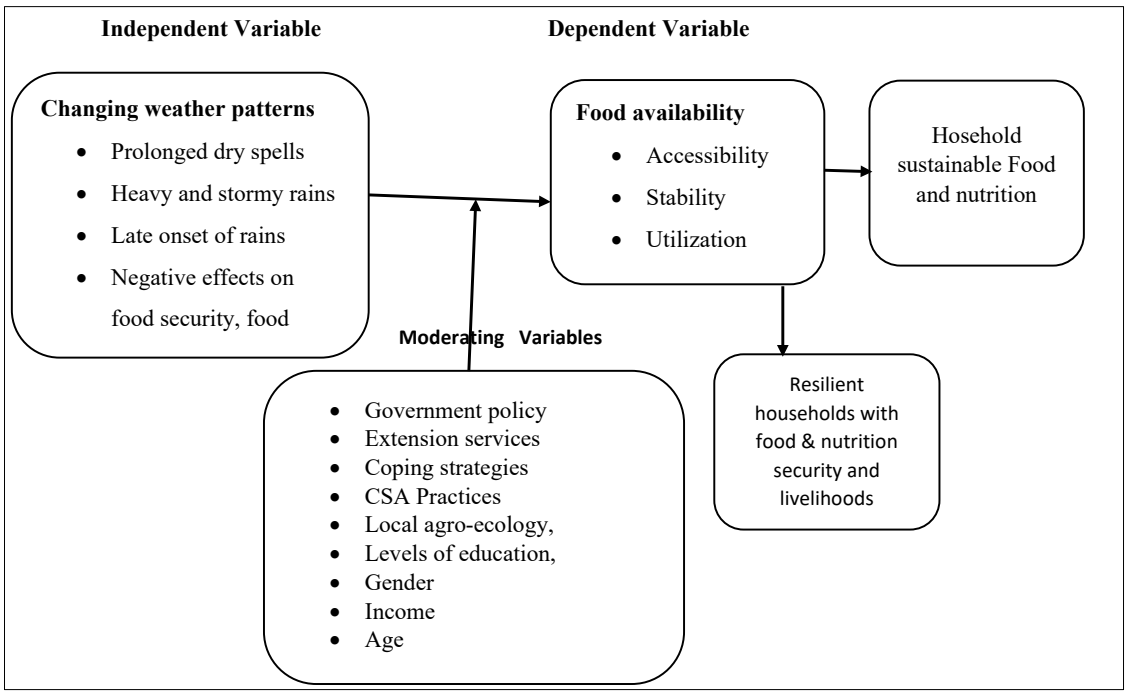

Figure 2: Conceptual framework

Source: Adopted from (Ogunrinde, et al., 2020)

The effects of weather changing 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) [37]. weather changing 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., 2017) [41]. 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., 2017) [41]. These play a key role in determining how individuals and communities are able to cope with the impacts of weather changing patterns like drought and maintain the functioning of their socio-economic systems (Robeyns 2005) [42]. The framework above was adopted from the scholars mentioned because it has tested measurements.

Chapter Three: Literature Review

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 (Carney,et al, 1999) [43] It focuses on the household's ability to sustainably provide for itself within the complex system of its environment (Scoones, 1998) [53]. 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 (Ibid)This was examined in the context of food availability, accessibility, stability and utilization.

Chambers and Conway, (1992) [45] 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 have to negotiate to reduce their vulnerability and improve their welfare (Valdivia and Quiroz 2001)[46] 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(Ibid).

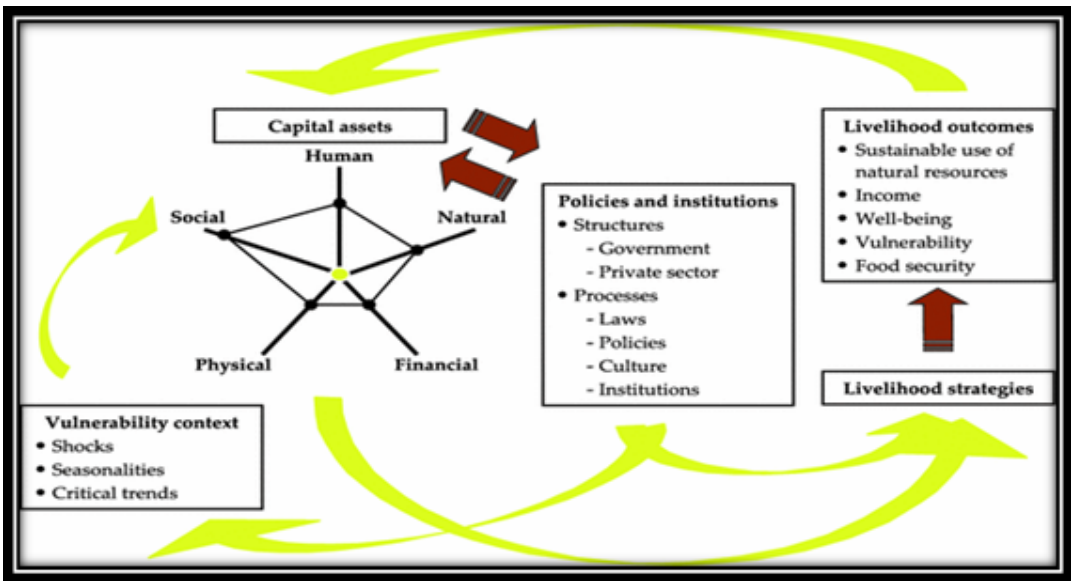

Figure 3: The sustainable livelihoods framework.

This theory is relevant to this study in a way in the midst of weather changing 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 weather changing 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.

Effects of Weather Changing Patterns on Food Accessibility among Households

According to Office of the Prime Minister (OPM 2011) [47] 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. The majority of 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.

As a result of weather changing patterns like occurrence of prolonged drought, Uganda faced higher-than-normal prices of basic food products. These higher prices were caused directly by the scarcity brought about by domestic food production losses as well as indirectly by speculation from traders in view of the drought affecting neighbouring countries. Inflation in 2011 rose significantly due to these higher prices of foodstuffs, in addition to other factors (OPM 2011) [47].

Agricultural growth in Uganda was impressive up to year 2000 when it was7.9 percent per year, but the growth rate has gradually declined since then, due in part to recurrent droughts. However, the relative performance in terms of annual growth rates varies by agricultural subsector and the year in question (Aryamanya, M, 2006).Food crops are greatly affected by the changes in weather patterns like droughts and less rains since most of them are annual in nature and depend greatly on the seasonal availability of rains. All the crops in this category are purely rain-fed, and any absence of rains directly translates into either their destruction or reduced production and productivity (OPM 2011) [47].

Otim (2007) stated that the national average for food intake in financial year 2005/06 was 2190 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 2007) [48].

Effects of changing weather patterns on food stability among households

Although the climate change patterns in some areas of the world will have positive effects on agricultural production (Ewert, et al 2009) [49] but the negative impacts of these changes will be so severe in hot and dry areas (Parry et al, 2004;Gregory et al. 2005) [50,51], so in developing countries the rise in temperature and the decrease in rainfall have been more severe (Sivakumar 2005) [52], and moreover the frequency and intensity of the occurrence of rare climatic phenomena (drought, heat, coldness and flood) will also be intensified (IPCC 2007)[3] and therefore take toll on crop production.

Climate change is commonly recognized to have major implications for food security and livelihoods (Thompson and Scoones 2009) [53]. 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 (Songok and Kipkorir 2017) [54] Due to its largely adverse effects on African agriculture and livelihoods, climate change has negative impact on food security (Niang, et al. 2014) [57].

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 (GoU 2007) [48], that severely affected the agricultural sector leading to famine, malnutrition, low production and productivity of crops and animals.

Drought also affects the availability of water resources by depleting underground and surface water potential (Carriere et al. 2020) [58]. Prolonged and severe droughts lead to low water levels in water bodies, underground aquifers and reservoirs, affecting the hydrology, biodiversity and water supply (Payus, et al., 2020). Although Uganda has abundant water resources, its distribution is uneven. The semi-arid areas of the country stretching from southwest through central to the northeast of the country often referred to as the 'cattle corridor' experience chronic water stress (Nimusiima et al. 2018) [59]. 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) [60]. On the other hand, floods also have negative effect on crop production and water resources; floods lead to pollution of drinking water sources leading to outbreaks of waterborne diseases such as cholera, typhoid and dysentery due to poor sanitation since a large proportion of the rural poor do not have pit latrines/ toilets (Gabiri et al. 2020) [61].

Effects of Weather Changing Patterns on Food Utilization among Households

Changing patterns in temperature have also had significant impacts on health and agriculture. Due to temperature rise, mosquitoes have invaded the highlands and malaria is now prevalent in these areas which were previously malaria-free. According to the government of Uganda (GoU 2007) [48], there was a general increase of malaria incidences throughout the country, particularly south-western Uganda where it reached epidemic proportions during 2007. Data from health units in the districts of in south-western Uganda in 1996, 1997 and 1998 revealed an increase in the cases of malaria cases ranging from twenty three percent in Rukungiri to One hundred and thirty five percent in Mbarara district (Ministry of Health, 1998). The country has seen unprecedented outbreaks of pests and diseases, such as the Coffee Wilt Disease, Banana Bacterial Wilt, that are likely to be a consequence of climatic changes (Cavallo, 2021).

According to (Mubiru et al. 2018) [62] Uganda's ecosystems are changing and there is a biodiversity loss due to extreme and changing weather patterns like droughts and unsustainable agricultural practices. Wildlife and other natural resources (wetlands, forests and mangrove swamps) depletion is a clear indicator of climate change (Russel, et al 2018) [63], 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 (Karavani et al. 2018) [65], cited that drier conditions and prolonged droughts frequently lead to outbreaks of forest fire which result into serious environmental consequences, late on set of rains gets worse affecting agricultural productivity and causing food insecurity In addition (Berman, et al 2014) [66] , stated in his study that climate change reduces on the socio-economic development of the country by impacting infrastructure, health and livelihoods negatively.

Adaptation Strategies to Effects of Weather Changing Patterns

The effects of drought 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. 2017) [41] Changing weather patterns like drought coping strategies are likely to be more limited for resource-constrained people, for example, those whose livelihoods are heavily dependent on natural resources [70]. Deressa, et al. (2008) indicated that 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 and (Robeyns 2005) [42] 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.

In reaction to weather changing patterns and 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 (Trarup and Mertz 2011; Tambo, et al 2013) [71,72]. These shifts are sometimes aided by extension, or communication and support among farmers (Yaro, et al 2006) [73]. Demonstrating the important role of higher-level structures and processes. (Thomas et al. 2007) [74] 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 ((Philip K Thornton and Mario Herrero 2014) [74]. Farmers can adapt to shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and adjusting planting dates (IPCC 2015) [17]. 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 et al. 2014) [76].

Burney, et al 2010 [81], in their studies on Sub Saharan Africa found that solar-powered drip irrigation significantly increased household income and nutritional intake, particularly during the dry season. Households in the project were also less water insecure (more able to meet their daily water needs) than households outside of the scheme, although water access improved for all households over time Burney, et al. 2010 [81].

Chapter Four: Research Methodology

Research Design

This chapter provides descriptive account of the methods that were used in the study to address the research objectives and the research questions. In particular, 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

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 2012) [82]. 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 with regard to addressing the research questions

Study Area

This study was conducted This study was conducted in Bukiro Sub County found in Mbarara District in the south western 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 is 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 (MoW&E,2020) . Bukiro Sub County lies on the North Western part of Mbarara District and has four parishes (Bukiro, Nyanja, Nyarubungo and Rubingo) and covers an area of 261 km2 with a population of 32,323 (joseph carlos 2014) [83]. 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 Banyankore who speak Runyankore. The Sub- County has one main river, a tributary of River Rwiziemanating from Buhwejurunning 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) [84].

Study Population

Information was obtained from smallholder farmers in Bukiro Sub County 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, subcounty chief, Subcounty 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.

Sample Size

Using Cochran's (1963) formula for cross sectional studies, the sample size was determined as follows;

$$n = \frac{Z^2P(1-P)}{d^2}, \text{ Where:}$$

n = minimum sample size required;

Z = a statistic for a standard normal distribution. It is desirable to obtain results with a 95% level of confidence, such that the z-statistic is 1.96;

P = the anticipated prevalence of men willingness to support their spouses.

d = the margin of error in estimating P which will be set at 5%.

Therefore, the minimum sample size as

$$n = \frac{1.96^2 \times 0.4(1-0.4)}{(0.05)^2} = 368.8$$

At least 88respondents will be picked from each of the 4 parishes of Bukiro Sub County, and 16 key informants.

Total sample size

Small holder farmers 352

Key informants (local and district officers and leaders) 16

Total 368

Sampling Techniques

Sampling is a process of extracting a portion of the population from which generalization to the population can be made(Ahuja 2000) [85], 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. Systematic 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 professional (COD and Agriculture Officer are instrumental in reaching out to the females engaged in agriculture.

Data Collection Methods

Data was collected using a variety of methods such as questionnaire surveys; key informant interviews; observations; and household survey guides and details of the methods are presented". A survey is one of the tools used in the collection of research data (Postlethwaite 2005) [86].

Questionnaire Surveys

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.

A questionnaire is an instrument used for gathering data about variables of interest in a study, and consists of a number of questions or items that a respondent reads and answers (Malhotra 2017) [88]. Questionnaire surveys were used because they collect information with minimal errors but with high level of confidentiality and give respondents freedom to answer sensitive but true questions and give accurate and detailed information (Jenny Rowley 2014) [89].Questionnaire surveys provide 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. A questionnaire is defined as a survey instrument intended to self-administered questions (Wallace 2013) [87]. Semi-structured questionnaires were used to collect data from farmers in Bukiro Sub County. Research assistants were trained so that they are equipped with skills to collect reliable data

Interviews

These were used to obtain data from key informants. An interview refers to an oral interaction or discussion between an interviewer and the respondents (Jamshed 2014) [90]. 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 frame work for conducting the interviews in order to avoid deviations from respondents. Interviews were used because they eliminate response errors since it is interviewer who controls the interview process (Matteson 1993) [91].

Data Quality Control/Pretesting of Tools

Verification and confirmation of data collection tools 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) [92].

Data Collection Tools

Interview guides

These were data from key informants. This was because they have the ability to 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 the course of an interview (Atkins and Wallace 2015) [93]. The interviews lasted for between 30 minutes and One hour to avoid suspicion by the respondents. Interview guides were used because they helped interviewers to explain, better understand, and explore research subjects' opinions, behaviour and experiences about the topic.

Questionnaires

A questionnaire is defined as a survey instrument intended to self-administered questions (Azurah et al. 2020) [94]. 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. (Jenny Rowley 2014) [89] stated that questionnaires were preferred because they gave respondents freedom to answer sensitive but true questions.

Data Analysis

Quantitative data analysis

The data collected was summarized using descriptive statistics. Data from questionnaires was entered into Microsoft Excel so as 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 SPSS26 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.

Qualitativedata analysis

Completed answers generated from interviews were crosschecked 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 in order to establish areas of convergence and divergence. The analysis involved listing and summarizing data in compilation sheets of developed themes. According to (Bryman 2006) [95] 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.

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 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 wore a face mask at all times 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.

Chapter Four: Results

Response Rate

Questionnaires were tools use to collect data from respondents. 368 questionnaires were distributed to the respondents and 346 were returned representing 94% response rate. Key informants were also interviewed. Out of the targeted 16, ten (10) were interviewed which is 62% representation. Table 1 presents the response rate.

Table 1: Respondents

Tools	Distributed	Returned	Response Rate (%)
Questionnaires (small holder farmers)	368	346	94
Interviews (key informants)	16	10	62
Total	384	356	93

Source: Field data.

From table 1, 94% for small holder farmers and 62% for key informants responded in the interviews respectively sufficient enough above the recommended response rate of 50% for humanity studies according to Pielsticker and Hiebl, (2020)

Socio-Demographic Characteristics of Study Participants

Table 2: Socio-Demographic Characteristics of Smallholder Farmers

Characteristics		Frequency (percent)
Gender	Males	127 (36.7)
	Females	219 (63.3)
Age	18-36	236 (68.2)
	37-54	102 (29.5)
	≥55	8 (2.3)
Education	No formal education	4 (1.2)
	Primary	272 (78.6)
	Secondary	66 (19.1)
	Tertiary	4 (1.2)
Marital status	Married	302 (87.3)
	Divorced(Females)	40 (11.6)
	Divorced(males)	4 (1.2)
Family members	1-4	210 (60.7)
	5-8	66 (19.1)
	≥ 9	70 (20.2)
Occupation	Farming	302 (87.3)
	Business	44 (12.7)
Size of land owned (in hectares)	<1 ha	4 (1.2)
	1-3 ha	330 (95.4)
	>3 ha	8 (2.3)
	>8 ha	4 (1.2)
Crops grown	2 crops (beans & bananas)	142 (41.0)
	3 crops (maize, beans, g.nuts)	4 (1.2)
	4 crops (Bananas, Maize, Beans &g.nuts)	58 (16.8)
	4 crops (Bananas, Millet, beans,&gnuts)	57 (16.5)
	All crops	85 (24.6)
	4 crops (Bananas, Millet, beans,&gnuts)	57 (16.5)
	All crops	85 (24.6)

Source: Field data, 2022

Table 2 shows that of the 346 smallholder farmers in Bukiro Sub County enrolled into the study, the majority of the farmers engaged in agriculture were females, 63.3%(n = 219) age bracket found to be more productive in agriculture was 18-36 and 37-54 years, 68.2%(n = 236), these are young and energetic and work hard. Characterized by the less learned holding primary level of education, 78.6%(n = 272), these are immensely involved because they have no alternative forms of employed and work hard to meet their family food requirements and also the married farmers at 87.3%(n = 302) with a family size 1-4 family members in the household, 60.7%(n = 210) were the majority involved in farming at an overall 87.3%(n = 302) owned 1-3 hectares of land, 95.4% (n = 330) and mostly grew bananas, beans and millet, 41.0% (n = 142).,and this is backed by Weederker hr, et al., (2018) who indicated that "Basic socio-economic characteristics of the study population (age mean/range and sex ratio of the interviewees, ethnic background, economic status of households, number of household members) are known to be important factors influencing the coping and adaptation behavior of households".

Table 3: Socio-Demographic Characteristics of Key Informants

1.	Agricultural Extension Officer	Male	36-54	University degree
2.	Environment Officer	Male	36-54	University degree
3.	District Agricultural Officer	Female	36-54.	University degree
4.	CDO BukiroS/C	Female	36-54	University degree
5.				
6.	LC3 ChairpersonBukiroS/C	Male	>54	Certificate
7.	Sub county chiefBukiroS/C	Male	>54	University degree

Source: Field data, 2022

Table 3 Six key informants were interviewed and five (83.3%) were graduates serving as District Agricultural Officer, Agricultural Extension Officer, Community Development Officer and Senior Administrative Assistant (Sub county Chief). These professional have skills in farmers' mobilization and skilling in climate-smart agriculture for enhanced resilience! The two female professional are instrumental in reaching out to the females engaged in agriculture.

Description of Key Study Variables Patterns among Households in Bukiro Sub County

The effects of Weather changing patterns variables considered for this study were prolonged dry spells, late on set of rains and on food heavy and stormy rains due to their devastating effects on agricultural production like destabilising planting times, failed germination, poor crop growth and development, destruction of plants and fall off of crop leaves, failed pod formation and filling. The effects of these Weather changing 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) [37]. weather changing 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. 2017) [41]. Coping response varies depending on the prevailing ecological and socio-economic conditions: these may include local agro-ecology, levels of education, gender, age, level of income, availability of support systems and services (Ibin). (Robeyns 2005) [42] indicated that ecological and socio-economic conditions play a key role in determining how individuals and communities are able to cope with the impacts of weather changing patterns like drought and maintain the functioning of their socio-economic systems. The framework above was adopted from the scholars mentioned because it has tested measurements.

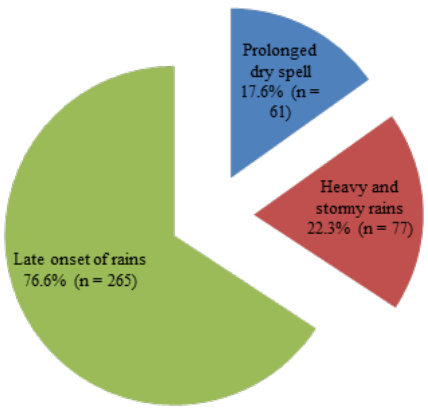

Figure 4: Description of weather changing patterns among households in Bukiro
Source: Field data, 2022

Three hundred forty six (346 N) participated in the study. When asked about factors that affected crop growing, a significant proportion 76.6% (n=265) indicated late onset of rains; and 22.3% (n=77) pointed out heavy and stormy rain events affecting their crops and only 17.6% (n=61) cited prolonged dry spells as affecting their agronomy. Clearly, weather variability is affecting smallholders' agricultural practices and this requires adaptation strategies to counter the negative phenomenon.

Table 4: Description of Status Quo of Food Availability among Households in Bukiro Sub County

Food availability		Frequency (percent)
Food accessibility	Consumption	119 (34.4)
	Sale	157 (45.4)
	Both	70 (20.2)
	No	157 (45.4)
	Yes	189 (54.6)
Food stability	No	70 (20.2)
	Yes	276 (79.8)
Food utilization	Yes	189 (54.6)
	No	157 (45.4)
Overall food availability	Yes	119 (34.4)
	No	227 (65.6)

Source: Field data 2022

Food stability, availability, accessibility and utilization was assessed (Table 5). Result reveals that 54.6% (n=189) accessed food; 79.8% (n=276) had food stability; and 54.6% (n=189) at food utilization. The results indicate that in all the three areas of food availability, the respondents accessed food.

Association between demographic characteristics and food availability in households in Bukiro Sub County.

Association between respondents' demographic characteristics and food availability in the study area was determined; and results reveal that, all the factors had very significant ($p<0.001$) levels of association. This is because the male worked harder than female crop cultivation; the age bracket 54% () 37-54 has horizon and most productive age-brackets in agriculture capable of venturing and taking risks; 61(22.4) attained primary but work hard to provide for the family; 211(336.8) are married and work hard to provide for their families while 191(63.2) are married but cannot access enough food for their families. Majority 210 have 4 members in their households and 65(31%) are able to access enough food while 145(69%) are unable to access enough for their households. Accessibility to land is another importance production factor and those with at least 1-3 acres had a better acess to food and were the majority at n= 330, and these 115(34.8%) had access and food availability while 215(65.2%) had acess to land but had less food availability probably due to other production factors. The crops mostly grown were bananas, beans and millet, 41.0% (n = 142). This is because bananas are perennial and can a stable source of food under normal circumstances whiles beans and millet are annuals and can provide food in a short time and also can easily be grown with less labour

These parameters are important because the form part of the production factors necessary to production and gathering of food for the households.

Table 5: Association between demographic characteristics and food availability in households in Bukiro Sub County.

Characteristics		Food availability (N = 346)		p-value
		Yes (n = 119)	No (n = 227)	
Gender	Male	111(87.4)	16(12.6)	<0.001
	Female	8(3.7)	211(96.3)	
Age	18-36	61(25.8)	175(74.2)	<0.001
	37-54	54(52.9)	48(47.1)	
	≥55	4(50.0)	4(50.0)	
Education	Never went to school	4(100.0)	0(0.0)	<0.001
	Primary	61(22.4)	211(77.6)	
	Secondary	54(81.8)	12(18.2)	
	Tertiary	0(0.0)	4(100.0)	
Marital status	Married	111(36.8)	191(63.2)	<0.001
	Divorced	4(10.0)	36(90.0)	
	Divorced	4(100.0)	0(0.0)	

other occupation	Farming	115(38.1)	187(61.9)	<0.001
	Business	4(9.1)	40(90.9)	
Size of land	<1	4(100.0)	0(0.0)	0.003
	1-3	115(34.8)	215(65.2)	
	4-8	0(0.0)	8(100.0)	
	≥9	0(0.0)	4(100.0)	
Crops grown	2 crops - beans & millet	4(2.8)	138(97.2)	<0.001
	3 crops -maize, beans, gnats	4(100.0)	0(0.0)	
	4 crops-Bananas& Maize & Beans &gnuts	54(93.1)	4(6.9)	
	4 crops -Bananas & Millet & beans &&gnuts	57(100.0)	0(0.0)	
	All	0(0.00)	85(100.0)	

Source: Field data 2022

Effects of Weather Changing Patterns on Food Accessibility among Households in Bukiro Sub County

Objective one of the study aimed at assessing the effects of weather changing patterns on food accessibility among households in Bukiro Sub County. Results are presented in tale 6 below.

Table 6: Association between Weather changing Patterns and Food Accessibility

Weather patterns		Food accessibility		p-value
		Yes (N = 189)	No(N = 157)	
Prolonged dry spell	No	128(44.9)	157(55.1)	<0.001
	Yes	61(100.0)	0(0.0)	
Heavy and stormy rains	No	189(70.3)	80(29.7)	<0.001
	Yes	0(0.0)	77(100.0)	
Late onset of rains	No	4(4.9)	77(95.1)	<0.001
	Yes	185(69.8)	80(30.2)	

From Table 7, food accessibility was significantly influenced by all the weather change patterns (p<0.01).Of those who answered to prolonged dry spells as a weather changing variable 44.9(128) indicated they were not affected by prolonged dry spell and had access to food while .65.5 %(n=175) were not affected and yet did not have enough food for their households meaning other factors of production could have been the cause of food insecurity, and all who indicated being affected by dry spells 100%(n=61) still had enough food for their families; For the households that answered to heavy and stormy rains, those who indicated having been affected by heavy and stormy rains n = 77(100%); and of those who indicated not having been affected by heavy and stormy rains 70.3% (n= 189) also had enough food while 29.7% (=80) were food insecure probably due to other factors. Additionally, all the households that experienced late onset of rains indicated food accessibility at 69.8% (n = 185) and food insecurity at 31.2% (=80). All in all, the households food security was significantly influenced by all-weather changing patterns (p<0.001).

Information from key informant interviews concurred. One study participant said:

Food accessibility is heavily and negatively affected by weather changing 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 slops are washed away down the valleys. The crops in wetlands are flooded and rotten and all in all harvests become very poor, affecting negatively food availability and accessibility (Sub county Agriculture Officer).

Effects of weather changing patterns on food stability among households in Bukiro Sub County

Objective 2 of the study aimed at assessing the effects of weather changing patterns on food stability among households in Bukiro Sub County.

Based on results in table 7 below, Food stability was significantly influenced by all the weather change patterns (p<0.01). Of those who answered to prolonged dry spells as a weather changing variable 75.4(215) were not affected by prolonged dry spell and had food stability in their homes while 24.6%(n=70) were not affected and yet did not have stable food supply

for their households meaning other factors of production could have been the cause of food instability, and all who indicated being affected by dry spells 100%(n=61) still had food supply stable for their families; those who indicated having been affected by heavy and stormy rains n = 77(100%) still had stale food supplies; and of those who indicated not having been affected by heavy and stormy rains 74% (n= 199) also had stable food supply while 26% (=70) had food instability probably due to other production factors. Additionally, of the households that affected by late onset of rains 73.6% (n=195) indicated food stability while26.48% (n = 70) had un stable food supplies. All in all, the households food stability was significantly influenced by all-weather changing patterns (p<0.001).

Table 7: Association between Weather Changing Patterns and Food Stability

Weather patterns		Food stability		p-value
		Yes (n =276)	No (n =70)	
Prolonged dry spell	No	215(75.4)	70(24.6)	<0.001
	Yes	61(100.0)	0(0.0)	
Heavy and stormy rains	No	199(74.0)	70(26.0)	<0.001
	Yes	77(100.0)	0(0.0)	
Late onset of rains	No	81(100.0)	0(0.0)	<0.001
	Yes	195(73.6)	70(26.4)	

Source: Field data, 2022

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 (Sub county Agricultural officer)

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 dry heavy rains or drying of crops by long dry seasons even outside Bukiro. The foods that come into our markets form outside reduces in quantities linking prices or even some households fail to set food completely due to reduce income market demand is high while supply become low (S/C Chief).

Effects of Weather Changing Patterns on Food Utilization among Households in Bukiro Sub County

Objective 3 of the study aimed at assessing the effects of weather changing patterns on food utilization among households in Bukiro Sub County. Results are presented in table 8 below.

Table 8: Association between Weather Changing Patterns on Food Utilization

		Food utilization		**p-value**
		No	**Yes**	
Prolonged dry spell	No	128(44.9)	157(55.1)	<0.001
	Yes	61(100.0)	0(0.0)	
Heavy and stormy rains	No	189(70.3)	80(29.7)	<0.001
	Yes	0(0.0)	77(100.0)	
Late onset of rains	No	4(4.9)	77(95.1)	<0.001
	Yes	185(69.8)	80(30.2)	

Source: Primary data, 2022

Results in Table 8 show that of the 346 smallholder farmers recruited in the study, food utilization was significantly influenced by all the weather change patterns (p<0.05). Specifically, all the households that experienced prolonged dry spell, 100% (n = 61) experienced no food utilization (p<0.001). However, all the households that experienced floods utilized food, 100% (n = 77).

Information from interviews concurred. One study respondent said:

"The utilization of food is negatively affected too people eat poor quality of foods, some eat partially with poor quality seeds due to poor harvest handling and end up suffering from stomach problems. Others eat few meals which are not enough for their bodies. So, food utilization is generally bad in bad weather conditions" (District Agriculture Officer).

Mitigation Measures for the Effects of Changing Weather Patterns on Food Availability

The final objective of the study was to determine the mitigation measures for the effects of changing weather patterns on food availability. Results are presented in table 10.

Table 9: Mitigation measures for the effects of changing weather patterns on food availability

Weather patterns	Coping and adaptation strategies	Frequency (Percent)
Prolonged dry spell	Irrigation	4 (1.2)
	Grow drought resistant crops	265 (76.6)
	Mulching	265 (76.6)
	Manuring	203 (58.7)
Heavy and stormy rains	Drainage channel/trenches	269 (77.7)
	Grow crops on higher grounds	201 (58.1)
Late onset of rains	Irrigation	4 (1.2)
	Drought resistant crops	265 (76.6)
	Manuring	203 (58.7)

Source: Field data, 2022

Respondents were asked to propose mitigation strategies challenges posed by weather variability; 77.7% ((n=269) proposed that drainage channels be constructed to address heavy and stormy rains effects; and 76.6% (n=265) for three strategies; growing drought resistant crops and mulching to counter effects of prolonged dry spell; and still drought resistant crops to address the late onset of rain effects on crop production.

Mainly farming takes place in these ecosystems. People dig garden there like for sweet potatoes. Other graze cows in those wetlands especially during dry season there's also brick laying there for the swamp of Nyakambu, but within swamp people cut grass for mulching banana plantations. Some people have drained parts of this swamps for both animals grazing especially cows and for crops production said Sub county Chief,

In regard to floods, the majority suggested drainage channel, 77.7% (n = 269). However, few suggested irrigation, 1.2% (n = 4). Others suggested growing crops on higher grounds, 58.1% (n = 201).

On the contrary, a participant indicated negative effects of drainage channels. "Grazing in ecosystem leads to their destruction. Some farmers dry wetlands by digging channels that take away water and dries the areas. This brings drier seasons and short periods of rain" said the sub county chief.

The District Agriculture Officer informed the research that "That one is very high. They have over cultivation the mountain bases, slopes and the top. They have cut down all the tress, the mountains are above and when it rains heavily all the soils and crops are washed away into the lower land. They have drained wetlands at a very high rate. Sincerely it is extremely too much."

In regard to late onset of rains, the majority suggested growing drought resistant crops or mulching, 76.6% (n = 265). However, few suggested irrigation, 1.2% (n = 4).

Discussion, Conclusions and Recommendations

Discussion of Findings

Effects of weather changing patterns on food accessibility among households in Bukiro Sub County

The study revealed that changing weather patterns had significant effect on food accessibility among small holder farmers' households in Bukiro Sub County. Most farmers accessed food despite prolonged weather variability in form of prolonged drought. The smallholder farmers adopted strategy of growing drought resistant crops in valleys where water table is still high in dry seasons and able to sustain crops.

The study further revealed that heavy and stormy rains (floods) had a significant association with food accessibility among households in Bukiro Sub County as the floods destroyed food crops, limited people from harvesting and block peoples' access to markets to buy food, which limits food accessibility and increasing food prices, and this agrees with (OPM 2011) [47] which highlighted that as a result of weather changing patterns, Uganda faced higher-than-normal prices of basic food products. These higher prices were caused directly by the scarcity brought about by domestic food production losses as well as indirectly by speculation from traders in view of the drought affecting neighbouring countries.

Effects of weather changing patterns on food stability among households in Bukiro Sub County

The study revealed that changing weather patterns had significant effect on food stability in small holder farmers' households in Bukiro Sub County. Specifically, households that experienced late onset of rains 195 (73.6%) experienced food instability, and this is because late onset of rainfall delays planting and maturing of crops and this can have negative effects if there is early cessation of rainfall. This causes food shortage and therefore limitation in food availability and accessibility. In all cases, it negatively affects food price since there will be high demand for limited food in the market. This revelation concurs with (OPM 2011) [47] which stated that high variability in weather events affect food production negatively and increases cost of food. Food crops are negatively by weather changing patterns as all are annual in nature, purely rain-fed, and any absence of rains directly translates into either their destruction or reduced production and productivity.

The study also revealed that heavy rains and storms had significant effects on food stability among small holder farmers' households in Bukiro Sub County. The revelation of the effect of heavy rains and storms on crop production was noticed significantly given that the farms were flooded. The storm shredded crop leaves, broke crop flowers and floods made gardens water-logged; and in both conditions crop production was negatively affected causing decline in food production, ultimately increasing food prices. This phenomenon directly affected food stability in terms of quantity and quality. This finding is agrees with IPPC, (2007) who underscored the significance of extreme weather event negative impacts on food stability.

Effects of weather changing patterns on food utilization among households in Bukiro Sub County

The revelation that food utilization was significantly affected by high seasonal variability in Bukiro Sub County caused by late onset of rains show that agricultural calendar was negatively affected in terms of length of the growing season, since early rainfall cessation causes crop failure and food shortage. Ultimately, the smallholder farmers are left with dwindling food reserves and utilize less food for their nutrition need. In families with infants, this situation can lead to malnutrition and stunted growth.

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

For succulent crops like banana that need high amounts of water, most farmers mulched their crops to avoid loss of moisture from soil. For legumes, the smallholders applied animal manure. These strategies are important as water and soil conservation strategies and sustain water and nutrients in soil thus enhancing crop production.

The revelation on growing of drought resistant crops is in agreement with Traerup and Mertz (2011) [71] and Tambo et al. (2013) [72] 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.

To curb the effects of heavy and stormy rains, smallholder farmers in Bukiro (77.7%) dig drainage channels on steep grounds to reduce on soil erosion, wash away of crops and in low lands to reduce on the water stagnation in crop gardens.

Conclusions

1. Weather changing patterns variables of Late onset of rains, heavy and stormy rains have significant negative effect on food availability, accessibility and stability among households in Bukiro Sub County because they disrupt planting preparations, wash way crops, destroy gardens, desiccate/dry crops causing poor pod formation and filling resulting into poor crop productivity increases household food insecurity.

2. Weather changing patterns (late onset of rains, prolonged dry spells), heavy and stormy rains significantly effect on food utilization due crop failure and food shortage. Ultimately, the smallholder farmers are left with dwindling food reserves and utilize less food for their nutrition need. In families with infants, this situation leads to malnutrition and stunted growth.

3. Different mitigation measures to counter effects of changing weather patterns on food availability have been adopted depending on the different weather patterns; but mulching, maturing and growing drought resistant crops, mixed cropping, timely planting, and digging of trenches to combat effects of heavy and stormy rains are the main mitigation measures adopted to counter the effects of weather changing patterns

Recommendations

1. Smallholder farmers in Bukiro Sub County need to adapt and to become more observant for signs or indicators of possible changes in weather conditions and plan wisely since weather is continuously changing unexpectedly. Indicators such as climate conditions (warm or cold) need to be keenly observed alongside weather reports from Ministry of Water and Environment so as to make key decisions such as early or delayed planting in order to improve food production and availability.

2. There is need for effective capacity building by government and other stakeholders to strengthen the most vulnerable groups who are usually the smallholder farmers in agricultural production with requisite knowledge and information necessary for mitigating the effects of weather changing patterns such as embracing climate smart agriculture practices, Ecological land use practices, appropriate farming systems, and proper post-harvest handling technologies

3. 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.

4. 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 weather changing patterns while improving on food production and security..

Areas for Further Study

• Longitudinal study could be done on effects of weather changing patterns on food security on the same area of this study.

• 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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