# CONTRIBUTION OF CLIMATE SMART AGRICULTURE PRACTICES TO HOUSEHOLD FOOD AVAILABILITY: A CASE OF BIDIBIDI SETTLEMENT ZONE1 AND HOST COMMUNITY IN ROMOGI SUBCOUNTY, YUMBE DISTRICT

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## DECLARATION

I, **Turyayesiima Nathan** hereby declare that this is my original work, is not plagiarized and has not been submitted to any other institution for any award.

Name_Turyayesiima Nathan__________________Signature_______________Date_13/9/2024_

## SUPERVISOR APPROVAL

This is to certify that this research titled "Contribution of climate smart agriculture practices to household food availability: A case of Bidibidi settlement (Zone1) and host community in Romogi subcounty, Yumbe district" has been done under my supervision and is now ready for submission.

Name: DR. ROSEMARY BULYABA______ Signature of the supervisor___

## DEDICATION

This research is dedicated to my family members whom I did not given enough time while undertaking this research. These are my wife Celia Twikirize, my children Turihihi Asiimwe Daniel, Kenkindi Aijuka Hannah, Kemigisha Siima Abigail, and Kworekwa Kwesiima.

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This is to acknowledge the guidance of Dr. Rosemary Bulyaba, my academic supervisor who gave me guidance during the entire study and report writing. I also acknowledge the patience she exhibited as I went through the learning process of some of the research concepts.

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## LIST OF ABBREVIATIONS

CARE- Cooperation for Assistance and Relief Everywhere

CSA- Climate Smart Agriculture

DDP- District Development Plan

DFID-Department of International Development

FCS-Food Consumption Scores

FFS- Farmer Field Schools

FANTA- Food and Nutrition Technical Assistance

FAO- Food and Agriculture Organization

FSN-Food Security and Nutrition Assessment

MAAIF-Ministry of Agriculture Animal Industry and Fisheries

NASA-National Aeronautics and Space Administration

NGO-Non-Governmental Organization

OPM-Office of the Prime Minister

PSA-Philippines State Authority

REC-Research Ethics Committee

SGD-Sustainable Development Goals

UBOS-Uganda Bureau of Statistics

UN- United Nations

UNFCCC- United Nations Convention on Climate Change

UNHCR-United Nations High Commission for Refugees

WFP-World Food Program

# ABSTRACT

This study was set up to investigate the contribution of climate smart agriculture practices to household food availability in Bidibidi settlement, Yumbe district. Following a threat to the environment due to tremendous pressure on the land by nationals in order to extend agricultural activities and South Sudanese refugees in search of settlement, the government of Uganda and NGOs accelerated promotion of climate smart agriculture practices in 2018. However, the impact of these practices on household food availability had not been studied and documented. The study was conducted in Bidibidi settlement-zone1 and Yumbe district host communities and targeted 375 farming households. Data on Climate Smart Agriculture (CSA) practices commonly practiced, drivers that influence farmers to apply these CSA practices as well as Food Consumption Scores (FCS) and frequencies of CSA practices application were collected. Data was analyzed using SPSS. Descriptive statistics were used for CSA practices while CSA uptake drivers and the relationship between CSA practices and household food availability were analyzed using binary logistic regression. The study results indicated that 94.9%, 82.4% and 79.2% of farmers grew climate adapted crop varieties, managed planting dates and did kitchen gardening, respectively. Household income, land ownership, group membership, access to irrigation water, household head/leadership, level of education and access to extension services were some of the significant factors that influence uptake of CSA practices.

. Agroforestry technologies, irrigation and kitchen gardening were found to significantly contribute to household food availability. Efforts to ensure that farmers attain land,

access extension and have access to irrigation and agroforestry technologies/inputs should be promoted to match these findings.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Study introduction

Climate change refers to a long-term shift in weather patterns, and these changes may be natural, for example, change in solar cycle or human-kind activity influenced. It is documented that human activities have been the main cause of climate change since 1800s (FAO, 2013). The negative effects of climate change impact everyone. These effects include, reduced access to water which increases the labor burden to females since they are largely responsible for collecting water in their households, reduced food production which threatens food availability, and water borne diseases which arise as a result of climate change especially floods (Agostino, 2010). To address these challenges as was documented by Agostino (2010), the United Nations Convention on Climate Change (UNFCCC) convened in 2008 to devise means of reducing greenhouse gas emissions since these are the primary causes of climate change from human activities such as large-scale cattle operations, open cultivation and deforestation. Promoting adaptation and mitigation measures as well as promotion of environmentally friendly development were key interventions debated in that convention as well.

This study looks deep into the relationship between practices of climate smart interventions on household food availability as a counter measure to human activities that bring about climate change. These are mitigation and adaptation measures to the climate change global challenge (Agostino, 2010). These are brought into Ugandan local perspective in this study conducted in Yumbe district, Uganda. The main objective of this study was to understand the relationship between climate smart agriculture practices and household food availability.

### 1.2 Overview of Climate Smart Agriculture

Climate Smart Agriculture (CSA) is a farming approach that sustainably increases productivity, resilience (adaptation) or reduces and removes greenhouse gases (mitigation) (FAO, 2013). It enhances achievement of national food security and development goals (FAO, 2015). CSA has three pillars of productivity, adaptation and mitigation. The CSA practices contribute directly towards attainment of Sustainable Development Goals (SDGs). The specific SDGs to which CSA contributes are SDG 1) no poverty, 2) zero hunger, and 13) climate action (FAO, 2015). Climate action, poverty and hunger being global concerns, solutions need to be developed at local, national, regional, and global scale for these challenges to be addressed.

According to the Skoet & Lipper (2016) report on the State of Food and Agriculture, without action, agriculture would continue to be a major contributor to global greenhouse gas emissions. By adopting climate-smart practices and increasing the capacity of soils and forests to sequester carbon, emissions could be reduced by 10-15% (Buis, 2019) while stepping up food production to feed the world's growing population (Tian et al., 2016a). The FAO report further alluded that adoption of climate-smart practices, such as the use of nitrogen-efficient and heat-tolerant crop varieties, zero-tillage and integrated soil fertility management would boost productivity and farmers' incomes. Widespread uptake and application of nitrogen-efficient farming methods alone would see the number of people at risk of undernourishment reducing by over 100 million by 2030 (FAO, 2016).

Newell et al. (2019), noted that achieving “climate smart” agriculture in ways, which align with other SDGs was a complex challenge. Newell et al. (2019) further added that, for Africa to reap the potential benefits of CSA, concrete actions must be taken. These actions would enhance the evidence base to underpin strategic choices, promote and facilitate wider adoption by farmers of appropriate technologies (Williams et al., 2015*)*. The same actions develop institutional arrangements to support, apply and scale-out CSA from the farm level to the agricultural landscape level; manage tradeoffs in perspectives of farmers and policymakers and strengthen technical, analytical and implementation capacities. In addition, ensuring that policy frameworks and public investments were supportive of CSA; develop and implement effective risk-sharing schemes (Williams et al., 2015). It should be noted that CSA is not a “one-size fits all” as it is context specific and requires clear assessment of specific needs of a particular geographic location (Chandra et al., 2018).

### 1.3. The Refugees influx in Uganda

Uganda is one of the top refugee-hosting countries in the world, with a protracted refugee situation and on-going influxes of refugees from neighboring countries. The country hosted 1,500,000 refugees as of October 2021. These were from South Sudan and the rest from Democratic Republic of Congo, Burundi and Somalia (UNHCR, 2021a). About 95% of these refugees live in settlements located in the West Nile and South-west regions of the country (UNHCR, 2021a). Initially, at the peak of the refugee population in Bidibidi, Yumbe district, there were many NGOs that provided assistance to both the refugee and the host community population. However, due to reduction in funding, several NGOs reduced their presence from over 25 to 11 active NGOs in livelihoods agriculture and food security in Bidibidi settlement (UNHCR, 2021b), and Uganda at large. The departure of NGOs therefore led to an increase in the economic and food security vulnerabilities. For example, WFP reduced the monthly food ration for refugees across Uganda to 60% (UNHCR, 2021a). In a quest for food, firewood and income from their environment, refugees in Ugandan refugee settlements resorted to tree cutting and over cultivation of the same pieces of land which is a threat to climate change (Ahimbisibwe, 2018; Amanda & Thereza, 2019). The effect of these negative coping mechanisms of tree cutting and poor farming methods on food availability need to be determined in order to establish and promote corrective measures.

### 1.4 Statement of the problem

Climate change stands as one of the main obstacles to achieving universal food security, and if not managed, climate change will severely exacerbate global malnutrition and food insecurity (Haque, et al., 2017). With this threat at hand, and in an effort to achieve SDGs, African countries agreed on a joint program to promote CSA oriented projects for the environment to continue producing resources, including food sustainably for generations to come (Williams et al.,2015). This is however yet to yield results for Africa. According to the state of the world's forests report by FAO released in 2020, much as global forest cover has stagnated around 30% to 31% for the last 10 years (2010-2020), more than half of these forests are in five countries of Brazil, Canada, China, Russian Federation and United States of America and not Africa. In Africa, the same period has instead seen forest cover reduced. In Uganda for instance in the same period (2010-2020), tree cover reduced from 15.6% to 11.7% (FAO, 2020). This could be attributed to a number of human accelerated activities including but not limited to refugee influx in the country, expansion of agricultural land and charcoal burning.

Regarding refugee influx, Uganda hosts Bibibidi settlement, the second largest refugee settlement in the world after Kutupalong refugee camp in Bangladesh. Yumbe district, where Bidibidi settlement, was faced with South Sudanese refugee influx in 2016 that increased demand for both settlement and agriculture land (UNHCR, 2016). This exacerbated the threat of environmental degradation and climate change. This influx and other human activities would be the cause for the observed increased unpredictable weather patterns. To mitigate this challenge, humanitarian organizations and government extension teams came in to train refugees and host communities on sustainable and climate smart agriculture. The main climate smart agriculture practices promoted in the district include promotion of climate adapted crop varieties, irrigation technologies, relay/kitchen gardening, intercropping, soil and water conservation practices, and agro forestry (Eriksen et al., 2019).

Despite the importance of these practices, there are limited studies that have investigated the practices in the Ugandan context to determine how individual CSA practices impact farm household food availability. Additionally, no study has been conducted in Yumbe or any other refugee-hosting districts to analyze the impact of the existing CSA practices on reversing the negative effects of refugee's influx on the environment, food production and availability. This study was therefore set to investigate the impact of CSA practices on household food availability in Yumbe district.

### 1.5 Objectives of the study

The general objective of the study was to determine the contribution of climate smart agriculture practices on household food availability in Yumbe District.

The specific objectives were:

i) To assess the climate smart agriculture practices that farmers currently apply in Bidibidi refugee settlement and host community of Romogi sub county, Yumbe district.
ii) To evaluate climate smart agriculture practices uptake drivers in Bidibidi refugee settlement and host community of Romogi sub county, Yumbe district..
iii) To determine the relationship between climate smart agriculture practices and household food availability in Bidibidi refugee settlement and host community of Romogi sub county, Yumbe district.

### 1.6 Research questions

The following research questions were used to guide the study:

i) What are the common CSA practices that farmers in Bidibidi settlement and host community apply.

ii) What are the factors that influence uptake of different CSA practices in Bidibidi settlement and host community.

iii) Which CSA practices contribute significantly to household food availability in Bidibidi settlement and host community.

**1.7 Scope and limitations of the study**

The study was conducted in Bidibidi refugee settlement and the host communities of Romogi Sub County of Yumbe district. Given that climate smart agriculture is context specific, this study specifically dealt with the context of long drought seasons experienced in Yumbe that extend from November to March of every year (Yumbe DDP, 2020) and, the reducing tree cover as hastened by refugee's influx (UNHCR, 2016). The study also focused on the food availability component of food security such as access to land, crop and animal production, food stock as well as household income and expenditure/debt (FSN, 2016; PSA, 2020).

The study also focused on CSA practices that influence performance of field crops, fruits as well as vegetables. These were prioritized because they make a big component of daily foods consumed by households in Bidibidi settlement, Yumber district.

The research study was however limited in scope to only Bidibidi refugee settlement, and surrounding host community in Romogi sub-county, Yumbe district. The study was limited to only climate smart agriculture practices, leaving out the other components of CSA such as policy frameworks and value chain financing. The study did not also consider other factors that influence household food availability. This study would therefore not be able to make generalized inferences on climate smart agriculture as it relates to food security in totality. Important to note also, other factors other than climate change have recently affected household food availability and access as reported in the Global Assessment of the Impact of Covid-19 (Salami et al., 2021).

### 1.8 Significance of the study

Findings of this study will inform government policy formulation in areas of climate action in refugee hosting districts. It will generally contribute to a pool of data to inform climate action policies(Espinoza & Aronczyk, 2021). The findings will also direct focus of development as well as humanitarian/refugee program implementing partners on priority areas to channel funding and implement climate action and climate smart agriculture interventions in a quest to increasing food availability. District local governments and implementing partners might use the findings to know the CSA adoption drivers and use the knowledge to hasten adoption to ensure sustainable farm productivity and household food availability in Yumbe district and Uganda at large.

This study was set to evaluate the adoption of CSA practices and their impact on household food availability in Yumbe district. The study area was selected given that Zone1 (in Romogi sub county) of Bidibidi Refuge settlement was the first to receive refugees from South Sudan in 2016 and suffered environmental degradation (Bako et al., 2021). Trees in Bidibidi were cut down to create space for shelters. Furthermore, refugees cut trees for fuel and cleared land for agricultural purposes (Amanda & Thereza, 2019). This exacerbated the already growing challenge that was being posed by national locals opening more land for agriculture. The study fills the knowledge gap that existed in the areas of climate smart adoption drivers and the relationship between climate smart agriculture and household food availability in Yumbe district for sustainability (Espinoza & Aronczyk, 2021).

### 1.9 Conceptual framework

The conceptual framework in figure 1 depicts the diagrammatic relationship between the variables of the study. The framework highlights the CSA practices as will be assessed in objective one, the drivers/factors for CSA uptake as were documented by other studies in other locations(Wekesa et al.,2018; Fausal et al.,2021; Jamil et al.,2021); objective two. On the other hand, the framework highlights the dependent variable as the effect of practicing climate smart agriculture conceptualized as increased farm household food availability. Further, the research considered government policies and enabling environment, that is, good governance, peace and security and appropriate government policies to be the moderating variables that influence the relationship between the main study variables.

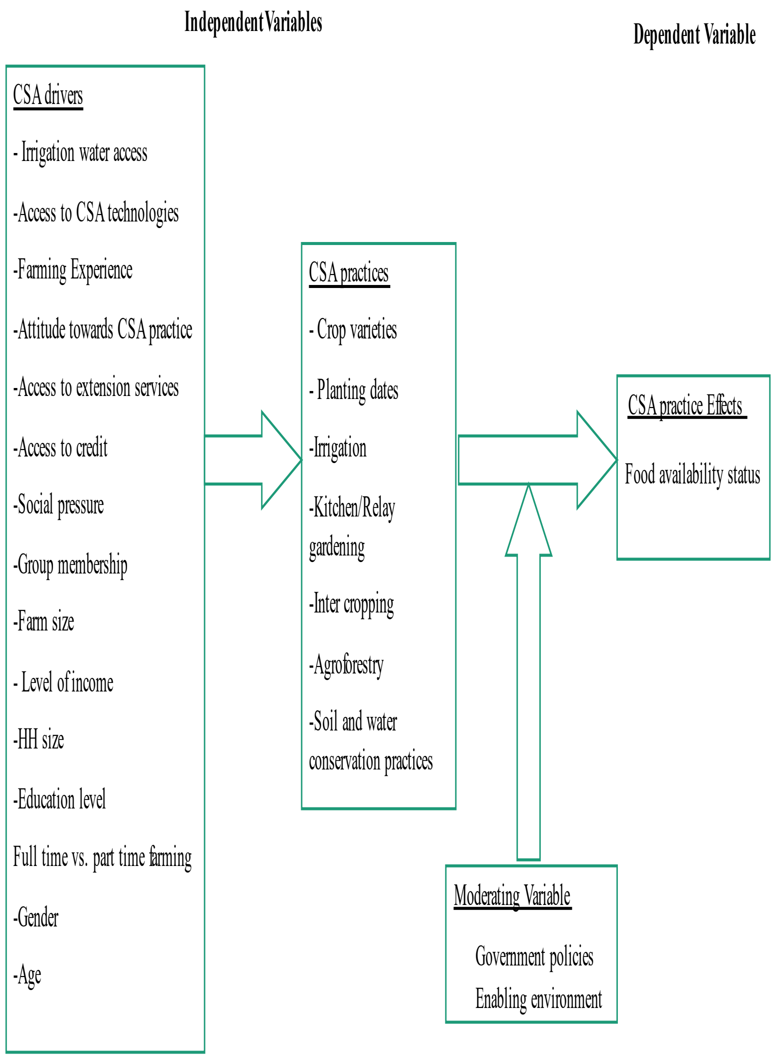


*Figure 1.1: Conceptual framework showing the relationship between study variables*

# CHAPTER TWO

## LITERATURE REVIEW

This section reviews literature related to climate change, the concept of climate smart agriculture and food security/availability. The section is more particular on literature related to the three study objectives that is, climate smart agriculture practices, and drivers and the relationship between climate smart agriculture and food availability.

### 2.1 Climate smart agriculture, climate change and food availability

Food availability is determined by use of a food balance sheet. The food balance sheet tool makes use of data for household food production, household food stocks, traded food as well as the population to determine food availability in a given community (PSA, 2020). Specific to refugee settlements, in addition to food aid, food availability is dependent on access to land, how much food is produced from crop and livestock production, household income as well as household expenditure or debt (FSNA,2016). For this reason, climate smart practices that sustainably utilizes the land to ensure food production for the current and next generations would be of interest to refugee communities.

According to Palombi and Sessa (2013), climate-smart agriculture is an approach for developing actions needed to transform and reorient agricultural systems to effectively support development and ensure food security under climate change. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible. The CSA concept is not a prescribed practice or a specific technology that can be universally applied. An approach requires site-specific assessments of the social, economic and environmental conditions to identify appropriate agricultural production technologies and practices (Williams, et al., 2015; Chandra et al.,2018).

This new concept of CSA has become an important phenomenon following the reality that climate has changed for the worse. For example, average temperatures have increased decade after decade and the increase seems to be at an increasing rate since the 1950s (World Economic Forum, 2021). Global temperatures have risen by averagely 0.8$^{o}$C than the 20$^{th}$ century average since the 1950s and the bigger increase is noticeable since 1970s to date (Lynch, 2011). It is believed that there is a direct relationship between global warming and catastrophic weather events such as flooding (World Economic Forum, 2021). According to Amanda & Thereza (2019) during an environmental scoping mission in Bidibidi settlement, Yumbe, community members attributed, in focus group discussions that the changing climate is responsible to unpredictable rainfall patterns and shorter rains than before. With this rising temperature, drought, unpredictable rains and floods, the world now has to deal with the effects they come along with since reversing the increase is far from reach. For example, it is predicted that a mere increase by 2$^{o}$C would lead to a reduction in water availability in some African areas by 20%-30%, a reduction of crop yield by 10% and up to 10 million people would be exposed to flooding (Brahic, 2007). All these ultimately affect food availability. A case in a point, according to the world bank report of 2011, Sub-Saharan Africa faces the challenge of low household food availability and poverty associated to changing climatic conditions.

The African governments are therefore in a dilemma of increasing greenhouse gas emissions due to increased agriculture activities in pursuit of increased food production to feed their people (World Bank, 2011). It is reported that, agriculture sector ranks number two (after energy sector at 73.2%) in in impacting climate change by emitting 18.3% of the greenhouse gases annually (Ritchie, 2020). To come to terms with these predictions of changing climate effects, the world has to devise means for producing food for its ever-increasing population predicted to hit 9.1 billion by the year 2050 (World Bank, 2011).

In Uganda, climate change is equally evident as seen in continuous irregularities in rainfall patterns with flooding in some locations and extended dry seasons in others, as well as increasing temperatures that have led to a reduced snow cap on top of Mt. Rwenzori. As climate varies, the country becomes even more susceptible to floods and drought events which affect social economic wellbeing of the population (Nepworth, 2008). The same Nepworth(2008) scope mission report further indicated that human induced climate change will possibly raise average temperatures in Uganda by 1.5ºC in the next two decades and possibly by 4.3ºC by the 2080. Regardless of changes in rainfall, changes in temperature are likely to have significant implications on water resources, food security, natural resource management, human health, settlements and infrastructure. In Uganda, like the rest of the world, there are likely to be changes in the frequency or severity of extreme climate events, such as heat waves, droughts, floods and storms (Nepworth, 2008).

Similar to majority of Ugandan smallholders who depend on agriculture for a livelihood (Mwesigye, 2006), agriculture is a major source of livelihoods for Bidibidi settlement refugees. Therefore, building their capacity to adapt to changing climate and become resilient to climate change is vital for sustainable livelihoods and food security. The ability to cope with the impacts of weather shocks and natural disasters brought by the effects of climate change depends largely on the household's resilience, or its capacity to absorb the impact of, and recover from, a shock, and one of the sure ways is by practicing CSA (Rainforest Alliance, 2016). Given reduced food rations by world food program, the refugee community in Uganda is left with no option but to largely attempt agricultural production to meet food needs . However, with the climate change threats highlighted by Nepworth, 2008 refugees just like the host communities in Uganda ought to have increased capacity to adapt to these climatic changes as recommended by Mwesgye, 2006.

### 2.2. Climate smart agriculture practices defined

Climate smart agriculture practices are diverse and different depending on the context. According to Barnard, et al.(2015), agro-forestry, crop rotation, intercropping, minimum tillage, soil cover maintenance, residue retention, water conservation, improved management of livestock and soil carbon as well as breeding plants and animals adapted for climate conditions, comprise climate smart agriculture practices. Jamil et al. (2021) in the study about climate smart agriculture adoption in Punjab Pakistan, extended the list of CSA practices to include irrigation, fertilizer reduction, soil and water conservation practices, zero tillage as suitable climate smart practices.

Wekesa et al. (2018) in the study of the effect of climate smart agriculture on food security in Kenya summarized CSA practices into four themes. The four themes were crop management practices such as use of improved crop varieties, use of legumes in crop rotation, use of cover crops, changing planting dates and efficient use of inorganic fertilizers, general field management practices such as use of terraces, planting trees and use of live barriers. The third theme was farm risk reduction practices like diversified crop and animal breeds, and irrigation, and the last theme was soil conservation practices like use of organic fertilizers, planting food crops on tree land and use of mulching.

In Uganda according to CARE international (2021) report on Scaling up Climate Smart Agriculture in Uganda, a wide range of climate smart agriculture practices were being promoted by different agencies. These practices included crop rotation, mixed cropping, soil and water conservation practices, agro forestry, promotion of energy saving stoves to reduce pressure on forests, promotion of biogas a source of cooking energy, promotion of specific climate suitable crop and animal varieties/ breeds, micro/mini-irrigation, and back yard gardening. Zizinga, et al.(2022) in the study on CSA practices essential for maize productivity in Uganda, they found that application mulching and planting basins both of which are soil and water conservation practices were most significant in increasing maize yields. Other CSA practices according to Eriksen, et al.(2019) that are commonly practiced in Uganda include planting climate adapted crop varieties, irrigation technologies, intercropping as well as agroforestry practices.

### 2.3. Factors for adoption of climate smart practices

Research shows that several factors including cultural, political, infrastructural may influence the adoption of climate smart agriculture practices (Wekesa et al.,2018; Fausal et al.,2021; Jamil et al.,2021).

Fausal et al. (2021) studied farmers' adoption of climate smart agriculture practices and concluded that access to climate information, availability of irrigation resources, and other specific CSA technologies were key for farmer uptake and adoption of CSA practices. Additionally, to factors above, Jamil et al. (2021) in their study, added farmers' attitude about the technologies and education level. More factors as studied by Wekesa et al. (2018) in Kenya included age of the farmer, gender, years of education of the household head, farm size, and perception on soil fertility. The researchers found past experience with extreme weather like floods, hailstorms or extended drought to be an important factor in adoption of climate smart agriculture practices. Additionally, farming experience, distance to input source/shop, membership to groups, access to extension services and access to credit influenced practice of one or more CSA practices (Jamil et al., 2021; Wekesa et al., 2018). Other significant factors according to Jamil et al. (2021) were access to irrigation water, and access to extension services while Fausal et al. (2021) concluded that education, social pressure and land holding as being key drivers in adoption of climate smart agriculture practices. These were found to influence uptake of CSA practices and therefore impact household harvests and food availability.

Barnard, et al.(2015) seemed to summarize all above factors into two categories. That is, physical factors or the means required to practice climate smart agriculture, and nonphysical or software factors. The physical factors include physical inputs such as land, human resources, equipment, and finances. Non-physical factors are related to institutional, cultural, policy and regulatory environments, information, knowledge, skills, technology and innovation. Knowledge of these factors and the categories they fall therefore help researchers to draw appropriate recommendations based on which factor come out to be significant in specific contexts.

A recent study by Kifle et al., 2022 in Ethipia found that farmers are influenced by family size, farming system, on farm income as well as off farm income for them to adopt soil conservation practices while on farm and off farm income sources were found to influence adoption of soil fertility management. On the other hand, adoption of micro irrigation was reported to depend on access to irrigation inputs, farm size as well as the distance from the market. Access to extension services and access to credit were also reported for the practice of agroforestry and crop diversification. Sanogo, et al.(2023) also reported marital status, education level, group membership, farming experience, gender to influence adoption of different CSA technologies in Mali. The farming experience, access to mass media and training as well perceived reduction in rainfall were reported by Zakaria, et al.(2020) to be the factors that influenced CSA adoption by rice farmers in Northern Ghana.

In Uganda, factors that influence uptake of different CSA practices are not any different from what is documented from elsewhere in the world. For example, Nakabugo, et al.(2018) while studying the factors for adoption of CSA practices in Nakasongola district of Uganda, they identified age of the household head, land size, land ownership, household size as well as access to improved crop varieties as the most significant factors responsible for adoption of CSA practices.

As for Sserunkuma (2005) in his study on factors for adoption and impact of improved maize varieties in South-Western highlands of Uganda, he identified distance to markets, farm land size, level of education as well as access to extension services as key factors for adoption of different CSA practices. He noted that distance to the market was associated to the practice of crop rotation while farm size was negatively associated to use of manure, and terracing. Level of education for the household head was recorded to be positively associated to practice of soil and water conservation in South-western highlands of Uganda. He also found access to extension services associated to mulching and organic manure application on the farm.

### 2.4. Climate smart agriculture practices and household food availability

Adoption of improved agriculture technologies such as climate smart agriculture technologies is generally known to improve the wellbeing of the adopters. There are some reported relations between CSA practices and whether or not food will be available in a household. For instance, according to Martey et al. (2020), adoption of drought resistant maize in Ghana led to increased yields, expansion of acreage planted, and more food was available to the practicing farming households. The authors stated that planting drought tolerant maize gave increased yield by 150% from 936kg/ha to 2400kg/ha. Katerega & Holden (2021) concurred with this positive attribute of planting climate tolerant varieties in their study in Malawi. They observed 44% maize yield increase from 1254kg/ha to 1803kg/ha when comparing drought tolerant maize to other varieties. Therefore, adopting climate adapted varieties assures households of food availability since they get more yield and according to Martey et al. (2020) the farmers in Ghana were selling only 40% of the harvest leaving the balance for home consumption and other purposes.

Climate smart agriculture practices were documented to generate higher and more stable crop yields and incomes and enhance resilience to climate change in compared to conventional agricultural production methods (Barnard, et al.,2015). The resilience is assured because for example according to Chandalavada et al. (2021) short maturing sorghum was reported to be a major mitigant of hunger in arid and semiarid parts of Africa where rainy seasons are short.

Dapaah et al. (2000) reported that irrigation technologies have a positive impact on food availability. This is because, irrigated crops give better yields than unirrigated crops. The authors in their study in Canterbury New Zealand found that irrigated beans yielded 50% ($337 g/m^2$) more than the unirrigated beans. In Uganda, farmers in Mbarara who practiced back yard gardening and micro irrigation during the dry season that normally extends from late May to early September, were reported to have improved availability of fresh vegetables and fruits in their households, (CARE international, 2021).

Timely planting as a CSA practice was also reported to give better yields and therefore more assurance of food availability compared to very early or late planting in beans (Dapaah et al.,2000). The authors found that planting very early and planting very late were associated to poor leaf and pod development patterns. They noticed that timely planting; early November for this case, gave 26% better pod and leaf development.

The last example of how CSA practices impact household food availability is with agroforestry. According to Kiptot et al. (2013), planting nitrogen fixing (fertilizer) trees on the farm improve soil nutrients which lead to improved yields of other crops planted on the farm like maize by between (20-30%). The same authors also alluded that planting fodder crops like calliandra availed livestock with feeds and this improved milk yield by 0.6-1.3L per cow per day. On the other hand, fruit trees were reported to directly ensure food availability to households in Uganda and Tanzania during seasons when other crops are off season (Kiptot et al.,2013).

### 2.5. Data analysis approaches

Different data analysis methodologies have been used by different scholars depending on the purpose and intent of their studies. Descriptive and inferential are used depending on the nature of both the dependent and independent variables.

Descriptive statistics are used to describe the basis features of data used in a particular study. They provide summaries of the measures as related to the sample but not the population at large. In otherwards, they do not provide inferences about the population based on the sample. The descriptive statistics can be used to measure the frequencies like percent, measure centrality like use of mean, mode, median, and can also measure dispersion, for example by use of variance, standard deviation and quantiles(Mishra, et al., 2019). Much as the descriptive statistics provide information about the sample in terms of how spread it is distributed and which statistics are common, these statistics cannot be used to make conclusions about the population other than the sample (Mishra, et al.; 2019).

On the other hand, regression analytical models are used to investigate the relationships among variables and give the causal-effect relationships. Some of the regression analytical models used in quantitative analysis include multiple regression, path analysis, ordinary least squares, binary logistic regression, logit models. It should be noted that each of these models have their strengths and limitations, and these should be assessed prior to using the models. Model choice is also dependent on purpose of the research, availability and characteristics of the data, time, cost as well as the researcher's ability to properly use develop and interpret the model outputs (Zapotichna, 2021). Linear regression is recommended in situations where a relationship between the dependent and multiple independent variables is under investigation. Multiple linear regression can easily tell the extent to which part of the total variation in the dependent variable is influenced by changes in the independent variables (Verbeek, 2017).

Linear regression presents an easy tool to establish empirical relationships that exist between a dependent variable and a set of independent variables. Secondly, ordinary least squares (OLS) is by far the best linear predictor in a given sample whereby it gives the closest estimation of the actual outcome. It is also known to work well even in the circumstances where the model is not properly specified, it can still help make reliable predictions. On the other hand, linear regression models have some limitations. Interpretation of linear regression models requires making strong assumptions, and linear regression model specification is not always easy due to uncertainty of the rules to use in prescribing appropriate specifications. Linear models like OLS work best when both the dependent and independent variables are numerical variables (Mooi, 2014).

Given the limitations of linear logistic regression models, other regression models like the logistic regression models are chosen depending on the nature of the data and intent of the study. Binary Logistic regression is used to find the probability of an event happening or not happening. It fits data whereby the outcome is dichotomous/binary in nature. And it accommodates both continuous as well as categorical independent variables (Wilson, et al., 2015). Binary logistic model has the ability to retain the good features of linear regression much as it deals with dichotomous outcomes (Stoltzfus, 2011). Given this special ability to analyze dichotomous outcomes while retaining good features of linear regression, this model was chosen for my study.

# CHAPTER THREE

# RESEARCH METHODOLOGY

This chapter covers the methods that were used while conducting this study. It includes the research design, study population, sample size and selection, sampling techniques and data methods.

## 3.1 Research design

A cross sectional household survey method was used for this study. Survey method was best suited for descriptive research; it studies the opinion, behaviors, attributes and feelings of an individual or a group of people. Therefore, to get an accurate profile of households, events and situations, a descriptive survey research was employed.

## 3.2 Description of study area

The study was done in Bidibidi refugee settlement (zone1) and the surrounding communities of Romogi sub county in Yumbe District, which are located in West Nile region of Uganda. Zone1 of Bidibidi settlement was chosen given that it was the first zone to receive South Sudanese refugees in 2016. This caused tremendous negative impact on the region by refugee population in a quest for space for shelter and later clearing forests for firewood and farming. The district borders Southern Sudan in the North, Moyo district in the East, Obongi district and Adjuman districts in the South, and Terego, Maracha and Koboko districts in the West. The district has a population of 669,300 people according to (UBOS, 2020) population projections of which 241290 are refugees in Bidibidi refugee settlement as per office of the prime minister records of same year 2020. The Bidibidi settlement is located at N 3 341.8114, E 31 26 47.688. It is about 15km East of Yumbe town. According to UNHCR (2019), the district covers a land area of 61.012 square kilometers of which 41 square kilometers are arable land while the remaining portion of for household settlement.

The topography of the study area is 850 meters above sea level. The area as well as the entire district is largely flat. Soils are loamy with gravels spotted in isolated parts of the study area of Bidibidi. The area experiences tropical climate with a bimodal rainfall. The first wet season is from March to May with an interlude of a sunny season in June prior to the wettest season that is August to November. The long dry season begins late November until mid or sometimes end of March during which minimal rainfall of 60 mm/month is received. The area receives an average total rainfall of 1,250 mm. Mean monthly evaporation ranges from 130mm-180mm (Yumbe DDP,2020).

**3.3 Study Population and Sample size**

The study population was limited to households in Bibibidi settlement, zone1 and host community in Romogi sub county in Yumbe district. The total population of Romogi sub county where Bidibidi settlement zone1 is 45,576 people and 7,460 households. The study sample size was 375 respondents drawn from these 7,460 households. The sample size was read directly from table for determining sample size for a finite population by Krijcie & Morgan (1970). Sample size was determined using Krejcie & Morgan (1970) formula that is,

$S = X^2NP(1-P)/\ d^2(N-1) + X^2P(1-P)$ where; S = required sample size $X^2$ = the table value of chi-square for one degree of freedom at the desired confidence level N = the population size P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size) d = the degree of accuracy expressed as a proportion (0.05).

To arrive at this sample size a multistage sampling procedure was employed to select respondents. In stage one, Bidibidi settlement-zone1 in Romogi sub-county was purposively selected based on the fact that it was the first settlement to host South Sudanese refugees in 2016 which impacted on the sub county resource availability as well as environment. This exacerbated already worsening environmental conditions by Ugandan residents of the district that had also opened up large areas of land for agriculture following increased population, and high demand for food. This affected the environment of the area and the surroundings. In stage two, two parishes/sub zones were selected, that is, Bidibidi parish that hosts zone1 of Bidibidi settlement and Kiri parish in the host community. In the last stage, simple random sampling was used to select 375 farmer households from the source lists that were obtained from the local village leaders.

With lists of farmer households obtained from local leadership, the fish bowel/lottery technique (Haug, et al., 2006) was employed to obtain the actual households to participate in the study. Each village was considered separately after assigning the proportion of the sample that was going to come from each of the selected villages. This eased in the random sampling by handling each village list separately and performing the fish and bowl using numbers assigned to each household name.

### 3.4 Data collection

The study utilized both primary and secondary data. Primary data was collected using face to face interviews conducted by well-trained enumerators. Secondary data was collected by reviewing other scholarly papers and government publications.

To ascertain data on demographic and social economic characteristics, respondents were asked to respond to basic questions regarding their demographic and socio-economic characteristics. Questions included the respondents' sex, age, household size, number of children, and number of children below 18 and if any of the children is disabled. Other questions were inquiring about the education levels, sources of income, involvement in agriculture, access to land, size of land, land ownership. Some of the statistics from these interactions are presented. The age of the respondents was captured by asking the respondents the age brackets in which they fell. The brackets included 18-35, 36-60, and above 60 years.

Data on objective one regarding climate smart agriculture practices applied by respondents starting by desk review before field data collection. Prior to the data collection at data collection tools development, a list of CSA practices promoted by the district and other NGOs in the district was developed by consultations with the district production office as well as agriculture and livelihoods NGOs in Yumbe. The same list was verified by reviewing literature to see which CSA practices have been applied elsewhere in the region (Barnard, et al.,2015; Wekesa et al. 2018; Jamil et al., 2021). The practices were synthesized into 7 themes as in table 4.2.1 for which respondents were asked to confirm whether they apply each of them on their farms.

Objective two; climate smart agriculture practices uptake drivers, the respondents were asked to explain why they are motivated to apply each of the seven CSA practices. These drivers were the social economic characteristics of sex, age, household head, marital status, household size, education level, employment type, time assigned to agriculture, income sources, household income, debt status, land ownership, size of land, distance to the farm, access to food in the market, past experience with weather calamities, access to extension services, access to credit, group membership, and access to irrigation water(Zakaria, et al., 2020; Kifle, et at.,2022; Sanogo, et al., 2023) The enumerator would then to which of the predetermined reasons from literature the respondents' reason falls and he/she would put that response code against the practice for the categorical factors and dichotomous variables while for the numerical factors a corresponding number would be recorded.

Finally, for objective 3, the relationship between climate smart agriculture practices and household food availability, food consumption scores (FCS) were used as proxy for food availability(Nyangasa, et al., 2019). Use of FCS was to cater for food that the households purchase using from outside the farm but using household income. Using physical food found on the farm would have otherwise missed out on the food that is not produced at the household but is readily available as long as the household has an income to purchase this food (PSA, 2020). Respondents were asked to state how many times they consumed each of the food categories in the previous one week and the number was recorded. Keeping in mind the amount of food they reported to have harvested from their own gardens, follow up questions were asked to confirm that all the food consumed was either from own garden or using the income generated from farming. For free food and food bought using income from other sources, the frequency of the food category was adjusted to fit the would-be food from the household's own garden only. The enumerator then multiplied this number by the assigned weight per food category to get the total per food category. The weights used for each food category were as follows: cereals 2, tubers 2, pulses 3, vegetables 1, fruits 1, meat and fish 4, milk 4, sugar 0.5, oils 0.5 and condiments 0 ( WFP, 2008). To ascertain the FCS for the respondent, the enumerator summed up totals for each of the respondents.

### 3.5 Reliability and Validity

The validity of the data collection instruments was achieved by ensuring the tools are pre-tested to ensure that these tools are able to collect the intended data from the field. After training data enumerators, they conducted pretesting in the households in the same population of the study area to see whether the questions pick the desired information from the households. Corrections were made after the pretest to fine-tune the tools and make them ready for actual data collection.

### 3.6 Data analysis

The collected data were entered and analyzed using SPSS software and presented in frequency tables, that is, objectives one. For objective two, binary logistic regression was used to determine the factors that influence uptake of each of the CSA practices. The dependent variable of practicing or not practicing was a dichotomous and therefore coded as 1/0 for practice and not practice respectively. Similarly, objective three; that determined effect of practicing different CSA practices on household food availability, binary logistic regression model was used. Food Consumption Score (FCS) was used as a proxy indicator of household food availability. A dummy code of 1 was assigned to acceptable FCS total score of 35.5 and above while 0 was assigned for not acceptable FCS total score of less than 35.5 (WFP, 2008). For each household, the FCS was computed by multiplying each food group frequency by each food group weight and then summing these scores to get household total FCS score that was used to know whether the household has acceptable FCS or not acceptable FCS for the dummy code 1/0 respectively to be assigned. The frequencies of applying different CSA practices were used as explanatory variables in the binary logistic regression. It was anticipated that the longer the household practiced a CSA technology, the more the practice impacted the food availability in the household.

**The binary logistic model used for objectives two and three is presented below.**

The logit (P) is the natural log of this odds ratio,

Logit (P) = ln[P/(1-P)] = ln(odds).

ln [P/(1-P)] = ***a*** + ***b*** Xi

Where,

“ln” is the natural logarithm, logexp, where e=2.71828

“P” is the probability that Y for cases equals 1, p (Y=1)

“1-p” is the probability that Y for cases equals 0, 1 – p(Y=1)

“P/(1-P)” is the odds ratio.

ln[P/1-P] is the log odds, or “logit”

$P/(1-P) = e^{a+bX}$.

$P = e^{a+bX}/1+e^{a+bX}$

For objective two with n=21 number of predictors, the Model can be written as below:

$P = e^{a+b1X1+b2X2+.......+b21X21}/1+e^{a+b1X1+b2X2+........+b21X21}$

Where: $b_1$-$b_{21}$ are coefficients and $X_1$ –$X_{21}$ are the predictors.

The predictors$X_1$, $X_2$,….., $X_{21}$ are defined below.

$X_1$ is sex, $X_2$ age, $X_3$ household head, $X_4$ marital status, $X_5$ household size, $X_6$ education level, $X_7$ employment type, $X_8$ full time farmer, $X_9$ source of income, $X_{10}$ level of income, $X_{11}$ debt status, $X_{12}$land size, $X_{13}$ land ownership, $X_{14}$ distance to farm, $X_{15}$ access to food in the market, $X_{16}$ past experience with weather calamities, $X_{17}$ access to extension services, $X_{18}$ access to agriculture inputs, $X_{19}$ access to credit, $X_{20}$ Group membership, $X_{21}$ access to irrigation water.

For objective three with n=7 number of predictors, the Model can be written as below:

$$P = e^{a+b1X1 +b2X2+.......+b7X7} / 1+e^{a+b1X1+b2X2+........+b7X7}$$

Where: $b_1$-$b_7$ are coefficients and $X_1$ –$X_7$ are the predictors.

The predictors$X_1$, $X_2$,….., $X_7$ are defined below.

$X_1$ is climate adapted crop varieties, $X_2$ managing planting dates, $X_3$ kitchen/backyard gardening, $X_4$ intercropping, $X_5$ water and soil conservation practices, $X_6$ agro-forestry, and $X_7$ irrigation.

### 3.7 Ethical considerations

The researcher obtained clearance and a letter of introduction from Uganda Christian University and the consent of the respondents prior to the research. Additionally, the research protocols were submitted to research ethics committee (REC) for review and approval, after which, an authorization letter for data collection was acquired. Respondents' personal information was not disclosed to third parties and at analysis level, the data was anonymized. At analysis level, households were represented by unique identifiers such that confidential information of respondents cannot be traced back to the owner of the information by a third party reading the study report. All information read from previous studies and reports was cited and acknowledged to avoid plagiarism.

# CHAPTER FOUR

# RESULTS

This chapter entails study result presentation and analysis. The results are presented in such a way that demographic and social economic characteristics of the respondents are analyzed and presented first to give an overview of the respondents' statistics. Then, the results as per the three objectives follow in the order of the objectives beginning with objective one. Under objective one; to assess the climate smart agriculture practices that farmers currently apply; the climate smart agriculture practices are presented in a tabular form. This gives a clear view of which practices were being applied by majority of the respondents. Objective two; to determine climate smart agriculture practices uptake drivers, the results are also presented in tabular form summarizing the binary logit model outputs for each of the CSA practices. The third objective; to infer the relationship between climate smart agriculture practices and household food availability, is also presented in table form summarizing binary logit model output. The significance of the model was determined by looking at the significance of each estimator; the P-value, which helped decide which factors affect which CSA practice for objective two, and which CSA practices were statistically significant in terms of improving household food availability for objective three.

## 4.1Demographic and socio-economic characteristics of respondents

Statistics of key demographic and social economic characteristics are presented in table 4.1.The study found that most refugees and host community members of Bidibidi settlement were female. Nearly a half of respondents were in their mid-ages of 36-60, followed by the 18-35 age bracket and the smallest proportion in terms of age brackets was for those of 60 and above(Table 4.1).

**Table 4.1 Social demographic characteristics of refugee and host community households in Bidibidi refugee settlement-zone1, Romogi sub county, Yumbe district**

| | Frequency | Percent |
|---|---|---|
| **Sex of household** | | |
| Male | 164 | 43.7 |
| Female | 211 | 56.3 |
| Total | 375 | 100 |
| **Age of household** | | |
| 18-35 | 175 | 46.7 |
| 36-60 | 186 | 49.6 |
| Above 60 | 14 | 3.7 |
| **Access to Agriculture Land** | | |
| Total | 375 | 100 |
| **Yes** | 364 | 97.1 |
| No | 11 | 2.9 |
| Total | 375 | 100 |
| **Land ownership** | | |
| Yes | 139 | 37.1 |
| No | 236 | 62.9 |
| Total | 375 | 100 |

Results in table 4.1 also indicate that out of the households interviewed, close to 100% had access to land for agriculture. This was either on own land or through land hire or land given freely by members in the community who had more land than they could utilize. On the other hand, less than a half of the households owned the land on which they carried out agriculture. The vast majority did not own the land and were depending on hired or land acquired through other means for agriculture.

## 4.2 Climate smart agriculture practices applied by refugees and host community of Bidibidi refugee settlement.

This section presents results of objective one in table 4.2. Upon analyzing the results, it was confirmed that the top three CSA practices in Yumbe district were planting climate adopted crop varieties, managing planting dates to conform with changing rain fall patterns and planting kitchen gardens, in a descending order. The least practiced CSA practices in Bidibidi refugee zone1 and its host community of Romogi subcounty in Yumbe district were agroforestry and irrigation.

**Table 4.2 Climate smart agriculture practices commonly practiced by refugees and host community of Bidibidi settlement**

| CSA practice | Frequency | % |
|---|---|---|
| Planting climate adopted crop varieties; quick maturing varieties | 355 | 94.7 |
| Management of planting dates to suit changed rainfall patterns | 309 | 82.4 |
| Planting kitchen/back yard garden | 297 | 79.2 |
| Intercropping | 280 | 74.7 |
| water and soil conservation practices; mulching, cover crops | 263 | 70.1 |
| Irrigation | 256 | 68.3 |
| Agroforestry | 88 | 23.5 |

## 4.3 Drivers of climate smart agriculture practices in Bidibidi settlement zone1 and host community of Romogi subcounty by smallholder farmers

This section presents results for objective two, that is, assessment of climate smart agriculture practices uptake drivers in Yumbe district. Binary logit model was used for this objective and the P-values read from model outcomes for factors influencing uptake of each of the CSA technologies were used to ascertain whether the factor significantly influenced uptake of the CSA technology in question.

**Table 4.3 Factors influencing uptake of climate adapted crop varieties, managing planting dates and planting kitchen gardens**

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| **Dependent Variable: Climate adapted crop varieties** | | | | | | | | |
| Household head | 1.415 | 1.06 | 1.78 | 1 | 0.182 | 4.116 | 0.515 | 32.87 |
| Full time farmer | 0.083 | 0.05 | 2.74 | 1 | 0.098* | 1.086 | 0.985 | 1.198 |
| Household income | 0.000 | 0.00 | 13.08 | 1 | 0.000*** | 1.000 | 1.000 | 1.000 |
| Group membership | -2.236 | 0.77 | 8.53 | 1 | 0.003*** | 0.107 | 0.024 | 0.479 |
| **Dependent Variable: Managing planting dates** | | | | | | | | |
| Land ownership | 2.352 | 0.40 | 35.09 | 1 | 0.000*** | 10.502 | 4.824 | 22.86 |
| Marital status | -0.531 | 0.42 | 1.60 | 1 | 0.205 | 0.588 | 0.259 | 1.337 |
| Employment status | -20.639 | 140.53 | 0.00 | 1 | 0.999 | 0.000 | 0.000 | . |
| Acc. to irrigation water | -1.117 | 0.35 | 10.09 | 1 | 0.001*** | 0.327 | 0.164 | 0.652 |
| Household head | 1.129 | 0.65 | 3.04 | 1 | 0.081* | 3.093 | 0.870 | 10.99 |
| Years in school | 0.119 | 0.05 | 5.85 | 1 | 0.016** | 1.126 | 1.023 | 1.239 |
| Dist. to the farm | -0.044 | 0.03 | 1.88 | 1 | 0.169 | 0.957 | 0.898 | 1.019 |
| **Dependent Variable: Kitchen gardening** | | | | | | | | |
| Land ownership | 2.898 | 0.40 | 53.94 | 1 | 0.000*** | 18.130 | 8.367 | 39.28 |
| Marital status | -0.573 | 0.42 | 1.88 | 1 | 0.170 | 0.564 | 0.249 | 1.278 |
| Household size | 0.032 | 0.03 | 1.03 | 1 | 0.311 | 1.033 | 0.970 | 1.099 |
| Employment status | 0.468 | 0.93 | 0.25 | 1 | 0.616 | 1.597 | 0.257 | 9.929 |
| Source of income | -0.816 | 0.63 | 1.70 | 1 | 0.193 | 0.442 | 0.129 | 1.511 |
| Acc. to ext. services | 0.432 | 0.56 | 0.60 | 1 | 0.438 | 1.540 | 0.517 | 4.586 |
| Acc to agro-inputs | -0.942 | 0.51 | 3.45 | 1 | 0.063* | 0.390 | 0.144 | 1.053 |
| Acc. to irrigation water | 0.774 | 0.37 | 4.43 | 1 | 0.035** | 0.461 | 0.225 | 0.948 |
| Constant | 0.220 | 0.96 | 0.05 | 1 | 0.819 | 1.246 | | |

*Significant at 10%, ** at 5%, *** at 1% level

Table 4.3 provides a summary of the factors responsible for uptake of climate adapted crop varieties. The results show that households that do farming as a full time job and those with higher incomes were statistically likely to plant climate adapted crop varieties than their counterparts. Farming households with higher income levels and those that belonged to farmer groups had 100% more chances of adopting climate adapted crop varieties than their counter parts with lower incomes. Conversely, households that belonged to groups had 10.7% less chances of adopting climate adapted crop varieties compared to their colleagues who did not belong to groups.

Adoption of managing planting dates like early planting was influenced by land ownership, number of years one spent in school and being a head of a household, while having access to irrigation water was found to negatively influence adoption of managing planting dates. Households that owned their own farm land and those whose household heads had spent more years in school had 10.505 and 1.125 more chances respectively of adopting management of planting dates compared to their counterparts who did not own the land on which they farmed and who had spent less time in school.

Uptake of kitchen gardening as a CSA technology was influenced by land ownership and households that owned land had 18.13% more chances of adopting kitchen gardening as opposed to households that did not own land. The study also revealed that access to agro-inputs and access to irrigation water negatively influenced uptake of kitchen gardening technology causing 39% and 46% less chances in each case.

As indicated in table 4.4, intercropping CSA technology is statistically influenced by land ownership, marital status and group membership. Households that owned land had over 39 more chances of adopting intercropping than households that did not own land. Households that belonged to farmer groups and where the respondent was married had 0.279 and 0.433 higher chances of them adopting intercropping.

**Table 4.4 Factors influencing uptake of intercropping and water and soil conservation practices**

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| **Dependent Variable: Inter-cropping** | | | | | | | | |
| Age | | | 3.635 | 2 | 0.162 | | | |
| Age(18-35) | 1.32 | 0.79 | 2.742 | 1 | 0.098 | 3.740 | 0.785 | 17.822 |
| Age(36-60) | 0.87 | 0.79 | 1.217 | 1 | 0.270 | 2.391 | 0.508 | 11.247 |
| Land ownership | 3.69 | 0.41 | 78.16 | 1 | 0.000*** | 39.86 | 17.60 | 90.235 |
| Marital status | 0.84 | 0.44 | 3.547 | 1 | 0.060* | 0.433 | 0.181 | 1.035 |
| HH income | 0.00 | 0.00 | 0.300 | 1 | 0.584 | 1.000 | 1.000 | 1.000 |
| Group member | 1.28 | 0.33 | 14.67 | 1 | 0.000*** | 0.279 | 0.145 | 0.536 |
| Market food availability | 0.88 | 1.01 | 0.753 | 1 | 0.386 | 2.399 | 0.332 | 17.309 |
| **Dependent variable: Soil & Water conservation practices** | | | | | | | | |
| Sex | 0.50 | 0.34 | 2.295 | 1 | 0.130 | 1.661 | 0.862 | 3.201 |
| Age | | | 7.132 | 2 | 0.028** | | | |
| Age(18-35) | 2.70 | 1.01 | 7.089 | 1 | 0.008*** | 14.88 | 2.039 | 108.66 |
| Age(36-60) | 2.47 | 1.02 | 5.896 | 1 | 0.015*** | 11.84 | 1.611 | 87.052 |
| Household size | 0.04 | 0.04 | 1.266 | 1 | 0.260 | 1.04 | 0.971 | 1.116 |
| Full time farmer | -0.04 | 0.04 | 1.057 | 1 | 0.304 | 0.96 | 0.894 | 1.035 |
| Source of income | 1.45 | 0.74 | 4.016 | 1 | 0.045** | 4.28 | 1.032 | 17.739 |
| Land ownership | 3.74 | 0.39 | 91.79 | 1 | 0.000*** | 42.41 | 19.70 | 91.302 |
| Distance to farm | 0.04 | 0.03 | 1.538 | 1 | 0.215 | 1.041 | 0.977 | 1.108 |
| Acc ext. services | -0.98 | 0.53 | 3.456 | 1 | 0.063* | 0.372 | 0.131 | 1.055 |
| Acc to agro-inputs | 0.63 | 0.50 | 1.627 | 1 | 0.202 | 1.889 | 0.711 | 5.019 |
| Employment type | -2.13 | 2.82 | 0.573 | 1 | 0.449 | 0.118 | 0.000 | 29.915 |
| Constant | -3.15 | 1.22 | 6.698 | 1 | 0.010 | 0.043 | | |

*Significant at 10%, ** at 5%, *** at 1% level

Age of the household, having agriculture as the main source of income, land ownership significantly influenced adoption of water and soil conservation practices at different levels of significance, according to the study results. Being in the youth age bracket of 18-35 would increase adoption of water and soil conservation practices by about 15 times and these chances reduced by about 2 units when an individual transitioned to the mid adult age bracket of 36-60 years. Depending on agriculture as the main source of income and land ownership were also increasing the chances of the household to uptake the water and soil conservation technology by 4.3 and 42.4 more times respectively (Table 4.4).

**Table 4.5: Factors influencing uptake of agroforestry and irrigation technologies**

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| **Dependent variable: Agro-forestry** | | | | | | | | |
| Years in school | -0.08 | 0.041 | 4.35 | 1 | 0.037** | 0.917 | 0.846 | 0.99 |
| Source of income | -0.47 | 0.499 | 0.91 | 1 | 0.340 | 0.621 | 0.234 | 1.65 |
| HH income | 0.00 | 0.000 | 2.79 | 1 | 0.095* | 1.000 | 1.000 | 1.00 |
| Land size | -0.01 | 0.008 | 2.16 | 1 | 0.141 | 0.989 | 0.974 | 1.00 |
| Land ownership | 1.98 | 0.323 | 37.89 | 1 | 0.000*** | 0.137 | 0.073 | 0.25 |
| Acc ext. services | 1.34 | 0.359 | 14.1 | 1 | 0.000*** | 0.260 | 0.129 | 0.52 |
| Acc to credit | 0.29 | 0.361 | 0.67 | 1 | 0.413 | 1.344 | 0.662 | 2.72 |
| **Dependent Variable: Irrigation** | | | | | | | | |
| Household head | 0.72 | 0.39 | 3.33 | 1 | 0.068* | 2.062 | 0.948 | 4.48 |
| Land ownership | 1.73 | 0.29 | 35.86 | 1 | 0.000*** | 5.652 | 3.206 | 9.96 |
| Acc to irri. water | 2.05 | 0.37 | 31.22 | 1 | 0.000*** | 0.128 | 0.062 | 0.26 |
| Household size | 0.07 | 0.04 | 3.64 | 1 | 0.056* | 0.936 | 0.874 | 1.00 |
| Source of income | 0.83 | 0.55 | 2.26 | 1 | 0.132 | 2.295 | 0.778 | 6.77 |
| Debt status | -0.49 | 0.31 | 2.48 | 1 | 0.115 | 0.608 | 0.328 | 1.12 |
| Group member | 0.73 | 0.38 | 3.78 | 1 | 0.052* | 2.073 | 0.994 | 4.32 |
| Constant | 1.11 | 0.44 | 6.213 | 1 | 0.013 | 3.019 | | |

*Significant at 10%, ** at 5%, *** at 1% level

The results in table 4.5 revealed that adoption of agroforestry practices was negatively influenced by level of education as shown by years spent in school and land ownership and access to extension services. It was however revealed that increasing household income increased chances of adopting agroforestry. Other significant factors included access to extension services and land ownership. Source of income, land size and access to credit were not significant factors.

Uptake of irrigation was revealed to be influenced by land ownership, access to irrigation water, household size, group membership and household leadership. These were significant at different levels of significance as shown in the table 4.5. For example, a household that belonged to a farmer group had over 2 more chances of practicing irrigation technologies as opposed to households that did not belong to groups. Households that owned land had over 5 times more chances to adopt irrigation technologies. Factors that were not significant for irrigation technology were debt status and main source of income for the household.

### 4.4 Climate smart agriculture practices and household food availability

This section presents results of objective 3, that is, relationship between CSA practices and household food availability. Binary logit model was used to predict this relationship.

**Table 4.6: Effect of different CSA practices on household food availability**

| | *B* | *Sig.* | *Exp(B)* |
|---|---|---|---|
| Climate adapted varieties | 0.024 | 0.311 | 1.025 |
| Kitchen/back yard gardening | -0.061 | 0.067* | 0.941 |
| Intercropping | 0.024 | 0.386 | 1.024 |
| Water & soil conservation practices | 0.008 | 0.803 | 1.008 |
| Agroforestry | 0.051 | 0.096* | 1.052 |
| Irrigation | 0.047 | 0.048** | 1.048 |
| Constant | 0.879 | 0.001 | 2.409 |

**Significant at 10%, ** at 5%, *** at 1% level*

According to results in table 4.6, practicing agroforestry and irrigation technologies positively influenced household food availability at 10% and 5% significance levels respectively. On the other hand, the results indicate kitchen gardening to negatively influence household food availability. Households that practice agroforestry 9.6% chances of having sufficient food in their households while those that practiced irrigation technologies had 4.8% more chances of having sufficient food in their households compared to their counter parts who were not diversifying their crop diversity by doing agroforestry and those who only depended on rainfall for them to grow food for their households. Households practicing kitchen gardening had 6.7% much less chances of having sufficient food in their households compared to households who did agriculture on a much large scale

# CHAPTER FIVE

## DISCUSSION OF RESULTS

In this chapter, the findings of the study are discussed. The conclusions depending on the findings are made and recommendations based on the findings are also given. Finally, the chapter provides areas that still need further research.

### 5.1 Socio-economic characteristics

The study revealed that Bidibidi settlement, zone1 and host community had more women than men. Higher number of females reported in this study may be attributed to a high female population in Yumbe district (52.5%) as reported in Yumbe district development plan (2015). Additionally, UNHCR (2021) report also indicated that majority of refugees (52%) in Bidibidi refugee settlement were women. Dawa, 2018 report on cross boarder movement by South Sudanese refugees explained the high number of women and children in the settlements compared to men that there are limited livelihoods opportunities for men in the refugee settlements since much of humanitarian livelihood opportunities tend to target women. Due to this lack of livelihoods opportunities, men end up crossing back to South Sudan during cropping seasons to grow food that they send to their households that remain in the settlements being cared for by their female counterparts while the children are getting a seemingly better education in the Ugandan refugee settlements. Dawa, 2018 found that this situation was the same for other settlements in Northern Uganda including Rhino camp refugee settlement, Imvepi refugee settlement and Adjuman refugee settlement all in Northern Uganda. Studies conducted in other refugee hosting countries also report refugee women comprising more than 50% of refugee population while the women, children and youth comprise over 80% of the refugee population, for example the case of Congolese refugees in Rwanda (Bilgili, et al., 2017).The higher number of women in the settlement is attributed to the fact that men stay outside their homes in search of casual labour employment from which they earn an income that is sent to their wives who in turn use it to cater for the family and the balance used to start up petty businesses with the refugee camps. The female refugees in Rwandan refugee camps reported to be more secure while in refugee camps compared to their male counterparts and the difference was significant (Bilgili, 2017)

In terms of age, less than 5% of the refugees and people in host communities were above 60years. This is in agreement with UNHCR(2021) refugee statistics report which puts Bidibidi refugee population of age 60+ at 3%. This same trend is seen in Kenyan refugee camps where persons above 60 years comprise 2.8% and majority refugees being those between the age of 18-59 years(Kenya-UNHCR, 2023). A low older population may be attributed to the fact that this age category is normally unable to flee conflicts since it normally involves walking long distances on food which make some to remain back on the conflict areas. Older people usually cannot walk long distances, have to guard family property (Ogwok, 2021).

Regarding land ownership and access, the high percentage (97.1%) that reported access to agricultural land may be attributable to the fact that the office of prime minister allocated every refugee household land for settlement and agriculture on their arrival since 2016. The size however kept on reducing as more refugees keep on arriving and they had to be accommodated in the same settlement (Berke & Larsen, 2022). A similar situation is experienced in other refugee settlements in Uganda (Turyamureeba, 2017). However, Bernerd et al. (2022), land under subsistence agriculture in Bidibidi kept increasing as more refugees came and they were allocated land. Contrary to the high percentage accessing land, only 37.1% of the households owned the land on which they carried out agriculture. This is consistent with the fact that over 60% of study participants were refugees and refugees are not allowed by law to own land (Uganda constitution, 1995). The land that the refugees were using for agriculture was the land which office of the prime minster secures from Ugandan nationals; landlords through signing of memorandum of understanding. Whereas refugees in other countries like Kenya and Tanzania are also allocated land, Turyamureeba (2017) reported that these countries are not as generous as Uganda. The land size provided is much smaller and can hardly support agriculture production. Other refugees access land through personal negotiations with landowners to either use it free of charge, pay a user fee in form of cash or harvest upon harvesting produce from the same piece of land. Turyamureeba (2017), in his study in Nakivale settlement, Isingiro district, further reported that refugees reported that in countries such as Rwanda found it hard to be allowed land to let since refugees were discriminated based on ethnicity which is not the case for Ugandan host communities.

## 5.2 Climate smart agriculture practices commonly applied in Bidibidi settlement and host community

The climate smart agriculture practices that the study found out to be common in the area were largely in agreement with studies elsewhere. The results are in conformity with the findings of Wekesa et al. (2018) in Kenya. Wekesa et al. (2018) in the study of the effect of climate smart agriculture on food security in Kenya found that planting of improved crop varieties which conform to changing climate like legumes in crop rotation, changing planting dates were most CSA practices applied. The study also agrees with Nakabuo, et al.(2019) in their study of CSA in Nakasongola district of Uganda when they found that early planting was an outstanding climate smart agriculture practice the farmers were applying. Efficient use of inorganic fertilizers, general field management practices such as use of terraces, planting trees and use of live barriers which in the case of this study fall under soil and water conservation were also found to be common practices in Kenya. Zizinga, et al(2022) had also found soil and conservation practice of digging planting basins significant in influencing maize productivity in Uganda. And with increased productivity it would imply increased food availability at the household. This practice was equally found to be widely applied by my study findings. The findings also agree with Eriksen et al.(2019) on the common practices applied in Uganda. My study findings also agree with CARE report (2021) that stated that applying kitchen gardening was common in Mbarara municipality. This study findings, however, have some differences from Wekesa et al. (2018) findings since it does not rank irrigation as among most applied CSA practices.

## 5.3 Drivers that motivate farmers to apply different CSA practices

A critical look at the drivers for planting climate adapted crop varieties after a regression analysis (Table 4.3.1) reveals that planting climate adapted crop varieties was significantly influenced by doing farming as a full time job that breeds experience and group membership. Findings suggest that concentrating on farming as a full time job gives one adequate skills and experience for him/her to ably identify crop varieties that match the climatic conditions in his/her locality. This is in concurrence with studies on adoption elsewhere. The full time involvement of farmers in demonstrations and hands on training help farmers evaluate the new technology and make informed decisions for its uptake as was reported by (Mwangi & Kariuki, 2015).

The study however differs in some ways from studies on adoption by other scholars. For example, Yirga & Alemu (2016) in a study on improved maize varieties adoption concluded that farmers who accessed extension services easily adopted improved maize varieties but access to extension services was not a significant factor for this particular technology in this study. Barnard, et al.(2025) report had also highlighted that access to CSA technologies and access to extension services were key in adoption of improved varieties. Yirga & Alemu (2016) argued that access to extension services is believed to facilitate behavior change in farmers which consequently bring about uptake of CSA technologies such as improved maize varieties. The study also differs from Sanogo, et al.(2023) findings on improved seed adoption drivers where they found marital status and education level significant when these two were not significant factors for the case of my study. They also found that group membership positively influenced adoption of improved seed but this was found to negatively influence adoption of climate adapted crop varieties in my study. Kifle, et al. (2022) disagrees with my findings on the effect of income on adoption of improved crop varieties. They found that increased farm income positively influenced adoption of diversified crop production on farms in Ethiopia.

This study found that managing planting was positively influenced by land ownership, household leadership and the number of years in school/level of education. The land ownership and household head/leadership factors can be attributed to the fact that farmers who own land would easily do the land operations timely since land is at their disposal compared to households that do not own the land and therefore have to first negotiate for land with landlords which might impact on their timeliness for planting. Similarly household heads would easily make decisions in a timely manner as opposed to their spouses who might in most cases want to first get consent of the household heads and in case the household head is not around, this might lead to delayed planting. The number of years spent in school positively influencing management planting dates is attributed to the higher literacy levels that come with more years spent in school. On the contrary, households with access to irrigation technologies failure to plant timely in the season is attributed to the fact that these households have an assurance that they can plant any time in the year since they have alternative source of water for their crops and do not depend on rains. Tessema et al. (2018) reported that promoting previous planting dates experience sharing amongst farmers play an important role in reducing effects of climate change in agriculture. Barnard, et al.,2015) reported that farmers with limited farming experience had hardships in adopting CSA. Farmers who plant timely in relation to onset of rains learn from their mistakes in previous seasons where they either planted so early or so late and they lose their crop. Krell et al. (2018), in their study on planting dates and social environmental factors in Kenya found that with experience, farmers planted +or – twenty days (2 dekads) from the onset of rains.

Results indicated that farmers who planted a kitchen garden were those who had access to irrigation water, and owned land and that those who had easy access to agro-inpputs less likely practicing kitchen gardening. This could be attributed to the fact that kitchen gardens need constant watering for the vegetables grown in those gardens to continue production all year round and lack of water access makes the practice impractical Sharma et al. (2011). For households whose water source is far, it becomes hard to have water to irrigate these backyard gardens. Even the wastewater from the kitchen that would be used to irrigate these small vegetable gardens, for households with limited access to water will be proportionately little and cannot sustain a kitchen garden. Landownership influencing positive uptake of kitchen gardening can be attributed to the fact that kitchen gardens are more or less permanent gardens that run all year round and establishing them on land that is not yours would attract higher rental charges for example. This study however did not find sex and education level associated to the practice of kitchen gardening and these factors had been found to be statistically significant in a study by (Rybak et al., 2018).

Regarding the practice of intercropping, farmers owned land, married and belonged to groups were found to significantly be influenced to apply the technology. Farmer groups are technology transfer platforms and therefore belonging to a farmer group gives one an opportunity to learn from colleagues different farming techniques including intercropping. Marital status influencing uptake of intercropping can be attributed to intrahousehold knowledge sharing as well as the fact that intercropping is most times labor intensive for some operations like weeding, and in this case the wife and husband can share the labor burden. Land ownership positively influencing intercropping technology can be attributed to restrictions that land owners normally put on tenants to plant some crops and not others in the rented/borrowed land. In this case if the intercrop takes a long period to mature and the land had been borrowed or rented for a seasonal crop, then the household would find it hard to practice intercropping for say beans and cassava. Other studies, for example, Mwangi & Kariuki (2015) also reported correlation of farm size, land ownership and adoption of agriculture technologies. Farm land ownership and size was reported by Mwangi and Kariuki to affect agriculture technology adoption in two directions. For some technologies that required large land sizes, households owning large land pieces were reported to easily adopt them. They further reported that for some other technologies like zero grazing, greenhouse farming, intercropping, they reported to be more likely adopted by farmers who owned small landholdings. The findings of my study however disagree with Herath & Takeya (2003) findings when they investigated factors responsible for intercropping in rubber plantations in Sri Lanka. They established that farmers who were sole owners of the land were not adopting intercropping which may imply that they had unlimited access to the land in terms of size and ownership. My study and that of Herath & Takeya (2003) noticeably agree in the sense that social participation like group membership were significantly influencing uptake of intercropping while both studies did not find full engagement on farm that breeds farming experience to be statistically significant regarding to the practice of intercropping. Kifle et al.(2022) studied factors that influence adoption of crop diversification and conservation agriculture as CSA practices. Intercropping, depending on the context is both a crop diversification and conservation agriculture technology. In their findings, they identified that access to credit influenced uptake while household income positively influenced uptake. Both of these factors were neither positively nor negatively found to be significant in my study.

The practice of soil and water conservation was positively influenced by age of the household, agriculture being the main source of income, land ownership and access to extension services. It is possible that since age comes with experience, it would be the reason that farmers who were of age were also able to adopt soil and water conservation technologies. This is in agreement with Sanogo, et at.(2023) findings that adoption of conservation agriculture in respect to organic manure, composting and natural regeneration are influenced by farmers age and experience. Farmers with more years of farming experience are most likely to be exposed to other farmers who are doing these practices and are able to compare results in terms of practicing the technology and not practicing the technology(Mwangi & Kariuki, 2015).

Similarly, having agriculture as the main source of income means that the household is ready to do all it takes to attain a harvest from their farms which might the reason these households were applying these soil and water conservation practices. And, given that extension services increase farmers knowledge and skills, it was of no doubt to find that extension services influenced uptake of these conservation practices. Soil and water conservation practices are most times costly in terms of resources and time, this would the reason only land owners were able to adopt them easily on their farms compared to farmer tenants who would not be sure whether landlords could allow them use the land for proceeding seasons, and hence could probably not be attracted to invest in these practices whose benefit on the farm go beyond a single season. Kifle et al.(2022) however found that access to extension services had a negative effect on adoption of some soil conservation practices and the argument was that some communities depend on their traditional knowledge. They also reported income to influence conservation agriculture negatively while my study did not find a significant relationship for this factor. Gender and education were however not found to be significant influencers of the uptake of this technology as was the case with Sanogo, et al.(2023) findings.

Factors including number of years spent education, agriculture as main source of household income, land ownership and access to extension services were all significant influencers for the uptake of agroforestry technologies. Years spent in school and access to extension services are always associated to high literacy levels, knowledge and skills which are all essential for adoption of a technology that is nontraditional like agroforestry. This is backed by the fact that Yumbe district in which Bidibidi settlement is found is characterized by distribution of agricultural inputs by NGOs as well as government (Wambede et al., 2019). Some of these inputs include agro forestry technologies. Wambede et al. (2019) reported that the over 40% adoption of agriculture technologies in Yumbe district is attributed to 60% of free inputs acquired from government and NGOs through their extension networks. The NGOs distribute fruit/tree seedlings and saplings, seeds and small ruminants. It becomes easier to households that access these technologies cheaply and/or most times freely to adopt agro forestry as compared to households with limited access to these technologies. During extension services, farmers many times receive free tree saplings and in many other cases, they are given linkages to access these saplings which increase adoption.

Given that agroforestry technologies come at a cost it could be the reason household income was positively influencing uptake of these technologies. And since agroforestry investments are not seasonal but multi-year in nature, farming households that owned their farmlands could easily adopt these technologies compared to farming households that depended solely on borrowed or rented farm lands. Since land ownership is also closely related to farm land size available to the household for production, it can also be possible that households with no land ownership have limited farmland and are constrained to apply agroforestry technologies. My findings agreed with Odukuniyi & Tekana, 2019 study on the fact that membership to farmer groups and associations was not influencing the practice of agro forestry while extension services significantly associated to the practice of agro forestry. Recent scholars also agree with my findings especially on the effect of household income (Kifle, et al.,2022) and on the effect of education on the uptake of agroforestry technologies (Sanogo, et al., 2023).

Results indicated that farmers who reported to practice irrigation of whatever form, had easy access to irrigation water, which is the similar to findings by Fausal et al. ( 2021) and Kifle, et at.(2022). Many of these reported that they acquired irrigation water from the same sources as for domestic use and others used using domestic wastewater. This implies that irrigation is impossible where there is no water source for the same purpose. Given that Yumbe district is water stressed, surface irrigation water sources are limited which makes promotion of the practice quiet challenging.

Other factors that were found to significantly influence uptake of irrigation technologies were land ownership, household leader/headship, household size and group membership. Other than micro irrigation of bucket and bottle irrigation, as scale of irrigation increase, it demands large capital investments which might not be feasible to do on land if it does not belong to the farming household, hence, the reason for the significant influence of land ownership on irrigation technologies adoption. Household headship and size of the household positive influence on irrigation technologies could be attributed to the decision making capabilities to invest in these technologies on one hand and the labor availability on the other hand especially in circumstances where the irrigation technology being adopted requires labor to physically do watering of the garden. Amadu (2022) study reported that family labor; household size was key for adoption of irrigation technologies. As already discussed, farmer groups and associations are platforms of knowledge and experience sharing amongst farmers as well as platforms to acquire economies of scale when purchasing inputs. This could be the reason group membership was positively influencing uptake of these technologies Additionally, farmers with extended knowledge some of which could be acquired from group associations find it easy to uptake new technologies(Serote et al. 2021).

Whereas this study did not find access to extension service to be highly associated to the practice of irrigation, Adroit (2008), in the study of factors influencing irrigation technology adoption and its impact on household poverty in Ghana had concluded that it was a key factor, just like Kifle et al. (2022) study findings. Amadu (2022) in the study done in Malawi also found a statistically significant relationship between access to farmer extension facilitators who use participatory training approaches, and adoption of CSA. However, Amadu’s 2022 study agrees with my study’s finding on household size. Given this back-to-back relationships between Amadu, Adroit and my study findings, this study findings do not necessarily disagree with Adroit (2018) findings on access to extension services. The discrepancy may be attributable to the methodology of the extension services delivery.

## 5.4 The relationship between CSA practices and household food availability

The study results that irrigation technologies and practicing agroforestry impact household food availability may be attributed to a number of reasons. Households that practice agroforestry are guaranteed of fruits for the households for the better part of the year compared to households that do not practice agroforestry. Common fruit trees planted in most households were mangoes and paw paws, with paw paws most common in the refugee settlement according to observations during the research period. The study findings agree with Wekesa et al.(2018) in Kenya. In their study of effects of climate smart agriculture practices on household food availability, in Kenya, they concluded that a farming household practicing crop management practice such as use of improved varieties, farm management practices such as planting trees on crop land; agro forestry and soil management practices would improve household food security. Branca, et al. (2011); Kalyebara & Bruchara (2008) equally agree with the study findings in that their findings confirmed that application of improved agronomic practices including use of agroforestry practices adapted to the changing climate gave higher yields on the farm. The high yields imply increased food availability. The agroforestry practices lead to reduced soil loss through erosion which guarantees soil nutrients, increased yield and food availability to the households applying these practices (Branca et al., 2011).

Another CSA technology that came out strongly from this study findings was irrigation technologies. This can be attributed to the fact that farmer households that produce food on irrigated lands were able to produce food all year round irrespective of the scale. This makes food available in these households during bumper and lean seasons as opposed to households that only depend on rainfed agriculture which might have food during main seasonal harvests and limited food during lean seasons.

Applying these CSA practices in combination with other good agronomic practices reduce carbon emissions hence reducing the greenhouse effect while guaranteeing increased farm productivity. This speaks into the mitigation and productivity pillars of climate smart agriculture (Branca et al., 2011).

Finally, the practice of kitchen gardening technologies was fond to have negative effects on the household food availability in the study area. This can be attributed to the fact that much as kitchen gardens provide a constant supply of vegetable sources, these are always on small scale, and households that depend solely on these small-scale backyard gardens are prone to suffering food deficits. This is common in the refugee settlements including Bidibidi settlement where majority depend on food aid and small kitchen gardens.

The practice of soil and water conservation practices as earlier documented by Eriksen, et al.(2019) in the study “Can climate interventions open up space for transformation? Examining the case of climate-smart agriculture (CSA) in Uganda” was expected to significantly contribute to household food availability. This was however not the case with my findings since only two practices of agroforestry and irrigation turned out to be significant. Similarly, according to Zizinga, et al., 2022 during their study on impact of CSA practices on maize yield in Uganda, they found that mulching, which is a soil and water conservation practice was responsible for increased maize productivity which is key for household food availability. This means that the soil and water conservation practices ought to be further investigated in terms of their contribution to crop yields, productivity and household food availability.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

For objective one that assessed common CSA practices in Bidibidi settlement, it was found that despite a number of climate smart agriculture practices being promoted by government and other actors, climate adapted crop varieties and managing planting dates were more frequently practiced. This implies that, households tag value to harvesting food as early as possible from the start of the season. This may potentially be the reason they were largely planting climate adapted crop varieties. For the same reason, they were appropriately timing planting dates such that they can utilize the duration rains would be available to produce food for their households.

Regarding factors for uptake of CSA practices (objective2), the study found the following factor to be significantly associated with the practice of different CSA practices. (i) Landownership positively influenced management of planting dates, kitchen gardening, intercropping soil and water conservation practices, agroforestry and irrigation technologies uptake.(ii) Household level of income influenced uptake of both climate adapted crop varieties and agroforestry technologies. (iii)Group membership impacted irrigation technologies and intercropping positively while impacting adoption of climate adapted crop varieties negatively. (iv)Access to irrigation water similarly impacted some technologies positively (practice of irrigation technologies, kitchen gardening) while impacting others negatively(managing planting dates). (v)Household head/leadership were found to positively impact both management of planting dates and irrigation technologies uptake. (vi)Whereas, level of education captured in terms of number of years one completed in school showed positive influence for management of planting dates, it showed a negative impact for agroforestry technologies. (vii)Another key factor was access to extension services which was significant for both soil and water conservation practices as well as agroforestry. Other factors that were significant for uptake of different CSA practices were being a full time farmer, access to agro inputs, marital status, age, main source of income, and household size.

The CSA practices that significantly influence household food availability were found to be irrigation technologies and the practice of agro-forestry since they were associated with high food consumption scores, a proxy measure for food availability. This implies that, these irrigated farms and the different components of agro-forestry systems provided ready food, and of different varieties all year round, hence high performance by households that practiced these practices. It is also possible that harvests attained due to practicing of these CSA practices provided ready income used to purchase foodstuffs that were not produced on the farm. Kitchen gardening was found to negatively impact household food availability and this was attributed to the small scale these kitchen gardens cover hence limitations in terms of volume and variety of foods obtained from these kitchen gardens.

The general conclusion is that, to achieve food availability promotion of irrigation technologies and agroforestry practices need to be at the forefront for communities like Bidibidi settlement, zone1 in Romogi sub county, Yumbe district. These should however be supported by sufficient household income, inclusive land tenure systems, farmer institutional development, enhanced access to irrigation technologies, balanced decision making at household level, and improved education and extension services.

### 6.2 Recommendations

Based on the study findings discussion and summary conclusions, the following actions are recommended.

Recommendations for Objective 1:commonly practiced CSA technologies;

i) The government should intensify sharing of rainfall information from time to time for farmers to be able to manage planting dates at the onset of rains. This means that Uganda national meteorological authority has to work closely with district local governments and local radio stations to ensure weather information is disseminated timely.

ii) Since planting climate adapted crop varieties was highly practiced, the local government and NGOs should now focus on ensuring availability of quick maturing varieties for different crops like beans, maize, cassava grafted fruits. This will go along way in ensuring the households have varied food available at their households.

iii) For the practices that were least applied; agro forestry and irrigation, and yet they impacted greatly the household food availability status, more farmer sensitization ought to be made to promote the benefits that come with agroforestry and irrigation.

Recommendations under objective two: Drivers for uptake of CSA practices were as follows:

i) The local government to work on the ordinance that guarantees land user rights for refugees since land ownership was found to be a key factor that influenced uptake of a number of different CSA practices.

ii) The government needs to prioritize water for production by drilling high yielding boreholes and/or pumping water from existing natural water bodies onto mega overhead tanks which can now flow by gravity to farmer's gardens. This because, access to irrigation water was also a key factor for uptake of a number of CSA practices.

Recommendations under objective three; relationship between CSA practices and household food availability were as below.

i) Subsidized irrigation pumps and equipment should be availed on the market to improve on access to these technologies and make use of the benefits of irrigation technologies.

ii) The local governments, humanitarian and development partners should promote agroforestry technologies in refugee settlements and host communities to ensure household food availability in the face of continued reduced food aid ration reduction by World Food Program. These technologies are also reported to have positive impacts on the environment. Since, agro-forestry proved to have a positive impact on household food availability, and yet its uptake was low according to this study, efforts to popularize the practice should be put in place to leverage on its many benefits. This can be through radio programs and distribution of cheap fruit tree saplings.

iii) Kitchen gardening should not be promoted as a sole source but rather as a complementary source of household food to ensure volume and variety of food for the households.

iv) Diversified sources of income, inclusive land tenure systems, farmer institutional development and access to extension services should be prioritized by both state and none state actors to contribute to adoption of CSA technologies which translate into improved household food availability.

### 6.3 Areas for Further Research

Based on the study findings, one area still needs to be further investigated.

The same research should be replicated in other refugee hosting districts to see whether these findings hold true outside Yumbe district.

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**<u>Appendix1.HOUSEHOLD DATA COLLECTION TOOL</u>**

**<u>Participation Consent</u>:**

My name is ………………………., am here on behalf of Mr. Nathan Turyayesiima, a student of Master of Science in Agriculture and Rural Development at Uganda Christian University. He is conducting a research titled "Contribution of CSA practices to HH Food Availability in Yumbe District." You have been selected to participate in this study out of the farmers in this community. Here with me is a copy of his introduction letter from the University which the district production and marketing officer has received and endorsed. Please note that participation in this study is voluntary and no setback will come to you for none participation. All the personal information from you will be kept confidential and only for the purpose of this study. The interview will take between 30-45 minutes. Now I ask you; Are you willing to participate in this interview/study? Y/N. (*if yes, do the interview, if no, thank the farmer and move to the next household)*

**SECTION 1: HOUSEHOLD DEMOGRAPHICS AND SOCIAL ECONOMIC CHARACTERISTICS**

1.1 Yumbe District, West Nile Sub Region
1.2 Sub County……………………………………………………………
1.3 Parish……………………………………………………………………….
1.4 Village Name………………..…………………………………………….
1.5 Name of respondent………………………………………………
1.6 Sex of HH head 1: Male, 2: Female
1.7 Age of HH head**1**: 18 – 35, **2**: 35 – 60, **3**: Above 60 years.
1.8 Status of respondent in the household 1. Head 2. Spouse 3. Child 4. Relative
1.9 Marital Status of respondent 1. Single, 2. Married, 3. Divorced, 4. Widow(er)
1.10 How many people are members of this Household? ...........................
1.11 How many of these are children (i.e., below 18 years old) .....................

| Age (years) | #Male | #Female | #Disabled |
|---|---|---|---|
| 0-5 | | | |
| 5-10 | | | |
| 11-14 | | | |
| 15-18 | | | |

1.12 What is the highest education level of the HH head? *Tick level* (1. None 2. Primary 3. Secondary 4. Tertiary/vocational 5. University.)*And state # years of education since primary one …………………….*..

1.13 Are you employed? 1. Yes 2. No

1.14 If yes, how are you employed? 1. Full time on farm 2. business, 3. Employed by someone (daily, monthly)

1.15 How much time in days per month do you spend on agriculture activities as opposed to other income generating activities

| Category | #days per month |
|---|---|
| Agricultural activities | |
| Other income generating activities | |

*1.16* What is the household's main source of income? *1. Farming 2. Trading 3. Local brewing 4. Salary & Wages 5. Transport 6. Metal works / carpentry 7. Remittances 8. Others*

*1.17* On average, how much do you earn per month in Uganda shillings?...Shs

*1.18* How many household members are involved in income generation from whatever source?...........

1.19 Do you have any debt from an individual, VSLA, SACCO or bank 1=Yes, 2=No

1.20 If you have a debt, how much do your debtors demand from you?........Shs

1.21 Do you have access to land for agriculture? 1.Yes 2. No

1.22 If you have access to land for agriculture, what is the size of the land available to you for agriculture in acres…………………

1.23 Do you own the land on which you practice agriculture? 1.Yes 2. No

1.24 How long in kilometers is it from your home to your garden…………….

1.25 How do you travel to your garden? 1-on foot, 2-bicycle 3-motorcycle hire

1.26 Which crops do you grow on your farm? (Say yes to all that you grow), and state quantity harvested last season in kilograms

| Crop | Y/N | Qtty-kg | Crop | Y/N | Qtty(kg) |
|---|---|---|---|---|---|
| Maize | | | Beans | | |
| Sorghum | | | Cow peas | | |
| Millet | | | Ground nuts | | |
| Cassava | | | Okra | | |
| Rice | | | Green vegetables | | |
| Sweet potatoes | | | onions | | |
| Potatoes | | | Tomatoes | | |
| Peas | | | Fruits | | |

1.27 How much dry food; grain, flour or legumes of last season do you have stored for food?………..Kg

1.28 Are you able to find the food available on the market for foods do not produce on your farm? 1=Yes 2=No

1.29 Approximately, on what items did you spend most/highest in your household during the past 30 days-1month (***Tick Top 3)?***1.Food and other non-alcoholic drinks, 2. Alcoholic Drinks and other luxury drinks, 3. Rent, 4. Fuel and

Power, 5. Water, 6. Household Necessities, 7. Transport & Communication, 8. Health, 9. Education, 10. Agricultural inputs, 11. Other social obligations

1.30 And how much did you spend on the three top items?....................*(Note to enumerator; probe per item, then add)*

1.31 Has your farm/garden ever been hit by extreme weather calamities like floods or severe drought? 1.Yes 2. No

1.32 Do you have access to extension services in your community? 1.Yes 2. No

*1.33* If you have access to extension services, how many times have you met/got advice from the extension agents this year?................ (*Note to enumerator; this may include agriculture training sessions attended, personal visits to the extension agent for advice, etc.)*

*1.34* Do you have access to agro input shops/suppliers? 1.Yes 2. No

*1.35* If you have access to agro in put shops/suppliers, how many minutes can it take you to walk to the nearest agro input shop/supplier? ……………………. *(Note to enumerator; if the answer is given in hours, covert by multiplying by 60)*

*1.36* Do you have access to credit/loans whenever you want to borrow? 1.Yes 2. No

*1.37* If you have access to credit, where do you borrow? 1. VSLA/SILC group 2. SACCO 3. Commercial bank 4. Money lenders

*1.38* Are you a member of a farmer group or association 1. Yes 2. No

*1.39* If you are a member of a farmer group/association, what are the benefits you get from the group? 1. Trainings 2. Advice from fellow farmers 3. Bulk purchase of inputs 4. Bulk sale of produce 5. Social support.

*1.40* Do you have access to irrigation water? 1.yes 2. No

*1.41* If you have access to irrigation water, what is the source? 1. Borehole-hand pump 2. Motorized borehole 3. Open pond 4. River/stream 5. Domestic waste water

*1.42* Which irrigation technique do you use? 1. Bucket 2. Flooding 3. Sprinkler 4. Drip irrigation

## SECTION 2: ENUMERATION OF CURRENT CSA PRACTICES

4.1 Do you practice any of the following farming practices?1=yes, 0= No

| | Practice | Y/N |
|---|---|---|
| 2.1.1 | Planted climate adapted crop varieties such as drought resistant crop variety, quick maturing crop variety e.g., NAROCAS1 cassava variety, short maturing maize, vegetables etc. | |
| 2.1.2 | Managing planting dates;e.g., planting early at onset of rains | |
| 2.1.3 | Planted/established/managed a kitchen/backyard vegetable garden | |
| 2.1.4 | Practiced intercropping | |
| 2.1.5 | Practiced soil and water conservation e.g., mulching or planted cover crops, dug water ditches, zero/minimum tillage etc. | |
| 2.1.6 | Practiced Agro forestry | |
| 2.1.7 | Irrigation | |

## SECTION 3: DRIVERS FOR UPTAKE &CONTINUED CSA PRACTICE

3.1 What is the main factor have motivated you to begin and continue practicing the below CSA practices since you started doing the practice (*enumerator tackles one practice at a time, records one min factor per practice*)

*Key Responses*:

*1. Access to water for irrigation 2. Access to CSA technologies/inputs 3. Farming Experience*

*4. Attitude towards CSA practice 5. Freq. Access to extension services*

*6. Access to credit 7. Social pressure 8. Group membership 9. Farm size*

*10. Level of income 11. HH size 12. Education level*

| | | |
|---|---|---|
| *13. Full time vs. part time farmer 14. Gender 15. Age 16. Land ownership*<br>*17. Type of crops grown 18. Dist. To the farm 19. Past exposure to weather calamities,* | | |
| | Practice | Factors |
| 3.1.1 | Planted climate adapted crop varieties such as drought resistant crop variety, quick maturing crop variety e.g., NAROCAS1 cassava variety, short maturing maize, vegetables etc. | |
| 3.1.2 | Managing planting dates; e.g., planting early at onset of rains | |
| 3.1.3 | Planted/established/managed kitchen/backyard vegetable garden | |
| 3.1.4 | Practiced intercropping | |
| 3.1.5 | Practiced soil and water conservation e.g., mulching or planted cover crops, dug water ditches, zero/minimum tillage etc. | |
| 3.1.6 | Practiced Agro forestry | |
| 3.1.7 | Irrigation | |

**SECTION 4: FOOD AVAILABILITY AND CSA ADOPTION**

4.1 *Food consumption score (FCS) as a proxy indicator of household food security.*

How often have you eaten any of the following food groups in the past 7 days?

| Food item (customize for local context) | Food groups | Weight | Frequency | FCS |
|---|---|---|---|---|
| Maize, porridge, rice, sorghum, millet | cereals | 2 | | |
| Cassava, potatoes, sweet potatoes | tubers | 2 | | |
| Beans, peas, gnats, | pulses | 3 | | |

| | | | | |
|---|---|---|---|---|
| Vegetables and leaves | vegetables | 1 | | |
| Fruits | Fruits | 1 | | |
| Beef, goat, poultry, pork, eggs, fish | Meat&fish | 4 | | |
| Milk and other milk products | milk | 4 | | |
| Sugar and sugar products | sugar | 0.5 | | |
| Oils, butter, fats | oil | 0.5 | | |
| Condiments | condiments | 0 | | |
| TOTAL FCS SCORE | | | | |

4.2 How often have you applied the below CSA practice since you started using the practice.

| | Practice | Frequency; number of planting seasons |
|---|---|---|
| 4.2.1 | Planted climate adapted crop varieties such as drought resistant crop variety, quick maturing crop variety e.g., NAROCAS1 cassava variety, short maturing maize, vegetables etc. | |
| 4.2.2 | Managing planting dates; e.g., planting early at onset of rains | |
| 4.2.3 | Planted/established/managed a kitchen/backyard vegetable garden | |
| 4.2.4 | Practiced intercropping | |

| | | |
|---|---|---|
| 4.2.5 | Practiced soil and water conservation e.g., mulching or planted cover crops, dug water ditches, zero/minimum tillage etc. | |
| 4.2.6 | Practiced Agroforestry | |
| 4.2.7 | Irrigation | |
| 4.2.8 | Maximum period (seasons) spent applying any one practice | |

## Appendix1: Department Authorization letter to Research Ethics Committee (REC)

UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

FACULTY OF AGRICULTURAL SCIENCES

Department of Natural Resource Economics and Agribusiness Management

Date: 14TH July 2022

Ref: UCU/NREAM/002/2022

The Chairperson,
Research Ethical Committee,
Uganda Christian University
P. O. Box 4 Mukono.

Dear Sir/Madam

Greetings in the Lord Jesus Christ our Savior!

**RE: Recommendation Letter for NATHAN TURYAYESIIMA**

This is to certify that the above named person is a bonafide student in the Department of Natural Resource Economics and Agribusiness Management, pursuing a Master of Science in Agriculture and Rural Development.

The student successfully defended his proposal entitled: ***"Contribution of Climate smart agriculture practices to household food availability in Yumbe District"***

Therefore, he is allowed to seek clearance from Accredited Research Ethical Committee (REC) before he starts data collection.

The department will highly appreciate any assistance accorded to our student by your office.

Kind regards,

John Livingstone Mutyaba

HoD Natural Resource Economics & Agribusiness

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## Appendix2: Research Ethics Committee Approval for the Study

UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

**06/09/2022**

To: Nathan Turyayesiima

Uganda Christian University
0779980091

**Type:** Initial Review

**Re: UCUREC-2022-355: Contribution of Climate Smart Agriculture Practices to Household Food Security in Yumbe district, pdf, 2022-07-15**

I am pleased to inform you that the Uganda Christian University REC, through expedited review held on **01/09/2022** approved the above referenced study.
Approval of the research is for the period of **06/09/2022** to **06/09/2023.**

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **06/09/2023** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Uganda Christian University REC:

| No. | Document Title | Language | Version Number | Version Date |
|---|---|---|---|---|
| 1 | Informed Consent forms | English | pdf | 2022-07-15 |
| 2 | Data collection tools | English | pdf | 2022-07-15 |
| 3 | Protocol | English | pdf | 2022-07-15 |

Yours Sincerely

Peter Waiswa
For: Uganda Christian University REC