DETERMINANTS OF ADOPTION OF FRUIT TREE GROWING AS AN ADAPTATION PRACTICE TO CLIMATE CHANGE IN BUDAKA DISTRICT, EASTERN UGANDA

BY

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A DISSERTATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS IN GEOGRAPHY DEGREE OF KYAMBOGO UNIVERSITY

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DECLARATION

I **Ewongu Denis,** affirm that this thesis, titled Determinants of Adoption of Fruit Tree Growing as An Adaptation Practice to Climate Change in Budaka District, Eastern Uganda, is original with no submissions to other institutions for examination or evaluation. All references to external sources of information are duly acknowledged in the references section with appropriate credit assigned as necessary.

Signature……………………… Date…………………………

Ewongu Denis

19/U/GMAG/18996/PD

APPROVAL

This document hereby certifies that the research project entitled, " Determinants of Adoption of Fruit Tree Growing as an Adaptation Practice to Climate Change in Budaka District, Eastern Uganda," has been satisfactorily concluded under our guidance and is now prepared for its ultimate submission.

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DEDICATION

I devote this work unto God Almighty for His blessings of good health and knowledge, as well as my mother Elizabeth Akajo Ewongu.

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ABSTRACT

The study was carried out in Budaka District, Eastern Uganda, to establish the determinants of adoption of Fruit Tree Growing as an adaptation practice to climate change. The study aimed to characterize fruit tree farmers and their spatial distribution, establish the socioeconomic determinants driving the adoption of fruit tree growing, and establish how fruit tree farmers perceive the adoption of such practices concerning climate change adaptation. To accomplish these objectives, a mixed research design was utilized, which incorporated the gathering of primary and secondary data, comprising both quantitative and qualitative information. Structured questionnaires were employed to gather quantitative data from the participants, whereas qualitative data were derived from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs)."Additionally, secondary data were obtained through a literature review. The selection of participants was conducted through a purposive multi-stage sampling procedure, resulting in a sample size of 417, with 221 participants ultimately participating in the study. Thematic examination techniques were used to analyze qualitative data, while SPSS was used for quantitative data analysis. The statistical methods utilized in this research included the Chi-square test of independence, Correlation analysis, and Multiple Regression analysis. These methods were utilized to examine the associations and predictors pertaining to the Adoption of Fruit Tree Growing as a practice of adapting to Climate Change. The findings indicated a positive but small and statistically significant correlation ($r = .221$, $p = .003$) between climate change and the adoption of fruit tree growing. The multiple regression analysis showed that the independent variables (socioeconomic determinants) accounted for 84.6% of the variance in the dependent variable (adoption of fruit tree growing), with a significant predictive capability ($p = .000$). The data implies that the independent variables have a notable effect on the Adoption of fruit tree growing as a means of adapting to climate change. Based on these findings, the study underscores the importance of targeted interventions that consider key socioeconomic determinants to effectively promote fruit tree cultivation as a sustainable adaptation practice to climate change.

CHAPTER ONE

INTRODUCTION

1.0 Background of the study

Recent research has shed light on the early cultivation of fruit trees in the Old World, particularly in the Near East and Greece. Zohary (1975) and Weiss (2015) suggest that olives, grapes, dates, and figs were among the first fruits to be cultivated, with olives and grapes potentially having genetic materials from outside the Levant. Pérez-Jordà et al. (2017) further support this, indicating that these fruits, along with pomegranates, were introduced to the Iberian Peninsula in the 9th to 8th century BC. Liphschitz et al. (1991) reassess the beginning of olive cultivation, suggesting it may have started in Israel during the Chalcolithic Period. Together, these findings enhance our understanding of the early history of fruit cultivation.

Climate change poses significant challenges to global initiatives for sustainable development, food security, and poverty alleviation (Harvey et al., 2018). To address this, a shift towards sustainable production systems is needed, particularly in small-scale farming (Hoffmann, 2011). Biotechnology, including genetically modified organisms, can play a key role in this shift, but its adoption in sub-Saharan Africa requires effective regulatory frameworks and capacity building (Quaye, 2012). These actions can assist smallholder farmers in adapting to climate change and support the attainment of Millennium Development Goal 1 (MDG 1).

Smallholder farmers, especially in developing countries, are progressively adopting fruit tree cultivation strategies to adapt to climate change (Lasco, 2014). Agroforestry systems, which incorporate trees on farms, have been identified as a key tool in this adaptation process, enhancing smallholders' resilience to climate risks (Lasco, 2014). These systems offer benefits such as improved water utilization, enhanced soil productivity, and increased farm income (Lasco, 2014). In sub-Saharan Africa, smallholder farmers are utilizing indigenous methods like multiple cropping and mulching to cope with climate change (Ozor, 2013). Agroforestry systems not only provide adaptation benefits but also offer commercial opportunities, making them a pathway to climate-smart agribusiness for smallholder farmers (Kassa, 2022).

The importance of indigenous fruit trees for subsistence farmers in Africa is clear, as they provide crucial food security, nutrition, and income. Nonetheless, their distribution is affected by variables like farm size, geographic location, and national policies (Miller, 2018). The cultivation of these trees has been linked to poverty reduction, influenced by socioeconomic variables like gender, education, and occupation (Schreckenberg, 2006; Agea, 2010). Notably, specific indigenous trees like *Strychnos cocculoides* and *Schinziophyton rautanenii* in Namibia play a crucial role in enhancing household income and food security (Elago, 2015).

Implementing effective strategies is essential to lessen the impact of climate change on fruit trees and the fruit industry, as emphasized by numerous studies. Ramirez et al. (2015) indicate that climate change effects on fruit trees necessitate adaptation strategies to address challenges such as phenological changes, reduced chilling hours, and aberrant precipitation. Additionally, Abobatta (2021) discusses the physiological, anatomical, and morphological mechanisms employed by fruit trees to cope with abiotic stress. Additionally, Chen (2012) and Rajatiya (2018) highlight the necessity for adaptation and mitigation strategies, with Chen particularly focusing on the effects of climate change on China's tropical fruit industry and the importance of technical preparations, while Rajatiya underscores carbon sequestration and robust adaptation strategies. Fujisawa's (2011) research on the adaptive practices of apple growers further elucidates the critical role of effective strategies in reducing the impact of climate change on fruit trees and the fruit industry.

Uganda's agriculture is heavily reliant on rain, making it vulnerable to climate change (Farley & Farmer, 2013). The country's rainfall variability, particularly in the onset and withdrawal dates, affects the growing season and crop yields (Mubiru, 2012). Farmers have observed changes in rainfall and temperature, with drought and floods significantly impacting crop production (Okonya, 2013). Smallholder farmers have adapted to these changes through various strategies, including crop diversification and the use of climate-resistant varieties (Hisali, 2011). However, climate anomalies such as droughts and higher temperatures continue to pose challenges to agricultural productivity and livelihoods (Call, 2019).

Uganda's limited ability to adapt to climate change stems from constrained livelihood opportunities and limited knowledge about adaptation strategies (Burton, 1997). This is particularly evident in the agricultural sector, where farmers may not choose fruit trees due to a lack of information (Snelder, 2007). Climate change significantly affects livelihoods, potentially negatively impacting 70-97% of households (Bagamba, 2012). However, the uptake of climate change adaptation actions is low, with factors such as lack of coordination, dispersed knowledge and ineffective communication hindering progress (Tenywa, 2017).

Several factors affect the adoption of sustainable agricultural practices, particularly the cultivation of fruit trees. These factors include characteristics related to households and fields, such as gender, stability of tree ownership, availability of seeds and supplies, guidance from extension and research institutions, land size per household, fuelwood scarcity, and main household income source (Kakuru, 2014). Additional significant factors include the availability of credit and extension services, farm earnings, and marketing duration (Atube, 2021). Local policies are essential in enabling adjustment to climate change. Ensuring inclusive policy development and execution, enhanced climate information services, and a robust local institutional framework are imperative (Twinomuhangi, 2019). Sarvina (2019) suggested adjusting planting time, using resistant varieties, and adopting efficient irrigation technology as adaptation strategies for fruit crops.

The available data has mainly focused on how climate change affects crop productivity and the adaptation practices chosen by smallholder farmers. Factors like awareness of climate change, support from institutions, and socio-cultural influences have been shown to affect the adoption of adaptation practices. However, these findings may not directly apply to the specific context of adopting fruit tree growing as an adaptation practice to climate change in Budaka District. These insights consistently emphasized the importance of farmers' perceptions in decision-making and their adoption of strategies to adapt to climate change (Acquah, 2011; Mangheni, 2012; Zizinga, 2017).

Understanding the distinct elements influencing the adoption of fruit tree cultivation as a climate change adaptation practice in Budaka District is crucial. The main aim of this study is to fill the current research gap by conducting a systematic analysis of the factors influencing the adoption of fruit tree cultivation in this area. By identifying and analyzing these factors, this study will offer practical recommendations for policymakers, agricultural extension services, and development agencies to promote the extensive adoption of climate-resilient agricultural techniques in Budaka District for sustainable agricultural practices and community resilience.

1.1 Statement of the Problem

Climate Change presents notable obstacles to agricultural output and food stability in diverse areas worldwide, including Budaka District in Eastern Uganda. Altered precipitation patterns, rising temperatures, and heightened occurrences of extreme weather events are diminishing the effectiveness of conventional farming practices. As a result, agricultural harvests are declining, worsening the situation of food insecurity, and putting the livelihoods of small-scale farmers at risk. The agricultural sector in Uganda, particularly subsistence farming, is well-documented to face challenges due to the effects of climate change (Tumwine, 2019), which are further compounded by human-induced activities like deforestation (Nuwagaba, 2013).

One promising strategy for adaptation is the cultivation of fruit trees, which offers advantages such as increased resilience to climate change, enhanced biodiversity, and supplementary income sources. Despite these benefits, the adoption rate of fruit tree cultivation in Budaka District remains low. Government initiatives like the Plan for Modernization of Agriculture (PMA) and National Agriculture Advisory Services (NAADS) aim to promote commercial crop cultivation, yet the adoption rate for fruit tree cultivation stagnates at approximately 14% (Budaka Local Government Budget Framework, 2014). This is concerning, given the crucial role of agriculture in poverty alleviation, particularly among vulnerable populations (Christiaensen, 2010).

This study aims to fill the current research void by probing the determinants influencing the decision to engage in fruit tree farming as a strategy for coping with climate change in Budaka District. Identifying and analyzing these factors is essential for developing effective interventions and policies that encourage widespread adoption of fruit tree cultivation, thereby enhancing the adaptive capacity of local farmers to the diverse challenges posed by climate change.

1.2 Objectives

1.2.1 Main objective

The aim of this research was to determine the factors influencing the adoption of Fruit Tree growing as a technique to adapt to Climate Change in Budaka district, Eastern Uganda, in order to develop effective strategies for sustainable agricultural practices and community resilience.

1.2.2. Specific objectives

1. To characterise the fruit tree farmers and their spatial distribution in the study area.
2. To establish the socioeconomic parameters that influence the cultivation of fruit trees in Budaka district.
3. To determine the perceptions of farmers regarding cultivating fruit trees as a means of adapting to climate change.

1.3 Research questions

i. What are the common characteristics of fruit tree farmers and how are they spatially distributed?
ii. What are the socioeconomic factors that influence the adoption of fruit tree growing in Budaka district?
iii. How do farmers perceive fruit tree farming as a method of adapting to climate change?

1.4 Significance of the study

The objective of this study was to address theoretical inquiries concerning the factors influencing the adoption of fruit tree cultivation as a climate change adaptation strategy in Budaka District. Bellow et al. (2008) conducted research to investigate the viability of fruit-tree-based agroforestry among resource-constrained farmers. The research indicated that factors such as family size, land ownership, and the productivity of trees and crops were significant influencers of the ideal levels of fruit tree adoption. Gaining insights into these determinants can substantially bolster the climate resilience of smallholder farmers in Budaka District. By identifying and promoting effective adaptation practices, the findings of this study can help mitigate the adverse effects of climate change on agriculture, ensuring more stable and sustainable livelihoods for farmers. The study aligns with global and national efforts to promote climate-smart agriculture. The emphasis on fruit tree cultivation plays a role in supporting efforts aimed at fostering resilient agricultural systems that can withstand the impacts of climate change, thereby helping to achieve sustainable development goals.

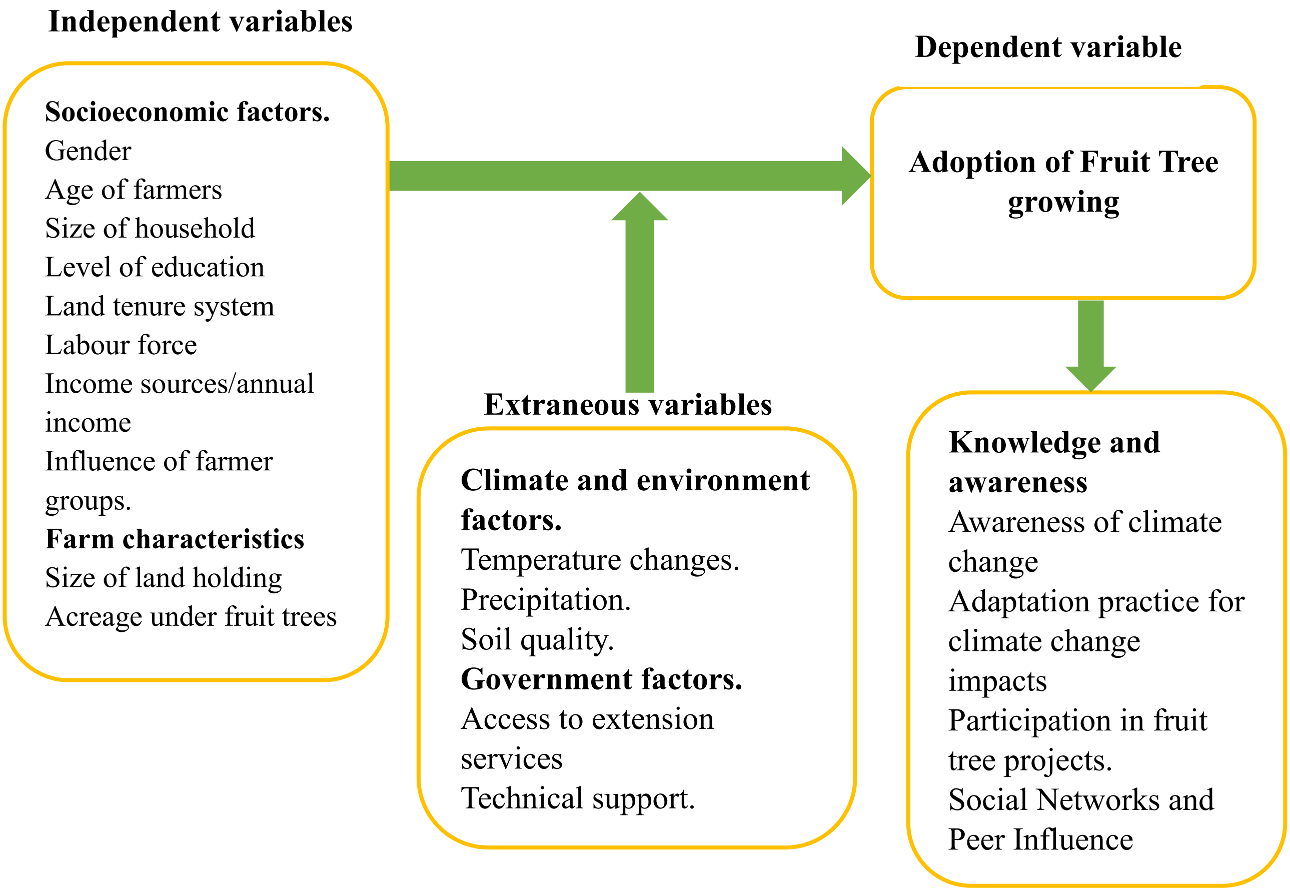
The results of this study provide important insights for policymakers, agricultural extension services, and development organizations. By identifying the key factors that affect the adoption of fruit tree farming, this research can guide the creation of targeted interventions, policies, and programs. These initiatives can effectively support sustainable agricultural practices and facilitate the implementation of climate adaptation strategies.

Fruit trees play a crucial role in environmental conservation by improving soil fertility, enhancing water retention, and providing shade and windbreaks (Hunter, 2021; Lowe, 2020). Hence, the study's findings can underscore the environmental advantages of cultivating fruit trees, promoting practices that support sustainable land management and biodiversity conservation.

This study is significant because it addresses critical aspects of climate resilience, food security, economic development, environmental sustainability, and policy formulation. The findings will play a crucial role in directing initiatives to boost the adoption of fruit tree cultivation as an effective climate change adaptation strategy in Budaka District, thereby improving the overall well-being of the local farming communities. By integrating local wisdom with scientific research, the study can offer holistic solutions that are culturally acceptable and practically feasible for smallholder farmers.

Additionally, the results of this study will provide a valuable reference for future researchers, fostering further investigation and enriching the growing body of knowledge. Ultimately, this thesis stands as a vital milestone in the researcher's pursuit of a Master's degree, representing a culmination of rigorous academic inquiry and practical relevance.

1.5 Conceptual framework



Source: Researcher's conceptualization.

The theoretical framework supporting this research explores the relationship between the adoption of fruit tree farming (dependent variable) and various socioeconomic factors (independent variables) that affect the acceptance of this agricultural practice as a climate change adaptation strategy. This framework posits that farmers' acceptance of fruit tree cultivation is shaped by their beliefs regarding climate change, while the level of adoption is determined by socioeconomic characteristics, which serve as the independent variables.

The suggested framework incorporates various farm-specific characteristics and socioeconomic factors, such as age, gender, household size, education level, access to credit, and income level, as primary determinants impacting the adoption of fruit tree cultivation. Additionally, institutional influences such as participation in fruit tree programs, the impact of farmer associations, and government policies are considered pivotal in shaping adoption trends.

It is postulated that this integration of farm and socioeconomic factors will drive the adoption of farming methods that promote fruit tree cultivation, thus fostering sustainable livelihoods within agricultural households. Furthermore, the framework acknowledges the moderating role of climate and environmental factors as extraneous variables, which help refine the theoretical predictions concerning the relationship between the independent and dependent variables.

1.6 Scope of the Study

1.6.1 Geographical scope

This study was conducted in Budaka District, located in the Eastern region of Uganda. Budaka District was selected as the study area due to its prominence as one of the primary fruit tree-growing districts within Eastern Uganda. The diverse array of fruit trees cultivated in the district includes mangoes, citrus fruits, avocados, jackfruits, among others, underscoring its significance in agricultural production. The district's strategic location, coupled with its well-established road network, renders it easily accessible to researchers. This accessibility facilitated efficient data collection processes and fostered interactions with local communities and respondents. In line with Singleton's (1993) assertion regarding the importance of aligning research location with researcher interest, Budaka District provided an ideal research environment conducive to establishing connections with the community and stakeholders involved in fruit tree cultivation.

1.6.2 Time scope

The study was done in 2021 between May and September. During this time, a variety of tasks were completed, including going to the district to introduce the research and getting to know the study region, collecting actual data, entering and cleaning the data, analyzing said data, and preparing a report.

1.6.3 Content Scope

The survey was primarily concerned with establishing the variables that influence the adoption of fruit tree farming, with a focus on using it as a technique of coping with climate change. It intended to establish among adoptive farmers especially the innovators who were open to trying new technology and the cautious adopters the characteristics of fruit trees cultivated, the quantity of trees, the amount of land, and the yield. It also documented farmers' perspectives of the usage of fruit trees as a climate change adaptation practice, as well as the socioeconomic variables influencing adoption. Additionally, the research explored the major challenges and limitations faced by farmers throughout the production and marketing phases of fruit cultivation, offering insights into the practical realities encountered in fruit tree farming endeavours.

1.7 Key words

Adoption; Fruit-tree growing; Perception; Adaptation; Climate Change, Socio economic factors.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The backdrop and justification for this investigation are provided by the material included in this chapter.

2.1 Climate change

Climate change poses a significant challenge to global food security and agricultural practices (Scherr and Sthapit, 2012). The anticipated impacts of climate change are projected to be extensive and multifaceted implications for food systems, including crop productivity, food availability, and food safety (Wheeler, 2013; Vermeulen, 2012). These impacts will be exacerbated in vulnerable regions, particularly for low-income producers and consumers (Vermeulen, 2012). Climate-smart agriculture, including modern breeding technologies and biotechnological strategies, is crucial for adapting to these changes and ensuring food security (Raza, 2019). The ability to address these challenges will be a major determinant of future global health (Myers, 2017).

Driven by human activities, climate change significantly threatens agriculture and food safety (Arora, 2019; Fitzgerald, 2016; Gustafson, 2011; Duchenne-Moutien, 2021). It has resulted in a higher frequency of extreme weather events, soil degradation, and decreased crop yields (Arora, 2019; Fitzgerald, 2016; Gustafson, 2011). Additionally, climate change has created emerging food safety issues, such as the spread of foodborne diseases and chemical hazards (Duchenne-Moutien, 2021). To address these challenges, sustainable solutions, including the development of new agricultural practices and technologies, are needed (Arora, 2019; Gustafson, 2011).

One promising adaptation strategy is the adoption of fruit tree growing. This method presents numerous benefits, such as the opportunity to bolster food security, generate economic advantages, and enhance environmental sustainability. The perennial nature of fruit trees makes them particularly effective in stabilizing ecosystems and offering long-term resilience against climate variability (Scherr and Sthapit, 2009).

Incorporating fruit tree cultivation into small-scale farming practices can mitigate the effects of climate change. This is especially critical for smallholder farmers in Sub-Saharan Africa, who face heightened vulnerability due to their reliance on rain-fed agriculture and limited ability to adapt (Harvey et al., 2014). These farmers face challenges such as low yields, poor access to services, and insufficient knowledge and inputs, but there is evidence that they are adopting various adaptation strategies, including crop diversification and water conservation techniques (Sani, 2016).

Studies stress the critical significance of adaptation and mitigation approaches in agriculture, underscoring the potential synergies between them (Rosenzweig, 2007). Climate change impacts the physiological and metabolic functions of plants, while inadequate agricultural methods contribute to increased greenhouse gas emissions (Malhi, 2021; Saini, 2020). Therefore, adopting specific agricultural practices, such as fruit tree growing, and developing new plant cultivars are essential to mitigate these effects. The role of perennial tropical fruit tree species in climate change mitigation and adaptation further underscores their potential (Scherr and Sthapit, 2009).

Smallholder farmers in East Africa face significant climate challenges, including increased temperatures and decreased rainfall, which are compounded by the region's reliance on rain-fed agriculture (Gbegbelegbe, 2018; Rockström, 2000). Increasing smallholder irrigation could aid in addressing these difficulties, yet it encounters obstacles like land ownership disputes and insufficient access to suitable technologies (Nakawuka, 2018). To support the adoption of fruit tree growing and other adaptive measures, African governments need to invest in climate-resilient projects, provide resources like credit and information, and improve extension services (Juana, 2013).

Understanding the complex and multi-scalar nature of adaptation to climate change is crucial (Adger, 2005; Scheraga, 1998). Adaptation strategies must consider potential impacts and side effects, and focus on creating synergies with mitigation efforts (Pielke, 1998). The interdisciplinary nature of adaptation highlights the need for a nuanced approach that considers diverse impacts and trade-offs (Simonet, 2010).

The uptake of agricultural adaptation measures in Sub-Saharan Africa, including Uganda, is influenced by various factors such as farmers' capacities and resource availability (Deressa et al., 2009; Juana, 2013; Sani, 2016). Despite the low uptake due to lack of coordination and sub-optimal communication services, these measures are critical for building climate resilience (Tenywa, 2017). Indigenous technologies, like multiple cropping and terrace building, have been effective but may need to be supplemented with new practices to cope with further warming (Ozor, 2013).

Hence, embracing the cultivation of fruit trees serves as a feasible strategy for adapting to alleviate the effects of climate change on agriculture. It offers a sustainable solution to enhance food security, economic benefits, and environmental sustainability, especially for vulnerable smallholder farmers. By leveraging modern technologies and fostering supportive policies, the potential of fruit tree growing can be fully realized as part of a comprehensive approach to climate adaptation.

2.2 Adoption of fruit trees

Adoption is the consequence of a person fully utilizing or incorporating a new idea or technique, and it is a necessary condition for the agricultural output to continue to rise. The backbone of the economies of East African countries are smallholder farmers, who not only produce the majority of food and livestock goods but also control the majority of the land (Salami et al., 2010). The majority of research on agroforestry uptake is based on surveys of "non-adopters" (Bannister & Nair 2002). Adopting new crop varieties, adjusting planting times, engaging in homestead gardening, planting trees, and migration are important strategies for building resilience to climate change impacts on agriculture and food production (Alam et al, 2017). Depending on how they integrate into their farm-family approach, various farmer owners may have varied perspectives on trees. Therefore, the adoption and management of fruit trees in agricultural areas will depend greatly on the family resource base, land rights, and the stage of the family's career (Nyaga et al., 2015). The capacity for trees to flourish within agricultural systems where small-scale farming is paramount has been recognized (Lengkeek et al., 2006; Kindt et al., 2007), and farmers' attitudes play a significant role in their willingness to do so. Adoption likelihood is projected to increase with a positive attitude towards fruit tree farming techniques and decrease with a negative attitude.

In the face of challenges related to climate change and food security (F.A.O. 2015), it is increasingly evident that agroforestry systems incorporating fruit trees are vital for sustainable agriculture. Farmers with access to resources and secure land tenure are more likely to successfully adopt and manage fruit trees. Experienced farmers who are in the later stages of their careers may have the knowledge and skills to integrate fruit trees effectively. The benefits of agroforestry systems with fruit trees are evident, and with support and positive attitudes, success is highly likely. Overall, growing fruit trees as an adaptation strategy to climate change can have multiple benefits for both farmers and the environment. It's a sustainable and resilient approach that can help communities succeed despite climate changes.

The adoption of fruit tree growing as an adaptation practice to climate change in East Africa, is influenced by a complex interplay of factors. Understanding these factors requires a multi-method approach that combines the strengths of various research methodologies. By leveraging the insights gained from case studies, experimental designs, geospatial analysis, and participatory methods, this study can generate comprehensive understanding of the drivers and barriers to adoption. This, in turn, can inform policies and practices that support smallholder farmers in building resilience to climate change by adopting sustainable farming methods.

2.3 Characteristics of the fruit tree farms and their spatial distribution

Fruit tree farms have been established in various locations using different methods and techniques. Traditional on-farm plantations have been successfully set up, featuring large orchard trees grown on seedling rootstocks, which ensures the long-term preservation of local landraces in their native regions (Pepristein 2018). A fruit tree cultivation method has been developed that includes steps such as pruning, watering, fertilizing, temperature controlling, intercropping, and disease and pest prevention (Tonggang 2019). Agroforestry initiatives have mainly focused on integrating understory crops and/or livestock with high-value tree systems, including apple orchards, olive groves, chestnut woodlands, and walnut plantations, to offer production, environmental, and economic benefits (Pantera 2018).

Research conducted on agricultural practices in Nigeria has demonstrated variations in the development and commercial viability of Chrysophyllum albidum, Irvingia gabonensis, and Garcinia kola within rainforest and derived savanna ecosystems (Onyekwelu et al. 2015). It's been observed that neither fruit range nor fruit length alone is enough to evaluate fruit tree production. Weather changes may result in both early and prolonged flowering in mango trees (Scherr and Sthapit 2009). Additionally, changes in fruit size, a typical characteristic of most cultivated fruits (Tanksley 2004; Zhang et al., 2006), may also occur under certain conditions (Kislev et al. 2006), and this could potentially help in predicting changes in yield. Different mango cropping systems exist in West Africa, catering to both local and international markets, and recent research has used unmanned aerial vehicles (UAVs) equipped with RGB sensors to map orchard land cover and estimate tree structure. Fruit tree farms are categorized based on the use of synthetic inputs, organic fertilization, and environmental friendliness (Dupré, Michels, and Le Gal 2017). There is significant heterogeneity in fruit quality traits, and farmers report the first fruit appearing as early as age 3 and as late as age 22 months (Anegbeh et al. 2005). "Point-source" measurements of tree health and yield can be scaled up to the orchard level using remotely sensed images in combination with a geographic information system (GIS) (Binam 2017). Rodríguez et al. (2021) report that temperate fruit trees contribute to 48% of global fruit production, with significant production in China, Turkey, the United States, Brazil, Italy, South Africa, and Spain. Pear production in Africa is concentrated in countries such as South Africa, Algeria, Tunisia, Egypt, and Morocco, with the majority of production occurring between 33-35° north and south of the equator (Ferandi et al., 2005). Mussidia nigrivenella, a pest of maize and wild host plants, was found to be nonrandom and aggregated on diverse host plants in Benin (Setamou et al. 2000). Sub-national data on agricultural production in Africa are often limited, making it challenging to assess spatial production patterns (Liangzi et al. 2007).

Understanding the characteristics of fruit tree farms and their spatial distribution is crucial for developing adaptation strategies. By using a combination of traditional knowledge, advanced technologies, and participatory methods, researchers and policymakers can help smallholder farmers build resilience to climate change through sustainable fruit tree cultivation practices. This comprehensive approach can contribute to food security, biodiversity enhancement, and improved livelihoods for farming communities in East Africa and beyond.

2.4 Socioeconomic parameters that influence the cultivation of fruit trees

The adoption of agricultural modernization, as described by Rogers (2003), is a cognitive process involving various stages before farmers make decisions. Trees help stabilize variations in food and income streams as well as labor requirements, thereby affecting farmers' decisions on tree cultivation (Arnold & Dewees 1997). Place (2009) notes that agroforestry adoption is affected by factors like climate and farm characteristics. In lower-income countries, a complex mix of socioeconomic, demographic, technical, institutional, and environmental factors impact farmers' adoption processes (Masangano, 1996). Hence, demographic traits of participants are vital in shaping their views on adopting or rejecting new ideas (Ghauri and Qureshi, 1999).

Research indicates socioeconomic factors significantly influence the adoption of new behaviors. Uganda, according to recent FAO data, ranks second in sub-Saharan Africa for fresh fruit and vegetable production, producing about 5.3 million tons yearly (Bruinsma, 2017). However, specific production data on Uganda's fruits and vegetables is limited (Dijkxhoorn et al., 2019). Njogu et al. (2014) found that socioeconomic factors like poverty, farm size, household head's age, and gender influence fruit tree diversity and abundance. Ong'ayo (1993) suggests that in Western Kenya, acceptance of tree planting is influenced by income, occupation, and education level. Engler et al. (2020) mention that resource availability, market incentives, and biophysical factors significantly impact fruit tree adoption in agroforestry systems.

Fruit-producing trees like orange, cashew, mango, and Irvingia gabonensis serve multiple purposes, providing fruit for consumption and sale, leaves for fodder, and fuelwood (Esj, 2014). Proximity of fruit trees to homes reduces fruit theft, according to Esj. Agea et al. (2010) note that farmers' attitudes towards native fruit trees are influenced by gender, education, farm size, and profession popularity. Farmers' decisions to plant fruit trees are influenced by factors like gender, security of tree tenure, availability of seeds, and support from extension services (Kakuru, 2014). Women, for instance, may plant fruit trees to supplement family income and improve child nutrition.

Fruit trees not only offer nutritious food and income but also enhance household well-being. Miller (2020) found that having fruit trees on farms leads to positive outcomes like increased consumption and improved child health. Establishing deciduous fruit trees in Uganda's highlands shows potential for income generation and nutrition (Turyomurugyendo 2021). Integrating medicinal tree species like Prunus africana offers farmers multiple benefits like medicine, timber, and windbreaks (Galabuzi 2021).

This review delves into highlighting socioeconomic factors such as age, gender, education, household size, land holding, income level, and access to credit. Despite substantial existing literature, significant research gaps remain in understanding the nuanced determinants of fruit tree adoption as a strategy to adapt to climate change. By tackling these elements, interventions can be tailored more effectively to the specific needs and circumstances of farmers, thereby enhancing the likelihood of successful adoption of fruit tree growing.

2.4.1 Age and Adoption

The correlation between the age of a farmer and the level of fruit tree adoption exhibits variations in different contexts. Yuan et al. (2017) found that older farmers tend to engage in commercial forestry more frequently than their younger counterparts due to limited employment prospects in farming, while in the context of peach farming in Jiangsu Province, China, it was found that as the labor force age increased, there was a reduction in labor investment in tasks such as pruning and flower/fruit thinning, which negatively affected the efficiency of chemical and organic fertilizers. In the Southwestern Highlands of Uganda, age negatively impacted the adoption of apple management practices, as older farmers were less likely to adopt these practices (Aheisibwe et al., 2019). Furthermore, research on peach production in Pakistan's Khyber Pakhtunkhwa province revealed that older farmers were more likely to adopt improved cultivars (ICs) in peach cultivation (Bellow, 2008). In contrast, Dwivedi et al. (2009) does not specifically mention the adoption of fruit tree growing. Instead, the paper focuses on farmers' preferences for trees in agroforestry and explores the relationship between the age and landholding of farmers with their tree preferences. Therefore, the relationship between age and the adoption of fruit tree growing is context-specific and influenced by factors such as labor demands, employment opportunities, and access to information and training. Whereas Palsaniya (2010) does not provide information about how the age of a farmer influences their decision to adopt fruit tree growing, instead farmer's willingness to adopt agroforestry increased over time and efficient land use and high production were main motives for adoption. Given the variations in how age influences the adoption of fruit tree growing across different contexts and the interplay of socioeconomic factors, continued research is crucial.

2.4.2 Gender and adoption of innovation

If they are not taken into account beforehand, the diverse roles that men and women play in a community can impede the adoption of farming activities like cultivating fruit trees. For instance, women may not be permitted to grow trees in some cultures (Juma & Ojwang 1996). Their findings also suggest that the adoption may be hampered by the various roles that men and women fill in a community. In some cases, women may be less likely to engage in tree growing due to their assigned roles and responsibilities, such as household chores and childcare Oloo et al (2013). Similarly, a study in the Philippines revealed that women preferred plantation crops and timber trees, while men favored fruit trees, indicating gender differences in tree species preferences Ureta et al (2016). While Pierre (2018) found that, agricultural spaces were found to be gendered, with women controlling tree products and men controlling cash crops, which influenced agroforestry practices. Yet, Gumucio et al (2019) established that women's empowerment indicators such as group participation, land control, agency in decision-making, and access to information were significantly associated with increased household implementation of climate-smart agricultural practices related to trees. In their study, Degrande et al (2006) do not directly answer the question of how the gender of farmers affects the adoption of fruit tree growing. Nevertheless, the study concludes that farmers' decisions concerning tree retention and planting are influenced by a intricate set of interrelated factors. Despite the presence of previous research, there remains a notable void in our understanding of how to adequately tackle obstacles specific to gender and utilize gender-related preferences and roles to encourage adoption.

2.4.3 Education and adoption

According to research by Weir (1999), improving literacy and numeracy may make it easier for farmers to find and interpret information and determine the right amount of inputs in a modernizing or rapidly changing world. The amount of educational attainment in a society's population is consequently a key indicator of its human capital and socioeconomic progress. More educated farmers, in the opinion of Saha (2018), are more aware of the advantages of agroforestry and are more eager to put it into practice. Tajebe & Gelan (2018) found that apple trees provided multiple benefits for food security, livelihoods, and climate adaptation, but their adoption was influenced by factors such as education, market, and pest problems. Other studies have indicated that farmers with higher education levels are more inclined to embrace new agricultural techniques, such as fruit tree cultivation (Khan 2009; Tajebe 2018; Khalwale 2018). In the case of apple-based agroforestry systems, formal education positively influenced the adoption of fruit trees Bellow et al (2008). Additionally, education can enhance individuals' understanding of agricultural practices, including breeding techniques to improve fruit size, appropriate methods of storage, and the use of inputs to lower prices (Salgür 2013). In the context of on-farm tree planting, education level was identified as a key factor influencing the adoption of tree planting practices McMulin et al (2020). Their results also indicated that farmers with higher education levels planted more trees, while those with lower education levels planted fewer trees. These findings suggest that education plays a crucial role in promoting the adoption of fruit tree growing practices, potentially due to increased knowledge and awareness of the benefits and techniques involved in fruit tree cultivation. Rasamoelina (2016) found that participation in educational programs is significantly related to higher levels of adoption of sustainable forest management practices. Technical assistance, management planning, and economic incentives are the most crucial factors in predicting adoption. Ullah et al. (2018) identified that factors such as farmer experience, off-farm income, livestock ownership, and access to credit are crucial in promoting the adoption of superior peach cultivars. They recommended enhancing institutional services to provide training in managerial and technical skills to support technology adoption. Similarly, Gebru et al. (2019) emphasized the important role of educational attainment in encouraging the adoption of agroforestry practices. Nonetheless, the research paper does not delve into the specific impact of education attainment on the adoption of fruit tree growing. While these studies highlight the importance of education in promoting the adoption of fruit tree growing, ongoing research is essential to deepen understanding, address gaps, and develop effective, context-specific strategies.

2.4.4 Household size and adoption

Studies have shown that larger household sizes are associated with higher levels of fruit tree planting Gebru et al (2019). This could be due to the need for increased food production and the opportunity to generate extra income on small land holdings (Bellow et al., 2008). Tree-based horticulture, which requires significant labor during the initial stages of tree planting and maintenance, is more likely to be chosen by larger households with greater labor costs (Dewees, 1994; Godoy, 1992). Additionally, households with larger family sizes may have more labor available for tree planting and maintenance German et al (2009). Family size, therefore, is a factor, which is believed to determine the availability of labor force on the farm (Ekepu & Tirivanhu 2016). According to Ghauri and Qureshi (1999), the respondents' demographic characteristics are significant in determining how they perceive and feel about adopting or rejecting new ideas. Maluki et al (2016) observed a correlation between the size of the family and the inclination to adopt fruit plants in their investigation. Additionally, the likelihood of adoption increases as one transitions from a large to a small family. Smaller household sizes have been associated with lower levels of fruit tree planting (Dhakal & Rai 2020). The scarcity of labor and the inadequate production of food to fulfill yearly demands could be contributing factors to this situation. The decision to engage in fruit tree cultivation is greatly affected by household size, with larger households being more likely to adopt this practice. Although current literature offers valuable insights into the correlation between household size and the adoption of fruit tree growing, continued research is essential to deepen and broaden the understanding of this topic.

2.4.5 Land holding or size and adoption

In regions with larger land holdings, fruit-tree-based agroforestry systems are more appealing and have higher adoption rates (Khalwale et al., 2018). The study also highlighted that factors such as land size, family size, education level, and the distance from home to the forest influence the adoption of on-farm tree planting. On the other hand, in areas with smaller land holdings, the adoption of fruit trees may be limited due to the need to prioritize food production and limited land availability (Bellow et al, 2008). Furthermore, the land tenure systems can also impact the adoption of fruit tree cultivation. In areas where customary land tenure systems are prevalent and provide farmers with more freedom in land utilization, the cultivation of fruit trees is more conducive (German et al, 2009). However, land ownership and land rights issues, such as unequal land distribution and gender imbalances, can hinder the adoption of fruit tree growing among rural households Mugure et al (2013). While Gebru et al (2019) insights that land size is considered an indicator for agroforestry adoption, the finding does not specifically discuss the relationship between land holding or land size and the adoption of fruit tree cultivation. According to Degrande et al. (2006), smaller farms had higher fruit tree densities, suggesting that the size of land holdings impacts the adoption of fruit tree growing. Dhakal (2020) discovered that landholding size is a major constraint to the adoption of agroforestry, as smallholder farmers are reluctant to spare farmland for tree planting, which would reduce field crop production and fail to meet their annual food demand. While Maluki et al (2016), discovered that agroforestry adoption was positively connected with the size of landholdings. Land access dynamics, encompassing availability, acquisition, and use changes, were identified by Mpozi et al (2020) as influential factors in the introduction of passion fruits in East Africa. Further exploration is essential to understand the variability and complexity of these factors in diverse contexts. This will facilitate the generation of valuable insights crucial for devising targeted and effective approaches to promote the growth of fruit trees.

2.4.6 Income level and adoption

According to Arnold (1996), the impact of income level on fruit tree growing is not explicitly discussed. The author's main argument revolves around how economic factors shape the adoption of commercial Non-Timber Forest Products (NTFPs) in agroforestry systems. Income from (NTFP) activities helps rural households meet seasonal needs. In contrast, resource-limited farmers with lower incomes may face constraints such as the inability to produce sufficient food to meet their needs or lack of market infrastructure, which limit their adoption of fruit-tree-based agroforestry (Bellow et al, 2008). Furthermore, farmers with significant off-farm income are more likely to engage in commercial tree cultivation as a long-term investment (Tajebe et al., 2013). Income level is also linked to education, with more educated farmers being more inclined to participate in commercial forestry and having better access to information and training (Tajebe & Gelan, 2018). Consequently, income level is a crucial factor in the adoption of fruit tree cultivation, with wealthier farmers being more likely to adopt these practices. In yet another study, Mekonnen (1998) discovered that households with higher incomes and greater proportions of non-farm income are far more likely to grow trees. This might possibly be the case as households have a secure financial situation and can afford to buy huge parcels of land to plant trees. Multiple case studies illustrate the important function farm trees serve in rural communities, potentially acting as valuable income sources through timber or non-timber products like fruits (Degrande et al., 2006; Kalaba et al., 2010). These studies lay a sturdy foundation for exploring how income levels, along with educational and economic factors, shape the decisions made by farmers to adopt agroforestry practices as a strategy for climate change adaptation.

2.4.7 Access to credit

Access to credit may enhance the availability of capital on the agricultural land for procuring the necessary inputs. Micro finance institutions, as suggested by Mohamed & Temu (2008), are commonly observed in developing nations like Zanzibar as a promising instrument for supporting the impoverished by providing capital to marginalized sections of society. Nevertheless, these establishments do not extend their reach to rural areas, which are predominantly inhabited by farmers. A farmer who has the privilege of financial assistance can acquire or lease land for the purpose of planting trees, along with acquiring high-quality tree seedlings. This practice contributes to the enhancement of on-farm tree planting as these seedlings possess a higher survival rate when planted (Ngwenya 2019). To encourage small-scale tree planting, Carnea (1992) recommended granting farmers access to financial opportunities. However, some authors have raised concerns regarding easy access to credit and loans, as they may result in dependence and prove detrimental if the desired outcomes are not achieved (Arnold 1997). Sub-Saharan Africa faces limited access to both legal and informal financing, making it arduous to bridge the liquidity gap, consequently leading to smaller landholdings for impoverished farmers (Miller 2016). Despite this, Kehinde et al (2018) focused on the effects of credit availability, which has been shown to impact the uptake of advanced technologies in cocoa farming. Nevertheless, the abstracts do not discuss how credit accessibility influences the adoption of fruit tree cultivation. Mukherjee (2020) does not address fruit tree cultivation adoption directly, but underscores that access to credit enhancements impacts the adoption of new technology and is a pivotal factor in this adoption process. Additional research is needed to determine the exact impact of credit accessibility on the adoption of fruit tree cultivation. Consequently, it remains uncertain whether credit accessibility directly influences the adoption of fruit tree cultivation. It has been found through multiple studies that having access to credit significantly increases the likelihood of adopting recommended technologies and practices (Reyes 2012, Darko 2015). Farmers who can avail credit are more inclined to invest in inputs such as improved crop varieties, pesticides, and farmyard manure, which ultimately leads to enhanced productivity (Selvaraj 1998). However, current evidence strongly indicates that enhancing access to credit can promote the adoption of this climate adaptation strategy. Additional research is required to accurately measure the effect of credit accessibility on adoption of fruit tree cultivation.

2.5 Farmers' perception regarding cultivating fruit trees as an approach for adapting to climate change

Farmers' attitudes towards the adoption of fruit tree growing as an adaptation measure to climate change vary across different regions and contexts. Farmers in Bangladesh have embraced a shift towards fruit-dominated farming systems over rice-dominated monoculture, influenced by factors like unpredictable rainfall, temperature fluctuations, labor shortages in rice farming, economic incentives, and agricultural input availability (Rana & Muniruzzaman, 2021). Similarly, in southern Italy, farmers exhibit keen interest in participating in on-farm conservation programs focused on cultivating vine landraces as a climate change adaptation strategy (Sardaro et al., 2021). The behavioral intention of farmers in China to adopt adaptation measures is greatly influenced by psychological factors and social appraisal. The assessment of threats, coping strategies, and social factors all have a positive impact on their adaptation behavior (Feng 2017). The awareness and perspectives of smallholder farmers in the Philippines regarding climate change and agroforestry are generally positive, but there may be barriers to the correct practice of agroforestry and other adaptation measures (Evangelista et al 2016). In Shaanxi Province, China, cherry growers' perceived adaptation efficacy are shaped by elements like the attitude towards the behavior, subjective norm, and perceived behavioral control as well as age, household agricultural income, and perceptions of local climate warming and frost (Song & Shi 2020). The reviewed studies do not specifically mention farmers' attitudes towards the adoption of fruit tree growing as an adaptation measure to climate change. According to Linder & Campbel-Arvai (2021), it is crucial to take proactive steps like crop diversification and adopting new varieties to bolster the resilience of farms against the anticipated climate impacts. However, the fruit growers in Michigan encountered difficulties in rationalizing these modifications due to their uncertainty about the future climate changes. These studies underscore the importance of considering regional and contextual factors, environmental conditions, social norms, and psychological perceptions. However, these studies also reveal significant gaps in comprehending farmers' attitudes, highlighting the need for additional research.

2.6 Summary of reviewed literature

Many regions across the globe possess a longstanding cultural practice of utilizing trees within agricultural settings. Since the early 1990s, a notable discrepancy has been observed between the frequency at which trees are integrated into farms and the advancements made in the realm of agroforestry knowledge. Consequently, this has led to an influx of research endeavors dedicated to comprehending the reception of agroforestry innovations within tropical regions (Mercer 2004). It is imperative to note that the acceptance of fruit trees is subject to significant variations on a large scale, encompassing both ecological and socioeconomic contextual factors. Patterns of tree cover on agricultural lands, biodiversity, numerous utilities, the depth of management, and occupied ecological niches are among the topics investigated and characteristics identified (Somarriba 2017). Factors such as the size of the household, land ownership, government subsidies, livestock management, energy sources, and overall income have a notable positive impact on tree cultivation on agricultural land (Singh et al., 2021). Conversely, age exerts a negative impact on the adoption of such practices (Gebru et al 2019). Furthermore, the availability of agricultural land and accessibility to markets emerge as crucial constraints that impede the adoption of these practices (Bellow et al 2008). These findings underscore the necessity for interventions, such as the increased adoption of proven technologies, the establishment of linkages between farmers and markets, and the organization of farmers into groups to facilitate the pooled utilization of resources. These interventions serve to promote the adoption and sustainability of fruit-tree-based production systems. Farmers incorporate a diverse array of indigenous and non-indigenous tree species into their agricultural practices, taking into account their specific farm conditions, requirements, and asset profiles (Liyama et al 2017). Adoption was described by considering preferences, available resources for implementing new technologies, resource endowments, market forces, biophysical factors, risk, and uncertainty. Acevedo (2020) concluded that the adoption of climate-resilient crops is influenced by extension services and outreach programs, levels of education, access to inputs, and the socio-economic status of farmers. Therefore, the objective of this study was to identify the factors that impact the local acceptance of fruit tree farming among farmers in the Budaka district as a strategy for adapting to climate change. Ongoing research on the determinants of adopting fruit tree cultivation as an adaptation practice to climate change is vital due to the intricate nature of these factors, the identification of constraints and barriers, the importance of interventions, the need to understand local contexts, and the opportunity to address gaps in existing literature. Understanding the interplay of these diverse factors is essential for designing targeted interventions that effectively promote adoption.

2.7 Gap in the literature

The literature on agroforestry adoption presents diverse methodologies to elucidate farmers' behaviors and practices, offering nuanced insights into adoption processes (Tefere & Nigussie, 2018; Khan et al., 2021; Nair, 2019; Raj, 2019). By focusing on fruit tree cultivation as a strategy to adapt to climate change and exploring the socioeconomic factors influencing its adoption, this study aims to explore the intricacies surrounding the uptake of sustainable farming methods. This enhanced understanding has the potential to inform targeted interventions and policy formulations aimed at enhancing farmers' resilience to climate change through fruit tree farming.

Considerable scholarly attention has been devoted to understanding the uptake of agroforestry innovations in tropical regions, revealing a myriad of contextual factors both physical and socioeconomic that shape their acceptance (Leslie & McCabe 2013). Adoption dynamics can be elucidated by exploring factors such as individual preferences, resource allocation, endowments, market incentives, and biophysical considerations. However, there remains a conspicuous gap in the literature concerning the specific determinants driving the adoption of fruit tree farming as a climate change adaptation strategy in the context of Budaka District, Eastern Ugaanda. Despite its potential contributions to sustainable agriculture, food security, and economic development, studies by Bammanahalli et al. (2016) and Degrande (2006) fail to explicitly address the rationale behind embracing fruit tree cultivation. This gap highlights the need to identify critical variables that could facilitate the transition to these systems over conventional land management practices (Tajebe & Gelan, 2018).

The existing literature provides limited comprehensive coverage of the specific determinants influencing the uptake of fruit tree cultivation as a climate change adaptation strategy. Therefore, this investigation seeks to bridge this scholarly gap by introducing a pivotal covariate the perception of farmers regarding fruit tree farming as a climate change mitigation tool. Through an analysis of the socioeconomic factors shaping the adoption of fruit tree farming, this study aims to not only address identified gaps in the literature but also to advance sustainable agriculture, bolster food security, and foster economic opportunities through the promotion of fruit tree cultivation as a viable adaptation strategy.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter offers a comprehensive explanation of the methodology employed in conducting the research. It includes a summary of the research design, study population, sample size, sampling methods, data collection techniques, research tools, quality control checks, ethical considerations, data evaluation methods, and findings presentation.

3.1 Study area

3.1.1 Location

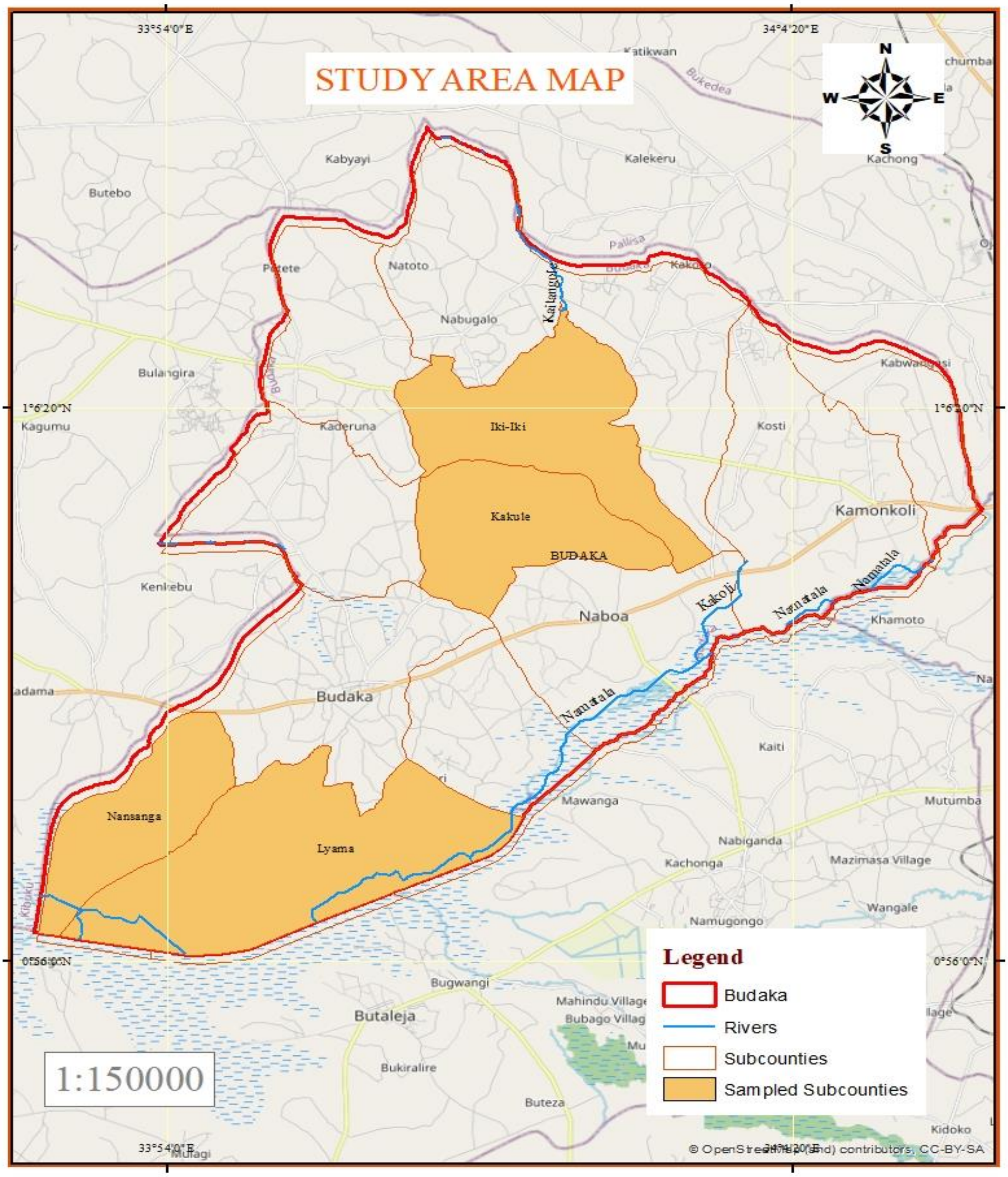
Budaka, situated in the eastern region of Uganda, occupies a geographic position of 1° 0′ 14″ North and 33° 54′ 32″ East. This district covers a total expanse of 410.4 km2 and boasts an average elevation of 1,080 meters above the sea level. Comprising of twelve (12) Administrative Sub-Counties, namely Budaka Town Council, Budaka, Iki-Iki, Kachodo, Kaderuna, Kakule, Kameruka, Kamonkoli, Katiira, Lyama, Naboa, and Nansanga, this territory is encircled by neighboring districts of Butebo to the north, Mbale to the east, Butaleja to the south-east, Namutumba to the south, and Kibuku to the west, (www.budaka.go.ug/district/geography)

Plate 1: Location of Budaka District

Source ArcMap10.8

The study was specifically conducted in the four subcounties of Kakule, IkiIki, Lyama and Nansanga.

Plate 2: Study area map



Source: ArcMap 10.

3.1.2 Topography

The topography of the Budaka District is typically characterized by low and flat terrain, which is notable for its shallow seasonal wetlands. Positioned at an elevation ranging from 900 to 1200 meters above sea level, it exhibits a prevailing altitude of 1,080 meters above sea level. With a mere 21 meters above sea level, there is minimal variation in terms of relative relief. Generally, the valleys tend to be expansive while the interfluves are level and gently curved, frequently safeguarded by a layer of murram. (www.budaka.go.ug/district/geography).

3.1.3 Climate

The climatic conditions in Budaka District consist of two distinct rainy seasons, namely from the months of August to November and from March to June, respectively. However, it is worth noting that occasionally, the expected pattern of rainfall may deviate from its defined course, thereby exerting a substantial impact on agricultural activities, particularly given that this form of farming is heavily dependent on precipitation. As per the meteorological department's records, the district's average annual rainfall was recorded at 1465mm during the period spanning from 1929 to 1970, with a monthly average of 122.08mm. The variations in temperature within the area are not particularly noticeable. Specifically, between the years 1932 and 1970, the district recorded maximum annual temperatures of 28.700 centigrade and minimum temperatures of 16.200 centigrade. Furthermore, the average monthly temperature increased to 17 degrees Celsius. (www.budaka.go.ug/district/geography).

3.1.4 Drainage

The drainage network in the Budaka district is predominantly controlled by rivers that originate from the Namatala and Lwere marsh complexes. The slopes of Mount Elgon play a significant role as the catchment areas for the wetland habitats. The primary water sources for these river systems encompass surface water flows, precipitation (rainfall), as well as groundwater discharge. These wetland ecosystems serve as a water supply for the drainage systems of the Palisa district and the neighboring districts of Lake Kyoga. The Namatala River, which acts as a natural boundary between the Budaka, Mbale, and Butaleja districts, holds a crucial position within the Budaka district. (www.budaka.go.ug/district/geography)

3.1.5 Soils

In Budaka district, there are two primary categories of soil. These categories consist of hydromorphic and ferritic soils. The ferralitic soil type is characterized by reddish-brown and sandy loams, as well as loams found on laterite. These soils exhibit a significantly low pH level of less than 5, indicating high acidity. Additionally, they are deficient in both accessible phosphorus and major transferable bases. However, they prove to be suitable for the cultivation of cotton, sorghum, millet, groundnuts, cassava, and pigeon peas. On the other hand, hydromorphic soils are commonly found in areas with year-round or permanent swamps or wetlands that are prone to waterlogging. These soil types are prevalent in the southernmost region of the district. Certain hydromorphic soils may also possess localized salinity and notable levels of cation saturation.

They are particularly advantageous for the growth of finger millet, sorghum, maize, and paddy rice. (www.budaka.go.ug/district/geography).

3.1.6 Vegetation

Budaka district's natural cover has been significantly altered by tree cutting, grazing, yearly or biannual grass fire (burning), combined with an abundance of traditional farming practices. Savannah grassland is the predominant type of grass cover. The district's main wetlands include a lot of vegetation that is swampy. The district has a few solitary patches of forest cover. Jami in the Kamonkoli sub-county and Kabuna in the Kaderuna sub-county are two local forest reserves in the area. The Budaka district lacks any national reserves. With impunity, rice farmers have badly destroyed the local reserves. It should be emphasized that encroachment has led to the conversion of more than 70% of wetland forests into paddy rice farming. Mangoes, jackfruit (Fene), tamarind (Mukoge), and other timber-bearing trees like "Mukunyu" are among the fruit trees that are suffering from degradation. (www.budaka.go.ug/district/geography).

3.1.7 Land use

The district's land tenure structure determines its pattern of land usage. According to the Land Act (CAP 227), the following kinds of land tenure—customary, freehold, Mailo, and leasehold—are used to determine who owns land in compliance with article 237 of the Constitution. In the district, mailo land is not very common. Leasehold and customary tenure are the two most popular types of land ownership. Most of the land is utilized for subsistence agriculture because tiny land holdings are by their very nature agricultural. (www.budaka.go.ug/district/geography).

3.1.8 Access to Study Area

Given the nature of this research, the study area was accessed first and foremost through a letter introducing the researcher to the concerned authorities in Budaka district, obtained from the department of Geography of Kyambogo University. The local leaders in the district and sub counties were contacted as entry points for the study whereby the study objectives were clearly presented and discussed. Thus, entry into communities for data collection was made possible when authorization to carry out the study in the district was secured. As a result, the communities were reached through the village council chairpersons in each of the four sub counties of Kakule, IkiIki, Lyama, and Nansanga, who guided the researcher to various homes to administer the surveys.

3.2 Research design

Research design pertains to the methods used for gathering, analyzing, interpreting, and presenting data in research endeavors (Creswell & Plano Clark, 2007). This specific study employed a mixed method research design in order to conduct a comprehensive investigation (Hafsa, 2019). The objective of utilizing this mixed method approach was to strengthen the credibility and dependability of the research findings, as well as to gain a thorough understanding of the topic by integrating both qualitative and quantitative data. The justification for adopting a mixed method design lies in its ability to facilitate the analysis of relationships among different variables, a task that cannot be accomplished through the use of a single research method.

Structured survey instruments to collect quantitative data on the determinants of fruit tree growing adoption was developed. Elements such as socioeconomic status, resource availability, climate change awareness, and historical farming practices were recorded. The survey instruments were administered to a representative sample of participants, ensuring diversity in demographics and geographical locations. Use of SPSS computer software was adopted for statistical analysis (e.g., Chi square and regression analysis) as a quick way to analyze relationships between categorical variables and identify significant predictors of fruit tree growing adoption as an adaptation practice to climate change. In-depth interviews, focus group discussions, or open-ended surveys to collect qualitative data on participants' experiences, perceptions, and attitudes towards fruit tree growing as an adaptation practice. Analysis and interpretation of both quantitative and qualitative data was done. The qualitative data provided context and depth to the quantitative findings and the implications of the combined findings were discussed for policymakers, practitioners, and other would-be researchers.

Due to the study's constrained resources, such as time and financial means, the aforementioned design proved to be suitable as it facilitated the gathering large amounts of data from a considerable number of participants in a relatively brief period (McNeill and Chapman, 2005).

3.3 Study Population

Neuman (2006) defined a population as a clearly defined group from whom a targeted sample can be chosen and that is described in detail. Therefore, the total number of farmers/households (N) that are engaged in farming activities in Budaka District was the study population taken into account in this study. (www.budaka.go.ug/district/geography). From this, a representative sample of respondents was collected for the study, which served as the sampling frame. The sampling units for primary data was thus the individual fruit growing farmers, non-adopter farmers, community leaders, elected leaders at district and sub county level and technocrats drawn from technical departments (CAO, RDC, Agriculture officers, Natural Resources, Environment, District Production and Marketing officer, Sub County Chiefs and Extension Workers).

3.4 Sample Size

The quantity of subjects, respondents, or observations drawn from the study is referred to as the sample size (Ahmed & Halim 2017). Using the equation provided by Krejcie and Morgan (1970), a sample size was calculated in order to establish the required number of participants for this research in order for it to be representative of the study population.

$$S = \frac{\chi 2NP(1-P)}{d^2(N-1) + \chi 2P(1-P)}$$

Where;

S = necessary sample size

χ^2 = the chi-square table value for one degree of freedom at the selected confidence level (1.96 x 1.96 = 3.8416).

N = the population size

P = is the population percentage which is assumed to be 0.50 to achieve the maximum sample size.

d = is the accuracy level proportionally stated (0.05).

From secondary information available in the district, there are an estimated 34,898 farming families in Budaka district. The study population as a whole was 34,898 according to this number, ***N***. A total sample size of 379 fruit-growing farmers in the district was determined by entering the various factors into the aforementioned method. In order to account for the absentee farmers, 10% more farmers were included, bringing the sample size to 417.

3.5 Sampling Techniques

According to descriptions in the literature, the sampling methodology is a way of choosing the people who will be the subject of the information (Gupta and Kapoor, 1970; Kish 1965). To choose the study participants, a purposeful multi-stage sampling strategy was used in this investigation. In the first stage, the leading County in fruit growing was sampled for the study. In the second stage, the four leading fruit tree growing sub counties were sampled. In the third stage the two parishes from each sub county were sampled (8 parishes in total) and in the fourth stage two villages per parish were sampled, sixteen (16) villages in total. Finally, eleven (11) respondents were sampled per village using the household lists available with the LC1s in the respective villages as the sampling frame. Criteria-Based Selection was established to differentiate between adopters and non-adopters. It was based on the number of fruit trees planted and duration of practicing adoption. To collect the required primary data for this study, questionnaires were distributed to a total of 176 respondents.

Table 3.1: Category of respondents

Category	Sub-category	Number of participants	Total number of respondents
District policy makers	CAO	**1**	
	Production/commercial officer	**1**	
	Natural resources and environment officer	**1**	
	Subcounty chiefs	**4**	
	Extension workers	**2**	**10**
Implementers/farmers		**176**	**176**
Focus groups		**35**	**35**
Total		**221**	**221**

3.6 Methods/tools for data collection

The mixed design incorporated both quantitative and qualitative data collection methods and tools. Primary data was obtained through questionnaires, Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs). This approach enabled the researcher to triangulate the study area and validate the questionnaire data, while also gathering secondary data through document analysis. A summary of the specific data collection techniques and technologies used is provided below.

3.6.1 Document review

The review of previous material served as the primary entry point for the investigation, providing the researcher with a comprehensive understanding of the state of fruit tree cultivation in the Budaka district at that time. The analysis of documents is a valuable qualitative research technique that permits the undertaking of studies with reduced resource requirements and mitigates ethical considerations (Vecchio et al., 2020). The researcher read all relevant written and electronic (both published and unpublished) literature. Therefore, the primary materials analyzed consisted largely of official government policy papers and directives on fruit production, technology adoption, and climate change adaptation. Others included; monthly and annual reports from the production department and other sister departments (natural resources, environment documents). The documents for specific programs that had previously been carried out in the fruit producing industry, such as NAADS, PMA, and Operation Wealth Creation, were also examined. Other particular publications on technology uptake and climate change adaptation, including the National Adaptation Plan of Action (NAPA) and a number of other pertinent documents, were also studied. Overall, the document review supplied the background knowledge needed to clarify meaning, deepen understanding, and find insights pertinent to the research challenge, and it assisted in the development of pertinent data gathering tools.

3.6.2 Questionnaire method

The primary instrument for gathering both qualitative and quantitative data from sampled respondents has been questionnaires. Questionnaires, when properly designed, distributed, and validated, can serve as a highly effective means of data collection (Marshall et al., 2005). The researcher distributed them as they mainly comprised closed-ended questions with a few open-ended ones. In order to avoid ambiguity and digression, respondents took this approach when responding to questions. The questionnaires collected information on respondents' socioeconomic status, aspects of fruit tree production (such as the amount of land planted with fruit trees and production limitations), factors influencing farmers' adoption of fruit tree farming, and farmers' opinions on the use of fruit trees as a strategy for coping with climate change. Regarding the cultivation of fruit trees in the region, it also documented additional relevant data. Prior to actual data collection, the questionnaire was developed, pre-tested, and refined as necessary. To elicit insightful comments from the respondents, questionnaires were given to both adopters and non-adopter farmers. While using non-adopter farmers as a control group was ideal to minimize bias in the study, other pertinent information from non-adopters was obtained through focus groups discussions.

3.6.3 Focus Group Discussions (FGDs)

This was another approach utilized to gather qualitative data from respondents. The selection of participants for the FGDs comprised individuals who were not included in the questionnaires, namely fruit growers, non-fruit growing farmers, community leaders, elders, religious leaders, and other opinion leaders in the communities. These groups of individuals possess extensive knowledge about their respective communities and are well acquainted with the factors that determine the cultivation of fruit trees in the study area. The participants were carefully chosen with the guidance of community leaders, elders, and opinion leaders. The decision was made to conduct only one FGD per sub county, ensuring that no more than 20 participants were involved, in order to adhere to the Standard Operating Procedures (SOPs) for COVID-19. However, two focus group discussions (FGDs) were conducted, with a combined total of 35 participants.

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were utilized in the selected study regions to gather qualitative data (sub counties, parishes, and villages). The participants in the focus group discussions (FGD) were randomly selected from fruit growers who were not surveyed, non-adopter farmers, seniors, and other opinion leaders in the communities who possess awareness and experience in the research area. It was expected that the study would conduct only one FGD per Sub County, with no more than 20 participants, in order to adhere to the COVID-19 Standard Operating Procedures (SOPs). However, a total of two (2) FGDs were conducted, involving thirty-five (35) participants. It is from these figures that the study was able to engage a significant and representative sample of Two hundred and twenty-one (221) participants, which is quite substantial and indicative of the study population.

3.6.4 Key Informant Interviews (KIIs)

Key Informant Interviews constituted an additional indispensable methodology for the collection of qualitative data. This approach was extended to technocrats in specialized departments, namely the Natural Resources/Environment Officer and the Production and Commercial Officers, as well as district leaders, including the RDC, LC5, and CAO. These groups of individuals possess a comprehensive understanding of the scientific principles underpinning the cultivation of fruit trees, the intricacies of marketing, the implementation of novel technologies, and the repercussions of climate change within the Badaka district. Moreover, they are well-acquainted with the challenges and constraints that farmers encounter when attempting to cultivate and market crops in this particular region. In order to facilitate the conduct of FGDs, a checklist was devised, which was equivalent to the one used for FGDs but encompassed more technical details. The purposeful sampling method was employed to identify participants for the Key Informant Interviews (KIIs). The respondents were required to possess a wealth of experience and were selected from among the district leaders (RDC, LC5, CAO) and the technical departments (production and commercial officer, natural resources and environment officer). Subsequently, an invitation was extended to the subjects via a formal letter and a subsequent phone call, wherein a mutually convenient time was established. These groups of individuals harbor a profound knowledge regarding the marketing strategies employed within the district, the adoption of technological innovations, and the implications of the evolving climate. Furthermore, they boast a deep comprehension of the technical aspects pertaining to the cultivation of fruit trees. Additionally, they exhibit a considerable awareness of the challenges and limitations that farmers in the area face when attempting to grow and market crops. As a result, the Key Informant Interviews (KIIs) were carried out with a maximum of 10 participants.

3.6.5 Observation method

This approach played a crucial role in establishing a connection between the documented information and the actual occurrences that took place in the research area. As stated by Kumar (2005), observation entails a purposeful, systematic, and selective act of perceiving and listening to an event as it unfolds. The importance of observation lies in its capacity to allow researchers to study individuals within their natural environments with the purpose of comprehending "phenomena" from their vantage point (Manion et al 2017). The research focused on actively and consciously observing phenomena, conducting thorough examinations, and documenting them. The researcher had to actively participate in the process of gathering data through observation in order to obtain firsthand impressions of the events. To discern the various types of habitats, techniques of management and cultivation, essential characteristics of fruit tree farms, farm size (measured in acreage), and the types of technology employed, an observational study was conducted. A fruit tree inventory of the selected households was used to gather quantitative data pertaining to the fruit trees present on the farms.

3.6.6 Geographic Information Sciences

In order to estimate, delineate, and characterize the spatial distribution of fruit tree farms, a point source Geographic Information System (GIS) data layer was utilized to establish the geospatial variability. The utilization of GIS enables the input of data, manipulation of the data, and generation of comprehensible results that can enhance our understanding of the phenomena (Knippers et al., 2001). The exact position of each sampled fruit tree farm was identified on-site using the Global Positioning System (GPS), and subsequent cartographic representations were produced and refined in QGIS/ArcGIS, while also being evaluated for distinctive attributes. Reference to the UTM projection method and the WGS84 Earth model was made for spatial alignment.

3.7 Quality control

Quality control is pivotal in research endeavors, ensuring the validation of accurate and dependable observational data, while also enhancing the efficiency and uniformity of said data (Bian et al, 2019). In an effort to regulate or mitigate the effects of auxiliary elements and determine if the instruments are measuring the intended variables accurately and consistently, the research examined the validity and reliability of the study instruments.

3.7.1 Reliability

The reliability of an instrument pertains to its ability to consistently gather the same data in identical circumstances (Amin 2004; Odiya 2009). In this particular study, the internal consistency approach was employed, which entailed administering a pretest of the instrument to a sample of respondents, and employing Chronbach's alpha coefficient to correlate the scores of the responses.

$$\boldsymbol{a} = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}}$$

Where; $N = \textit{the number of items}$

$\bar{\boldsymbol{c}} = \textit{the average covariance of the item pairs}$

$\bar{\boldsymbol{v}} = \textit{the average variance}.$

The majority of individuals believe that an internal consistency coefficient of at least 0.70 is adequate, despite the fact that there are no unbreakable laws governing internal consistency (Whitley, 2002, Robinson, 2009). A collection of measurements must possess consistency in order to be deemed reliable. The reliability of research findings is enhanced by reputability and generalizability.

3.7.2 Validity

The extent to which the data accurately reflect the subject being studied is referred to as validity (Ghauri and Gronhaug, 2005). In other words, for a test to be considered reliable, it must also possess validity (Wilson, 2010). In this particular investigation, the content validity was established through the implementation of a judging technique that involved conducting literature reviews and subsequent evaluations by expert panels or judges. The Content Validity Index (CVI) was calculated as CVI = $\frac{n}{N}$, with *N* representing the total number of panellists and *n* representing the number of panellists who identified an item as "important" (in agreement).

3.7.3 Other quality control

The study ensured the standardization and consistent application of data collection procedures amongst all participants or cases, in order to minimize variability and enhance the reliability of the results. In the case of Data Validation and Cleaning, it was imperative to regularly check and clean the collected data for errors, outliers, or inconsistencies, as this was crucial for maintaining data quality. This involved ensuring the accurate checking of respondents' questionnaire responses, conducting daily checks to ensure all questionnaires were properly filled, organizing and categorizing responses and opinions obtained from FGDs and KIIs prior to analysis, ensuring precision and consistency in recording discussions during FGDs and KIIs, accurately coding, entering, and cleaning data from questionnaires before analysis. The research adhered to established ethical guidelines to uphold the integrity of the study. Thorough documentation of research procedures, methods, and decisions was carried out to ensure transparency.

3.8 Ethical Considerations

The use of "informed consent" strategy was employed, in which all participants were treated with respect and civility after being told of the purpose and research methodology. The respondents' anonymity and confidentiality were upheld, and permission was requested before conducting the direct interviews. All interviews and discussions were carried out in open places in the usual community meeting places in the sub counties and village household units. During dissertation writing, care was taken to report honestly, avoid disclosing information that harms participants and language adopted is appropriate for research audiences.

Finally, a report detailing results of the research was prepared and will be shared with the study participants.

3.9 Data analysis and presentation of findings

Data analysis can be defined as the procedure of examining, purifying, manipulating, and modeling data, with the purpose of discovering pertinent information, drawing conclusions, and providing recommendations (Savenye, Robinson, 2004). Given that the research study produced both quantitative and qualitative data, both qualitative and quantitative approaches to data analysis were employed. Quantitative analysis primarily deals with numerical data such as numbers, measurements, and indices, whereas qualitative analysis focuses on non-numerical data, encompassing recordings, documents, transcripts, and images (Cooksey & McDonald, 2019). The SPSS statistical package was extensively utilized to evaluate the quantitative data. The chi-square test of independence was utilized to assess the presence of a meaningful connection between two categorical variables: adoption of fruit tree growing and socioeconomic factors. The formula for the chi-square test statistic is:

$$\chi 2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where:

O_{ij} represents the observed frequency in cell ij (the intersection of the i-th row and j-th column),
E_{ij} represents the expected frequency in cell ij under the assumption of independence,
The sum is taken over all cells in the contingency table.
The anticipated frequency (E_{ij}) for each cell is typically computed using the formula:

$$E_{ij} = \frac{R_i \times C_j}{N}$$

Where:

R_i is the sum of the observed frequencies in the i-th row,

C_j is the sum of the observed frequencies in the j-th column,

N is the total sample size.

The test statistic is compared against the critical value from the chi-square distribution corresponding to the degrees of freedom, or a p-value is calculated to determine the statistical significance of the result. Correlation analysis was implemented to assess the strength and direction of the relationship between farmers' perception about climate change and the adoption of fruit tree growing. Through this method, the researcher gained insight into how changes in one variable were related to changes in another. Multiple regression analysis was employed to investigate how the independent variables affect the dependent variable, with the purpose of establishing predictors for the adoption of fruit tree growing as an adaptation practice to climate change. The goal of multiple regression is to estimate the coefficients (β) such that the model best fits the observed data. The values of the independent variables enable the prediction of the dependent variable.

The general formula for a linear multiple regression model is:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn + \varepsilon$$

Here,

- Y is the dependent variable
- $X1, X2, \ldots, Xn$ are the independent variables
- $\beta 0$ is the intercept (the value of Y when all independent variables are zero).
- $\beta 1$, $\beta 2$,…,βn are the coefficients representing the change in Y for a one-unit change in each respective independent variable, holding other variables constant.
- ε is the error term, representing unobserved factors affecting Y that are not accounted for by the model.

The data have been presented in tables, pie/bar charts, graphs, and other acceptable formats for the study. The analysis predominantly yielded descriptive statistics, averages, and trends.

Based on the key responses, views, and opinions expressed by participants in the FGDs and KIIs, the qualitative data was categorized, classified, and coded into themes. Thematic analysis approaches were employed to examine the qualitative data, and the outcomes have been presented as patterns and trends in the development of fruit trees in the Budaka district. The challenges and limitations in fruit production and sales, as well as farmers' perspectives on the utilization of fruit trees as a climate change adaptation technique, have been elucidated.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

In this chapter, the socioeconomic characteristics of the respondents are examined in conjunction with statistical analyses aligned with the objectives of the study, a comprehensive assessment of the collected data, and an exploration of the initial findings. The data has been meticulously presented, analyzed, and interpreted through the utilization of frequency distribution, proportions, percentages, tables, and graphs. The primary aim of this research endeavor was to investigate the variables that influenced the adoption of fruit tree cultivation as a strategy for coping with climate change in the Budaka district, Eastern Uganda.

4.1 Characteristics of the Fruit Tree Farmers in Socioeconomic Terms

The selected respondents' socioeconomic traits were examined in this research. When describing the distribution of farms and the farmers who raise fruit trees, the following parameters were taken into consideration. Among the various factors are age, gender, occupation, family size, marital status, and yield. See table 4.1.

4.1.1 Demographic details of the respondents

Table 4.1: Characteristics of the fruit tree farmers: (Source field data September 2021)

Variable	*Category*	*Frequency*	*Adopter Frequency*	*%*	*Non-Adopter Frequency*	*%*	*Total %*
Age	18yrs	5	2	1.1	3	1.7	2.8
	19-29yrs	24	15	8.5	9	5.1	13.6
	30-39yrs	40	34	19.3	6	3.4	22.7
	40^{+}yrs	107	99	56.3	8	4.5	60.8
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Gender	Male	122	108	61.3	14	8.0	69.3
	Female	54	42	23.9	12	6.8	30.7
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Education	None	37	31	17.6	6	3.4	21.0
	Primary	88	77	43.8	11	6.3	50.0
	Secondary	36	28	15.9	8	4.5	20.5
	Tertiary	15	14	8.0	1	0.6	8.5
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Marital Status	Single	29	24	13.6	5	2.8	16.5
	Married	142	123	69.9	19	10.8	80.7
	Widow(er)	05	3	1.7	2	1.1	2.8
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Family size	1-6	57	48	27.3	09	5.1	32.4
	7-12	78	66	37.5	12	6.8	44.3
	13^{+}	41	36	20.5	05	2.8	23.3
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Occupation	Peasant	143	122	69.3	21	11.9	81.3

C. Farmer	11	09	5.1	02	1.1	6.3
Other	22	19	10.8	03	1.7	12.5
Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**

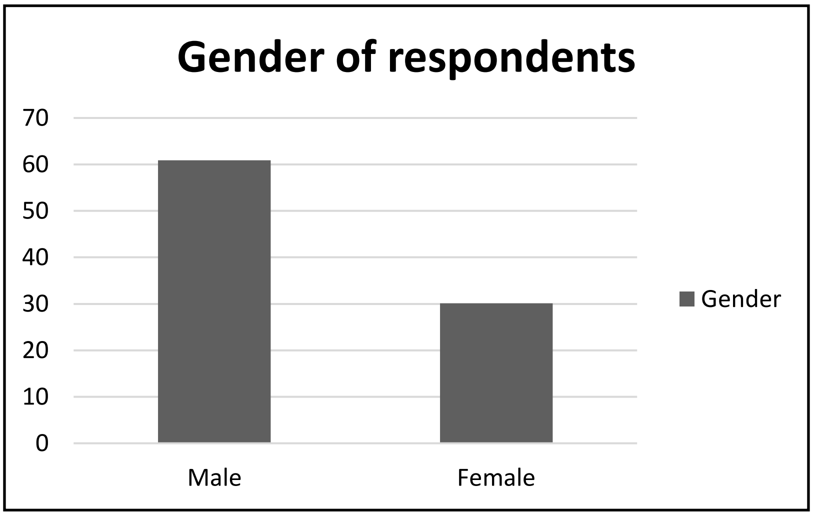
4.1.2 Age characteristics

The research found that a sizable percentage of the respondents were over 40 years old, or 60.8%, showing that the growers were primarily made up of middle-aged persons who were at an economically productive generation. The age group of 40 years and over, or 99 farmers, has the highest percentage of adopters, or 56.3%. There are 26 non-adopters. This implies that middle-aged farmers are a key demographic in the adoption of fruit tree growing as a climate adaptation strategy. Interventions should be designed to support their economic capabilities, leverage their experience, and address barriers to adoption, ensuring that this practice becomes a sustainable and widespread solution to climate change challenges.

4.1.3 Gender characteristics

Among those listed in table 4.1, 122 individuals (69.3%) were male, while 54 individuals (30.7%) were female. The data indicates that most respondents were male. Specifically, out of a total of 150 adopters, there were 108 males (representing 61.4% of the population) and 42 females (23.9%)). This implies that men are more likely to adopt fruit tree growing compared to women. Addressing these gender-based differences can lead to more inclusive and effective climate adaptation strategies.

Figure 4.1. Responders' gender



Source: Field data.

4.1.4 Education

Table 4.1. further illustrates distinctions in the educational backgrounds of the participants. Consequently, 21% of the respondents lacked a formal education, whereas 50% of them had only received an elementary education. The findings also reveal that a significant majority of 15% of the respondents possessed tertiary education, in comparison to the 36% who had obtained secondary education. Among the 77 individuals (43.8%) who attended primary school, there were adopters, while 11 individuals (6.3%) did not adopt. The implication is that individuals with at least a primary education are more likely to adopt fruit tree growing. Therefore, educational initiatives and literacy programs could play a crucial role in promoting the adoption of climate adaptation practices.

4.1.5 Marital status

The study categorized the participants into three groups based on their marital status: unmarried, married, and widowed (er). According to the report, 16.5% of the individuals surveyed were single, while the majority, 80.7%, were married (as shown in Table 4.1.). Furthermore, the data presented indicates that 2.8% were widowed or widowers. The report highlights that the majority of adopting farmers (69.9%) were married, while 13.6% were single, and 1.7% were widowed (er). Among the non-adopters, 5 individuals were single, 19 were married, and 2 were widows (er). This implies that married individuals are more likely to adopt fruit tree growing compared to their single or widowed counterparts. This could be due to the stability and support systems often associated with marriage, which may facilitate the adoption of new agricultural practices.

4.1.6 Household size

The results show that 32.4% of the respondents had between 1-6 members in their households, whereas 44.3% had between 7-12 members, and 23.3% had 13 or more members in their households. Table 4.1. displays that the largest proportion of adopters, 37.5%, had a family size between 7-12. Moreover, 20.5% of the farmers with the highest number of household members (13+) were adopters. On the other hand, among the non-adopters, 9 individuals had 1-6 members, 12 had 7-12 members, and 5 had 13 or more members in their households. These findings means that larger household sizes, particularly those with 7-12 members, are more likely to adopt fruit tree growing as an adaptation strategy to climate change. This could be due to the greater availability of labor and resources in larger households, facilitating the implementation of new agricultural practices.

4.1.7 Occupation

Table 4.1 provides the percentage distribution of participants according to their employment status based on their demographic characteristics. The data shows that 81.3% of the participants were peasant farmers, 6.3% were commercial farmers, and 12.5% were engaged in other forms of occupation. Among the 150 adopter farmers, 69.3% were peasant farmers, 5.1% were commercial farmers, and 10.8% were farmers in other occupations. In contrast, among the 14.8% non-adopters, 21 individuals were peasants, 2 were commercial farmers, and 3 were engaged in other sectors of production. The findings suggest that peasant farmers form the majority of those adopting fruit tree growing as a climate change adaptation practice. However, their adoption rate (69.3%) is lower than their overall representation (81.3%), indicating a gap that could be addressed with targeted support. Commercial farmers and those in other occupations have lower absolute numbers but proportionally higher adoption rates, which may reflect better access to resources and information.

Table 4.2: Characteristics of the fruit tree farms: (Source field data September 2021)

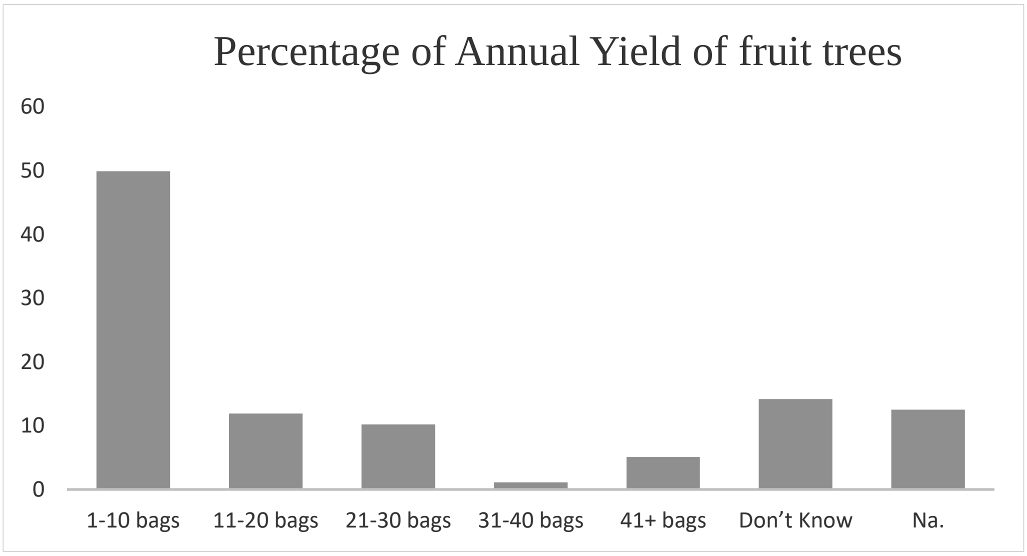
			Adopter		*Non-Adopter*		*Total*
Variable	*Category*	*Frequency*	*Frequency*	*%*	*Frequency*	*%*	*%*
Annual Yield	1-10 bags	79	79	44.3	01	0.6	49.9
	11-20 bags	21	21	11.9	00	0.0	11.9
	21-30 bags	18	18	10.2	00	0.0	10.2
	31-40 bags	2	02	1.1	00	0.0	1.1
	41^{+} bags	9	09	5.1	00	0.0	5.1
	Don't Know	25	22	12.5	03	1.7	14.2
	Na.	22	00	0.0	22	12.5	12.5
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Number of fruit trees	1-20	83	83	47.2	00	0.0	47.2
	21-40	41	41	23.3	00	0.0	23.3
	41-60	14	14	8.0	00	0.0	8.0
	61^{+}	11	11	6.3	00	0.0	6.3
	Non	27	01	0.6	26	14.8	15.3
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**
Type of fruit trees	Mangoes, Citrus, Jackfruit, Avocado	99	99	56.3	00	0.0	56.3
	Any two	49	49	27.8	00	0.0	27.8
	Others	02	02	1.1	00	0.0	1.1
	None	26	00	0.0	26	14.8	14.8
	Total	**176**	**150**	**85.2**	**26**	**14.8**	**100**

4.1.8 Annual Yield

Fruit tree characteristics exhibit variety-specific traits and are subject to the influence of cultivation techniques and the surrounding physical environment. In Table 4.2, a general overview of the farms' annual yield can be observed. Notably, 44.9% of the yield falls within the range of 1-10 bags, while 11.9% represents an annual output of 11-20 bags. Conversely, the lowest output recorded is 5.1%, which corresponds to 41+ bags. However, a significant proportion of farmers (14.2%) were unable to provide an estimate of their output.

The graph illustrates the variations in farmer output in terms of bags, serving as a foundational reference for determining the annual yield.

Figure 4.2. Percentage of dominant fruit tree types



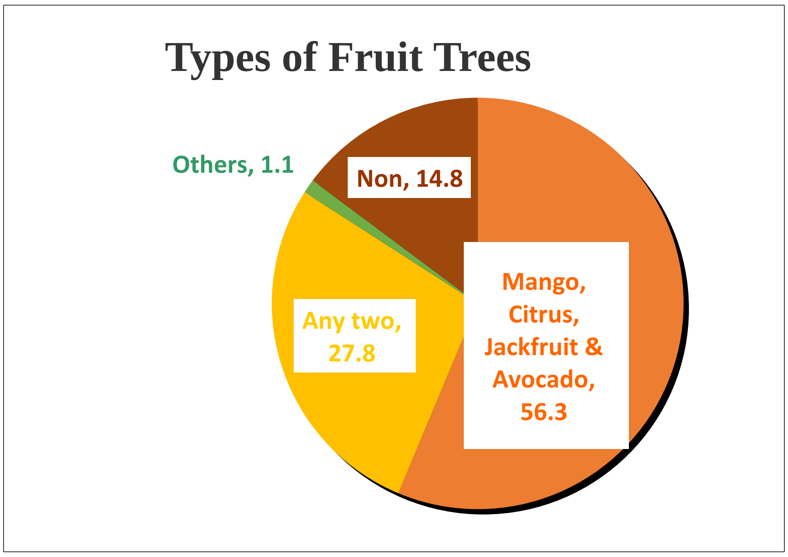
Number of Fruit trees. Source: field data

These findings suggest that the majority of farms have relatively low annual yields (1-10 bags), which may indicate challenges in cultivation techniques, variety-specific traits, or environmental factors. The low percentage of high-yield farms (41+ bags) emphasizes the possibility of enhancing productivity through targeted interventions. The significant proportion of farmers unable to estimate their output suggests a need for better record-keeping and yield estimation practices.

4.1.9 Types of fruit trees

Mangoes, Citrus, Jackfruit and Avocado are the dominant fruit tree types. 56.3% of the respondents owning them while 14.8% had no fruit tree.

Figure 4.3. Types of fruit trees



4.1.10 Number of Fruit trees/ fruit tree densities

Table 4.3: Number of fruit trees

		Number of fruit trees in percentage					
Variable	***Category***	**1-20**	**21-40**	**41-60**	**61^+**	**Non**	**Total**
	<1	22.2	3.4	0.0	1.1	1.7	28.4
	1-2	24.4	18.2	7.4	1.7	0.6	52.3
Farm	3-4	0.6	1.1	0.6	2.3	0.0	4.5
Size	5^+	0.0	0.0	0.0	0.6	0.0	0.6
	Na	0.0	0.6	0.0	0.6	13.1	14.2
	Total	**47.2**	**23.3**	**8.0**	**6.3**	**15.3**	**100.0**

Source: field data September 2021.

The investigation considered the size of the field and the density of fruit trees, resulting in the observation of the following characteristics. Among the farmers, 47.2% possessed 1-20 fruit trees, whereas 23.3% had 21-40 fruit trees, and 15.3% did not possess any fruit trees. The largest number of fruit trees was found among farmers who owned 1-2 acres of land, specifically within the range of 1-20 trees. The majority of respondents possessed land holdings ranging from 1 to 2 acres. These findings suggest that the majority of farmers in the Budaka district have a relatively low density of fruit trees (1-20 trees), which is closely associated with owning small land parcels (1-2 acres). The fact that 15.3% of farmers do not possess any fruit trees indicates potential barriers to adoption, such as limited land availability or resources for tree cultivation.

Plate 3: Dominant fruit trees

Plate 4: Dominant fruit trees

The dominant fruit trees of Citrus and mangoes. Source: Field data, 2021

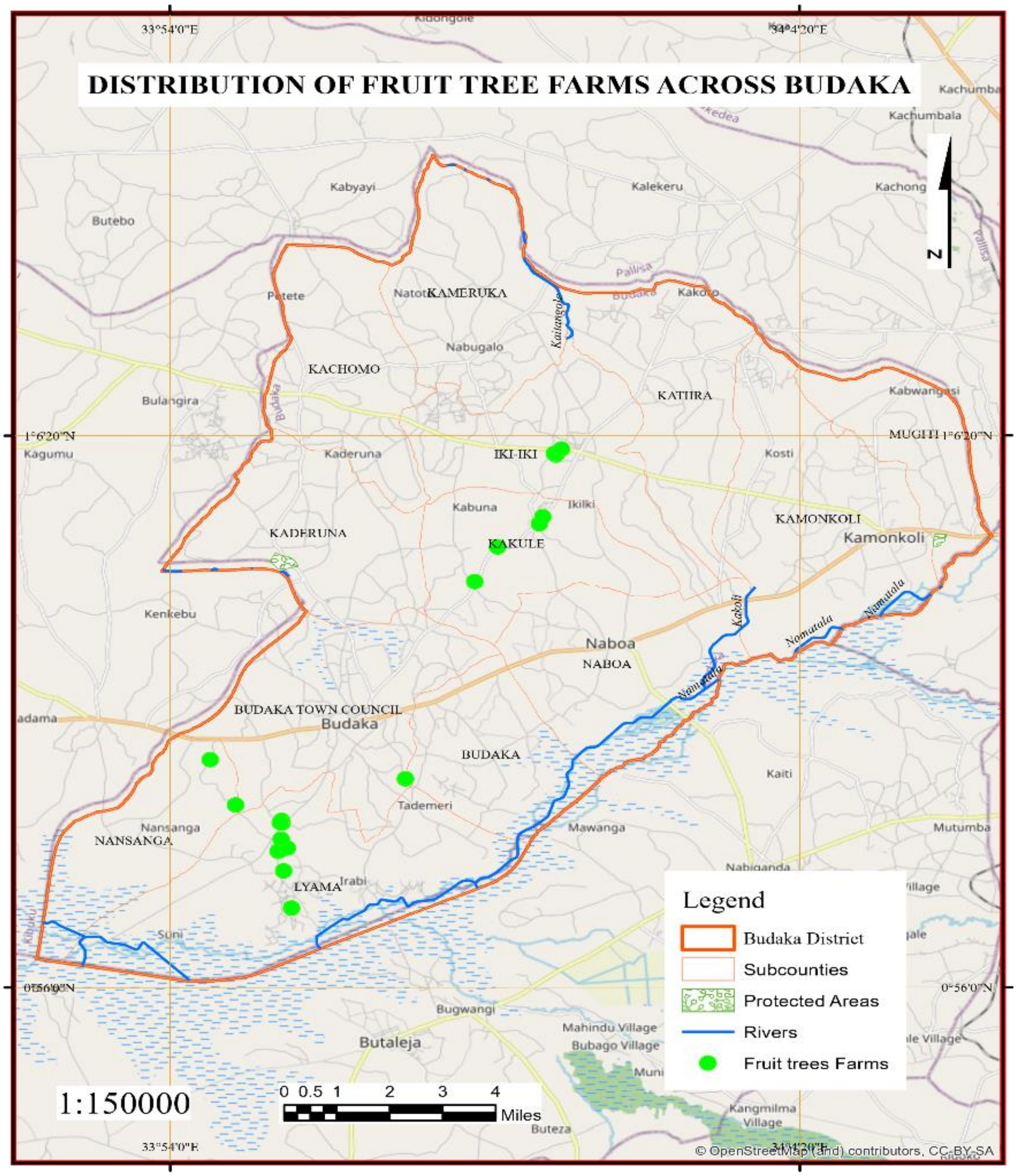
Plate 5: Dominant fruit trees: Avocado & Jackfruit

Source: Field data 2021.

4.1.11 Distribution of fruit tree farms

The spatial arrangement of fruit trees could potentially be influenced by variations in the environmental characteristics of the locations occupied by the indigenous community (Baldeck 2012). Utilizing GPS point source data collected in the field, a distributional map was generated to cover the sampled regions (Figure 4.5). It is worth noting that no particular area exhibited a concentrated abundance of fruit trees. The distribution of fruit trees throughout the district's topography is reasonably consistent, extending from the south-western to the north-eastern part, particularly in areas where agricultural land is present. However, the absence of high-density clusters may indicate that optimal growing conditions or intensive cultivation techniques are not being fully utilized in any specific area. To improve the adoption and effectiveness of fruit tree growing as an adaptation practice to climate change, it may be beneficial to identify and address local environmental factors that influence tree growth and productivity.

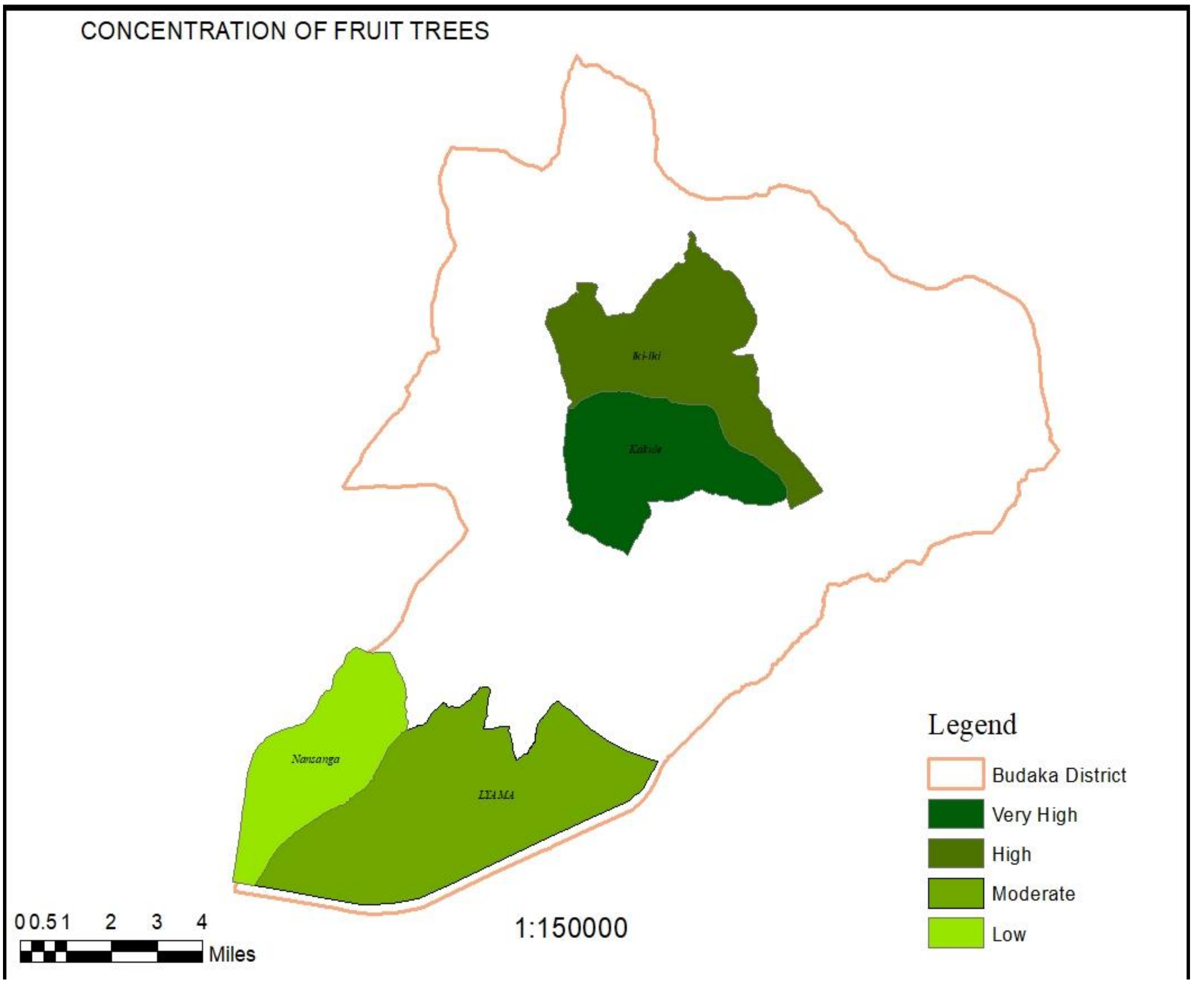
Plate 6: Distribution of fruit tree farms



Source ArcMap. 10.8).

However, the fruit tree density was found to be concentrated in the subcounty of Kakule

Plate 7: Concentration of fruit trees



Source. Field data & ArcMap 10.8.

4.2 An analysis of the Socioeconomic variables influencing Adoption of Fruit Tree Growing as a practice for adapting to Climate Change

As outlined in the objectives, this study aimed to identify the socioeconomic factors influencing the adoption of fruit tree cultivation as a strategy for adapting to climate change in the Budaka district. This investigation involved the characterization and evaluation of socioeconomic indicators such as age, gender, household size, marital status, occupation, education, labor, income, farm size, extension services, and access to credit. Each of these variables was examined and assessed in terms of their association with the adoption of fruit tree farming as a practice of adapting to climate change.

4.2.1 Age

The investigation examined age as a factor in determining the adoption of fruit tree cultivation. Various age categories participated in the survey. The role of age in adoption is anticipated, but it could result in either a positive or negative effect. The statistical analysis between age and the adoption of fruit tree cultivation is illustrated in Table 4.4, which presents the statistical analysis of frequency.

Table 4.4: The frequency table between Age and Fruit Tree Growing Adoption

			Age:				
			18 yrs	19- 29yrs	30- 39yrs	40+ yrs	Total
Adopter	Yes	Count	2	15	34	99	150
		% of Total	1.1%	8.5%	19.3%	56.3%	85.2%
	No	Count	3	9	6	8	26
		% of Total	1.7%	5.1%	3.4%	4.5%	14.8%
Total		Count	5	24	40	107	176
		% of Total	2.8%	13.6%	22.7%	60.8%	100.0%

Analysis of the frequency of responses among different age groups in the provided table revealed that, within the adopters' category, 1.1% of individuals are aged ≤18 years, 8.5% fall within the 19-29 years range, while 19.3% belong to the 30-39 years range, and a significant majority of 56.3% are aged 40 years and above. Conversely, among the non-adopters, 1.7% were 18 years old, 5.1% were within the 19-29 years range, 3.4% fell within the 30-39 years range, and 4.5% were 40 years and above. This statistical analysis provides evidence that the highest percentage of adopters is represented by individuals aged 40 years and above, while the youngest age group contributes a relatively smaller proportion to the adopter category.

To examine the connection between age categories and the adoption of fruit tree cultivation, the chi-square test of association (or chi-square test for independence) was employed to ascertain if there existed a notable association between these two categorical variables.

Table 4.5: Chi-square table depicting the association between Age and Adoption of fruit tree cultivation.

Chi-Square Tests

	Value	**df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	22.495[a]	3	.000
Likelihood Ratio	18.216	3	.000
Linear-by-Linear Association	20.690	1	.000
N of Valid Cases	176		

The statistical analysis revealed that the Pearson Chi-Squared test yielded a value of χ^2 = 22.495, with a degree of freedom (df) of 3, and a P-value of .000. This finding indicates a strong correlation. Consequently, it can be inferred that there exists a significant relationship between age and the adoption of fruit tree cultivation as a means of adapting to climate change. This assertion is supported by the fact that the obtained significance level of .000 is lower than the required P-value of 0.05 for this survey. The strong correlation between age and the adoption

of fruit tree cultivation highlights the importance of considering demographic factors in promoting climate change adaptation strategies. Understanding how age influences adoption rates can inform targeted interventions and outreach efforts.

4.2.2 Gender

The impact of societal roles on the adoption of farming activities can be influenced by the differing roles assigned to men and women. In specific cultures, women may encounter limitations in their ability to participate in the cultivation of trees (Juma & Ojwang 1996). An analysis of the statistical frequency relating to gender and the adoption of fruit tree cultivation as a response to climate change is presented in Table 4.6.

Table 4.6: Frequency table between Gender and Adoption of Fruit tree growing

			Gender		
			Male	Female	Total
Adopter	Yes	Count	108	42	150
		% of Total	61.4%	23.9%	85.2%
	No	Count	14	12	26
		% of Total	8.0%	6.8%	14.8%
Total		Count	122	54	176
		% of Total	69.3%	30.7%	100.0%

The aforementioned table reveals that 61.4% of males embraced the practice of growing fruit trees, whereas 23.9% of females also adopted this approach. Moreover, the percentage of non-adopting males was 8%, compared to 14.8% for females.

To assess the strength of the association between gender and the adoption of fruit tree cultivation as a means of adapting to climate change, a Chi-square test of independence was employed.

Table 4.7: Chi-square table for association between Gender and Adoption of Fruit tree growing Chi-Square Tests

Chi-Square Tests

	Value	**Df**	Asymptotic Significance 2-sided (P-Value)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-Square	3.434[a]	1	.064		
Continuity correction	2.633	1	.105		
Likelihood ratio	3.2.3	1	.072		
Fisher's exact test				0.070	0.055
Linear by Linear Association	3.414	1	.065		
N of Valid Cases	176				

The Chi-square test of independence examining the relationship between gender and the adoption of fruit tree cultivation as a practice to adapt to climate change yielded a χ^2 value of 3.434, with a significance P-value of 0.064, surpassing the required threshold p-value of 0.05. This indicates an insignificant association between gender and the adoption of fruit tree cultivation as a practice to adapt to climate change. Hence, gender does not have a significant impact on farmers' decisions to adopt fruit tree cultivation as a strategy to adapt to climate change. This suggests that factors other than gender may play a more influential role in farmers' adoption decisions. Therefore, promoting fruit tree cultivation as a climate adaptation strategy can still benefit all farmers, irrespective of gender, by fostering inclusive programs that address diverse agricultural needs and contexts.

4.2.3 Education level

This research examined education as one of the determining factors in the adoption of fruit tree cultivation as a climate change adaptation practice. Based on an education survey, individuals in the study area have a relatively low level of educational attainment. A statistical analysis of the frequency of education levels reported by respondents in the study area is presented in Table 4.8.

Table 4.8: Frequency table between education level and adoption of Fruit tree growing

			Education level				
			None	Primary	Secondary	Tertiary	Total
Adopter	Yes	Count	31	77	28	14	150
		% Total	17.6%	43.8%	15.9%	8.0%	85.2%
	No	Count	6	11	8	1	26
		% Total	3.4%	6.3%	4.5%	0.6%	14.8%
Total		Count	37	88	36	15	176
		% Total	21.0%	50.0%	20.5%	8.5%	100.0%

According to the statistical frequency, 17.6% of the adopters had not received any formal education, 43.8% had completed primary education, 15.9% had completed secondary education, and 8.0% of the adopters had attained tertiary education. In contrast, among the non-adopters, 3.4% had no education, 6.3% had completed primary education, 4.5% had completed secondary education, and only 0.6% had attained tertiary education. The results show that the majority of adopters had completed primary education.

To determine the significance of the relationship between education level and adoption of fruit tree farming, a chi-square test was conducted.

Table 4.9: Chi-square table for association between education level and Adoption of Fruit tree growing

Chi-Square Tests

	Value	**df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	2.792[a]	3	.425
Likelihood Ratio	2.801	3	.423
Linear-by-Linear Association	.005	1	.944
N of Valid Cases	176		

The chi-square test examining the relationship between education level and the adoption of fruit tree farming as a climate change adaptation strategy resulted in a $\chi 2$ value of 2.792 and a p-value of .425, significantly higher than the predefined threshold of 0.05. This suggests that there is no significant association between education level and the adoption of fruit tree cultivation, indicating that education level does not notably influence the adoption of fruit tree growing as a climate change adaptation practice. These findings highlight the need to explore other determinants such as socioeconomic status, that may play a more significant role in influencing farmers' decisions to adopt fruit tree growing that may influence adoption decisions. Consequently, interventions aimed at promoting fruit tree cultivation should take a multifaceted approach, addressing various determinants of adoption to ensure effectiveness and inclusivity across different educational backgrounds.

4.2.4 Marital Status

The study considered three categories of respondents, namely single, married, and widow(er), as key variables in determining the adoption of fruit tree growing as a climate change adaptation practice. The frequencies of these categories and their relationship to the adoption of fruit tree growing are shown in Table 4.10.

Table 4.10: Relationship between Marital status and adoption of Fruit tree growing

			Marital status			
			Single	Married	Widow(er)	Total
Adopter	Yes	Count	24	123	3	150
		% Total	13.6%	69.9%	1.7%	85.2%
	No	Count	5	19	2	26
		% Total	2.8%	10.8%	1.1%	14.8%
Total		Count	29	142	5	176
		% Total	16.5%	80.7%	2.8%	100.0%

Based on the frequency data, it can be observed that 13.6% of respondents claimed to be single, 69.9% were married, and 1.7% were widowed (er). The majority of the adopters were found to be married, as indicated in the table. On the other hand, among the non-adopters, 2.8% were single, 10.8% were married, and 1.1% were widow(er).

To determine the association between marital status and the adoption of fruit tree growing as an adaptation practice to climate change, the Chi-Square Test for Association was employed.

Table 4.11: Chi-square table for association between marital status and Adoption of Fruit tree growing as adaptation to climate change

Chi-Square Tests

	Value	**df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	2.886[a]	2	.236
Likelihood Ratio	2.238	2	.327
Linear-by-Linear Association	.076	1	.782
N of Valid Cases	176		

The Chi-square test of association between these variables resulted in a $\chi 2$ value of 2.886, with 2 degrees of freedom and a P-value of .236. Since this P-value exceeds the threshold of 0.05, it suggests that there is no significant relationship between marital status and the adoption of fruit tree cultivation as a climate change adaptation practice. These findings suggest that marital status may not be a significant determinant of adoption decisions, and highlight the need to explore other factors that may influence farmers' adoption of fruit tree cultivation.

4.2.5 Household size

This study also examined household size as a factor influencing the adoption of fruit tree cultivation, representing the number of individuals in a household. Therefore, Table 4.12 presents a statistical overview of the relationship between household size and the adoption of fruit tree cultivation as a strategy for climate change adaptation.

Table 4.12: The frequency of Household size and adoption of fruit tree growing as an adaptation practice to climate change

			Household size			
			1-6	7-12	13+	Total
Adopter	Yes	Count	48	66	36	150
		% Total	27.3%	37.5%	20.5%	85.2%
	No	Count	9	12	5	26
		% Total	5.1%	6.8%	2.8%	14.8%
Total		Count	57	78	41	176
		% Total	32.4%	44.3%	23.3%	100.0%

The findings indicate that 27.3% of the adopters had 1-6 members in a household, 37.5% had 7-12 members, and 20% had 13+ members in the household. Additionally, 5.1% of the non-adopters had 1-6 members, 6.8% had 7-12 members, and 14.8% had more than 13 members in the household. To assess how household size relates to the adoption of fruit tree cultivation as a strategy for adapting to climate change, a chi-square test was performed, and the findings are detailed in Table 4.13.

Table 4.13: Chi-square table for relationship between Household size and Adoption of Fruit tree growing as adaptation practice to climate change

Chi-Square Tests

	Value	**df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	.286[a]	2	.867
Likelihood Ratio	.297	2	.862
Linear-by-Linear Association	.219	1	.640
N of Valid Cases	176		

The chi-square test examining the relationship between these variables produced a $\chi 2$ value of 0.286, with 2 degrees of freedom, and a P-value of 0.867, which exceeds the significance threshold of 0.05 established for this study. This suggests that, according to the chi-square analysis, there is a slight yet positive association between household size and the adoption of fruit tree cultivation as a climate change adaptation strategy. While the association is statistically significant, its magnitude is relatively small. However, this finding still suggests that larger household sizes may be conducive to higher adoption rates of fruit tree cultivation. As such, interventions aimed at promoting fruit tree growing as a climate adaptation strategy should consider household dynamics and tailor strategies to accommodate larger households.

4.2.6 Type of labour

Household labor plays a crucial role in the adoption of fruit tree cultivation as an adaptation strategy, as it is essential for any agricultural enterprise to have a sustainable labor force in order to succeed. In order to investigate this variable in this study, we collected the following statistics from the respondents, which are presented in Table 4.14.

Table 4.14: Frequency for type of labour and adoption of Fruit tree growing as adaptation practice to climate change.

			Type of labour				
			Family	Hired	Both	Not applicable	Total
Adopter	Yes	Count	134	3	12	1	150
		% Total	76.1%	1.7%	6.8%	0.6%	85.2%
	No	Count	1	0	0	25	26
		% Total	0.6%	0.0%	0.0%	14.2%	14.8%
Total		Count	135	3	12	26	176
		% Total	76.7%	1.7%	6.8%	14.8%	100.0%

The findings indicate that 76% of the adopters utilized family labor, while 1.3% hired labor and 6.8% used a combination of both. It is important to note that the variable of labor type only applies to the adopters, and 14% of the respondents provided a response indicating that it was not applicable to them.

To assess if there is a statistically significant relationship between the type of labor and the adoption of fruit tree cultivation as a climate change adaptation strategy, a chi-square analysis was performed. The findings of this analysis are depicted in Table 4.15.

Table 4.15: Chi-square table for the relationship between Type of labor and Adoption of Fruit tree growing.

Chi-Square Tests			
	Value	**Df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	160.479[a]	3	.000
Likelihood Ratio	127.118	3	.000
Linear-by-Linear Association	125.690	1	.000
N of Valid Cases	176		

The chi-square test examining the relationship between these variables produced a notable $\chi 2$ value of 160.479, with 3 degrees of freedom, and a P-value of .000, which is below the specified threshold of 0.05. These results suggest a robust positive association between the type of labor and the adoption of fruit tree cultivation as a strategy to mitigate climate change. A strong positive relationship suggests that certain types of labor, such as commercial farming or non-agricultural occupations, are associated with higher adoption rates of fruit tree cultivation. This implies that interventions aimed at promoting fruit tree growing as a climate adaptation strategy should consider the labor context of the target population.

4.2.7 Farm size

Farm size represents the farmers' ability to cultivate as many crops as feasible for their household and the market. The finding that smaller farms are more productive than larger farms has long been documented Ricciardi (2021). Small farms may also provide higher yields than larger farms due to more intensive labor utilization. This survey asked respondents about the size of their farms, and the quantitative representation of those responses is shown in the table 4.16.

Table 4.16: Frequency table for Farm size and adoption of Fruit tree growing

			Farm size (acres)					
			<1	1-2	3-4	5+	Not applicable	Total
Adopter	Yes	Count	47	92	8	1	2	150
		% Total	26.7%	52.3%	4.5%	0.6%	1.1%	85.2%
	No	Count	3	0	0	0	23	26
		% Total	1.7%	0.0%	0.0%	0.0%	13.1%	14.8%
Total		Count	50	92	8	1	25	176
		28.4%	52.3%	4.5%	0.6%	14.2%	100.0%	28.4%

Based on the analysis conducted above, it was determined that the largest proportion of adopters, amounting to 52.3%, possessed land measuring 1-2 acres, while the smallest proportion of adopters, 0.6%, possessed 5 or more acres of land. In contrast, non-adopters owned less than an acre, accounting for 1.7%.

In order to establish a statistical significance association of this variable, a chi square analysis was run for level of association between farm size and adoption of fruit tree growing as a climate change adaptation practice.

Table 4.17: Chi-square table for influence of Farm size on Adoption of Fruit tree growing

Chi-Square Tests			
	Value	df	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	138.988[a]	4	.000
Likelihood Ratio	110.764	4	.000
Linear-by-Linear Association	104.351	1	.000
N of Valid Cases	176		

The chi-square test of association between these variables showed a significant $\chi 2$ value of 138.988, with 4 degrees of freedom, and a P-value of .000, which is below the specified threshold of **0.05**. These findings indicate a strong positive correlation between farm size and the adoption of fruit tree cultivation as a strategy for climate change adaptation. This indicates that farmers with larger land holdings are more likely to adopt fruit tree cultivation as a strategy to mitigate the impacts of climate change. Understanding this relationship is crucial for developing targeted interventions and policies that support smallholder farmers with limited land access to overcome barriers to adoption.

4.2.8 Income

This study primarily focused on the monetary compensation received by individuals in millions and how this income influenced the decision to engage in fruit tree cultivation as a method to adapt to climate change. The subsequent statistical data was derived from surveys conducted. This is shown in Table 4.18

Table 4.18: Frequency of income on adoption of Fruit tree growing

			Income per annum in millions.						
			<1m	1-2m	2m+	Not sure	No response	N.a	Total
Adopter	Yes	Count	32	17	50	49	2	0	150
		% Total	18.2%	9.7%	28.4%	27.8%	1.1%	0.0%	85.2%
	No	Count	3	0	0	2	1	20	26
		% Total	1.7%	0.0%	0.0%	1.1%	0.6%	11.4%	14.8%
Total		Count	35	17	50	51	3	20	176
		19.9%	9.7%	28.4%	29.0%	1.7%	11.4%	100.0%	19.9%

Table 4.18 demonstrates that individuals with an average annual income of 2 million shillings appeared to have the highest proportion of adopters (28.4%). Following this, 27.8% of individuals

were uncertain about their annual income. In the case of non-adopters, 1.7% had an annual income of less than one million shillings, while 11.4% found the question to be irrelevant.

A chi-square analysis was conducted to assess the significance of the relationship between income and the adoption of fruit tree cultivation as a strategy to adapt to climate change.

Table 4.19: Chi-square table for influence Income on Adoption of Fruit tree growing

Chi-Square Tests			
	Value	**Df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	133.657[a]	5	.000
Likelihood Ratio	106.229	5	.000
Linear-by-Linear Association	57.389	1	.000
N of Valid Cases	176		

The Chi-square test examining the relationship between income and the adoption of fruit tree cultivation as an adaptation practice to climate change yielded a statistically significant result with χ^2 = 133.657, df = 5, P-value = .000, which is below the predetermined threshold of 0.05. This finding suggests a significant positive correlation between income and the adoption of fruit tree cultivation as an adaptation practice to climate change. This means that farmers with higher incomes may have better access to resources, such as land, inputs, and knowledge, which enable them to adopt fruit tree cultivation more effectively as a climate adaptation strategy. Understanding this correlation is essential for developing targeted interventions to support farmers with lower incomes in adopting fruit tree cultivation and improving their resilience to climate change in Budaka district.

4.2.9 Access to credit

Access to credit is essential for farmers who otherwise cannot afford the necessary agro-inputs, thereby promoting the adoption of climate change adaptation practices. Credit provided by both formal and informal sources play a crucial role in the adoption of improved variety and wage payments (Selvaraj 1998). This study investigated whether credit providers were extending credit to farmers. The study assumed that the availability of credit facilities, from both formal and informal sources, would greatly facilitate the adoption of fruit tree cultivation.

Table 4.20: The frequency table for access to credit and Adoption of Fruit tree growing

			Access to credit		
			Yes	*No*	Total
Adopter	Yes	Count	19	131	150
		% of Total	10.8%	74.4%	85.2%
	No	Count	0	26	26
		% of Total	0.0%	14.8%	14.8%
Total		Count	19	157	176
		% of Total	10.8%	89.2%	100.0%

The statistics show that of those who adopted, 10.8% had access to credit, whereas 74.4% did not. Notably, 14.8% of non-adopters also lacked access to credit. To contextualize these findings, a chi-square test was conducted to determine the significance of the relationship between these variables.

Table 4.21: Chi-square table showing the impact of access to credit on the adoption of fruit tree cultivation

Chi-Square Tests					
	Value	**Df**	Asymptotic Significance 2-sided (P-Value)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-Square	3.692[a]	1	.055		
Continuity correction	2.494	1	.114		
Likelihood ratio	6.460	1	.011		
Fisher's exact test				.081	.040
Linear by Linear Association	3.671	1	.055		
N of Valid Cases	176				

The Chi-square test conducted to evaluate the relationship between credit availability and the adoption of fruit tree cultivation yielded a significant result, $\chi 2 = 3.692$, with 1 degree of freedom, and a P-value of 0.055. This P-value slightly exceeds the significance threshold of 0.05. Consequently, this analysis suggests that credit access does not significantly impact the adoption of fruit tree cultivation as a climate change adaptation strategy. This implies that other factors, such as land availability, knowledge, and additional socioeconomic factors, may play a more critical role in influencing farmers' adoption decisions. Therefore, interventions aimed at promoting fruit tree cultivation as a climate adaptation strategy should consider a broader range of factors beyond just credit access to effectively.

4.2.10 Agricultural Extension services

The research aimed to determine whether respondents had received agricultural extension services from government agencies or private sector companies. The findings indicated that 10.2% of the respondents acknowledged the services of extension workers, while 75% of them did. Interestingly, none of the non-adopters (14.8%) received any extension services. These findings indicate that a significant proportion of the respondents did not have access to extension services. Consequently, it was crucial to investigate the impact of receiving extension workers' services on the adoption of fruit tree growing. The summarized results can be found in Table 4.22

Table 4.22: Frequency table for access to agricultural extension services and Adoption of Fruit tree growing

			Access to Agricultural Extension services		
			Yes	***No***	**Total**
Adopter	Yes	Count	18	132	150
		% of Total	10.2%	75.0%	85.2%
	No	Count	0	26	26
		% of Total	0.0%	14.8%	14.8%
Total		Count	18	158	176
		% of Total	10.2%	89.8%	100.0%

A chi-square test was employed to assess the significance of the relationship between access to agricultural extension services and the adoption of fruit tree cultivation as a climate change adaptation strategy. The results of this analysis are presented in Table 4.23.

Table 4.23: Chi-square table for the association between access to extension services and the adoption of fruit tree cultivation

Chi-Square Tests					
	Value	**Df**	Asymptotic Significance 2-sided (P-Value)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-Square	3.475[a]	1	.062		
Continuity correction	2.291	1	.130		
Likelihood ratio	6.099	1	.014		
Fisher's exact test				.079	.048
Linear by Linear Association	3.456	1	.063		
N of Valid Cases	176				

The chi-square test conducted to analyze the relationship between Access to Extension Services and Adoption of Fruit Tree Growing yielded an insignificant outcome. The calculated χ^2 value was 3.477, with 1 degree of freedom and a P-value of .062, which exceeds the accepted threshold alpha value of 0.05. This indicates that there is no significant relationship between agricultural extension services and the adoption of fruit tree cultivation as a climate change adaptation strategy. Therefore, it can be concluded that extension services did not have a substantial influence on the acceptance of fruit tree growing as a strategy for climate change adaptation. This suggests that extension services alone may not be sufficient to drive adoption of fruit tree growing. Therefore, interventions should consider a holistic approach, incorporating various factors beyond extension services to effectively support adoption climate smart agriculture.

4.3 Evaluation of farmer perceptions of fruit tree growing as an adaptation practice to Climate Change

The third objective of this research was to determine the perceptions of farmers regarding cultivating fruit trees as a means of adapting to climate change. The researcher evaluated the acceptance of fruit tree cultivation as a coping strategy for climate change, based on participants' perceptions of temperature fluctuations, rainfall patterns, and extreme weather events being the key factors considered. The assumption underlying the study was that individuals needed to consider climate change as the main factor influencing their decision to adopt fruit tree planting. In order to understand the participants' perspectives, the study examined various factors such as their knowledge of climate change, climate change variables like prolonged drought, off/ on season rains, severe storms and techniques for managing climate change on farms. The results from the analysis of these variables are detailed in Table 4.24.

Table 4.24: Perception of farmers towards fruit tree growing as an adaptation practice to climate change

Variable			**Adoption**		
			Adopters	*Non-adopters*	*Total*
Knowledge/ Perception about Climate change.	Yes	Count	133	20	153
		% of Total	75.6%	11.4%	86.9%
	No	Count	17	6	23
		% of Total	9.6%	3.4%	13.1%
	Total	Count	150	26	176
		% of Total	**85.2%**	**14.8%**	**100.0%**
Climate variability	Prolonged drought	Count	49	5	54
		% of Total	27.8%	2.8%	30.7%
	On/off season rains	Count	56	15	71
		% of Total	31.8%	8.5%	40.3%
	Severe Storms	Count	10	0	10
		% of Total	5.7%	0.0%	5.7%
	Don't Know	Count	35	6	41
		% of Total	19.9%	3.4%	23.3%
	Total	Count	150	26	176
		% of Total	**85.2%**	**14.8%**	**100.0%**
On Farm adaptation practices	Mulching	Count	23	1	24
		% of Total	13.1%	0.6%	13.6%
	Irrigation	Count	19	0	19
		% of Total	10.8%	0.0%	10.8%
	Both	Count	4	0	4
		% of Total	2.3%	0.0%	2.3%
	Non	Count	104	25	129
		% of Total	59.1%	14.2%	73.3%
	Total	Count	150	26	176
		% of Total	**85.2%**	**14.8%**	**100.0%**
Fruit trees mitigate Climate change	Yes	Count	123	20	143
		% of Total	69.9%	11.4%	81.3%
	Don't know	Count	27	6	33
		% of Total	15.4%	3.4%	18.8%

	Total	Count	150	26	176
		% of Total	**85.2%**	**14.8%**	**100.0%**

According to the data in the table, the majority of respondents (86.9%) had knowledge about climate change. Out of these individuals, 75.6% were adopters of fruit tree farming, while 11.4% were non-adopters. On the other hand, 13.1% of the respondents had no knowledge about climate change. The study also explored the respondents' interpretations of climate variability. It was found that 30.7% of the respondents considered prolonged drought as a sign of climate change, 40.3% reported off-season rains, 5.7% reported severe storms, and 23.3% did not have a clear understanding of how climate change occurs. Furthermore, the study examined the on-farm adaptation practices used by the respondents to mitigate climate change. The results showed that 13.6% practiced mulching, 10.8% practiced irrigation, 2.3% practiced both, while 73.3% did not engage in any on-farm climate change adaptation practices. In terms of farmers' awareness of the benefits of fruit trees in reducing climate change, 18.8% of the respondents were unaware of these contributions, while 81.3% were aware of them. However, despite this awareness, a substantial portion of farmers are not engaging in on-farm climate change adaptation practices. This indicates a gap between knowledge and action, where although farmers are aware of climate change and its potential impacts, they may not be implementing adaptation strategies on their farms.

To determine the strength of the relationship between farmers' perceptions of adopting fruit tree farming as a strategy for coping with climate change, a correlation study was conducted, as shown in Table 4.25.

Table 4.25: Correlation analysis

		Perception about climate change	Adoption of fruit tree growing
Perception about climate change	Pearson Correlation	1	.221**
	Sig. (2-tailed)		.003
	N	176	176

**. At the threshold of 0.01, correlation is significant (2-tailed).

Source: SPSS output data.

The results revealed a statistically significant and weak positive correlation ($r = .221$, $p = .003$) between climatic changes and the adoption of fruit tree cultivation. This suggests that changes in climate can lead to a relatively higher adoption of fruit tree farming. The statistically significant and weak positive correlation between climatic changes and the adoption of fruit tree cultivation indicates that farmers are more likely to adopt fruit tree farming in response to changes in climate. This suggests that farmers perceive fruit tree cultivation as a viable adaptation strategy in the face of climate change.

Another important variable considered in the study was farmers' knowledge of the mitigation effects of fruit trees. To assess the relevance of the relationship between farmers' perception of the mitigation effects of fruit trees on climate change and the adoption of fruit tree cultivation as an adaptation method, a chi-square analysis was performed.

Table 4.26: Chi-square test of association between farmers' perception on how fruit trees mitigate climate change and adoption of fruit tree growing

Chi-Square Tests			
	Value	**df**	Asymptotic Significance 2-sided (P-Value)
Pearson Chi-Square	19.103[a]	4	.001
Likelihood Ratio	17.076	4	.002
Linear-by-Linear Association	13.529	1	.000
N of Valid Cases	176		

A statistically significant chi-square test result ($\chi 2$ = 19.103, df = 4, P-value = .001) indicates a strong relationship between farmers' understanding of how fruit trees mitigate climate change and their adoption of fruit tree cultivation. This finding is significant as it is below the standard threshold of alpha = 0.05. Therefore, it can be inferred that farmers' knowledge about the mitigating effect of fruit trees significantly influences their decision to adopt fruit tree cultivation as a strategy for adapting to climate change. The statistically significant chi-square test result suggests that farmers with a better understanding of the mitigating effects of fruit trees on climate change are more likely to adopt fruit tree cultivation as a strategy for adapting to climate change. This finding emphasizes the importance of farmer education and awareness-building initiatives aimed at enhancing farmers' understanding of the role of fruit trees in mitigating climate change.

4.4 The most important indicators/ determinants of adoption of fruit tree growing as an adaptation practice to climate change

A linear multiple regression model was used to determine the factors that would have the greatest impact on whether or not fruit tree cultivation would be adopted as a practice of climate change adaptation.

Table 4.27: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.920[a]	.846	.831	.14648

Source: SPSS output data.

The model summary provides the values for R and R^2. The high R value (0.920), equivalent to the simple correlation coefficient, indicates a robust relationship among the independent variables and the adoption of fruit tree cultivation as a climate change adaptation practice (the "R" Column). According to the coefficient of determination (R^2), 84.6% of the variability in the dependent variable can be attributed to the independent variables examined in this study. This underscores the significant influence of these independent variables on the decision to adopt fruit tree cultivation. The remaining 15.4% of the variance in the dependent variable represents unobserved factors that are not accounted for by the study.

Table 4.28: ANOVA

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	18.748	16	1.172	54.614	.000[b]
	Residual	3.411	159	.021		
	Total	22.159	175			

Source: SPSS output data.

a. Dependent Variable: Adoption of fruit tree growing

b. Predictors: (Constant), Age, Gender, Education Level, Marital Status, Family Size, Occupation, Income outside fruit trees, Farm size, Tenancy type, Type of labour, Perception about Climate Change, Knowledge on Mitigation effect of fruit trees, Membership in farmer Organisation, Services from Agricultural Extension Officers, Income, Access to credit.

Table 4.28 demonstrates the predictive accuracy of the multiple regression model for the dependent variable. It demonstrates the regression model's statistical importance. If p =.000, which is considerably less than the threshold alpha value of .05, then the regression model statistically significantly predicts the outcome variables, therefore, the model is a good fit to the data.

Table 4.29: Regression analysis of the dependent variable (Adoption of fruit tree-growing) and independent variables

Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	.591	.168		3.523	.001
Age:	-.045	.015	-.104	-2.896	.004*
Gender	.025	.026	.032	.947	.345
Education Level	-.016	.015	-.038	-1.077	.283
Marital Status	.022	.029	.026	.761	.448
Family Size	-.005	.017	-.011	-.311	.756
Occupation	-.027	.018	-.051	-1.516	.132
Income outside fruit trees	.036	.009	.154	4.176	.000*
Farm size	.096	.013	.342	7.273	.000*
Tenancy type	-.025	.023	-.036	-1.060	.291
Type of labour	.141	.016	.448	8.878	.000*
Perception about Climate Change	.078	.025	.114	3.169	.002*
Knowledge on Mitigation effect of fruit trees	.001	.016	.002	.073	.942
Member in farmer Organisation	-.082	.063	-.051	-1.298	.196
Services from Agriculture Extension Officers	.002	.045	.002	.039	.969
Income	.065	.023	.102	2.894	.004*
Access to credit	.071	.038	.062	1.868	.064
a. Dependent Variable: **Adoption of fruit tree growing**.					

Note: * means that those independent variables are significant at 5% level.
Source SPSS output data.

Coefficients and significance values for each variable have been utilized to identify the factors that exert the greatest influence on farmers' decisions to engage in fruit tree cultivation. The table highlights notable standardized coefficients and levels of significance evident in the model. The correlation between the variables is evident in the coefficient and significance values. Variables with significant coefficients and lower p-values have a more substantial influence on the adoption of fruit tree cultivation compared to variables with smaller coefficients and higher p-values.

A positive association between a variable and the adoption of fruit tree cultivation as a climate change adaptation practice is characterized by a coefficient value greater than zero but less than one, whereas a negative association is observed when the coefficient value is less than zero. A coefficient value of 1 signifies an ideal relationship, while a value of 0 signifies the absence of correlation between the variables.

The findings of the multiple regression model indicate that five variables; age, income, farm size, type of labor, and perception of climate change showed significant importance at the 5% level in influencing the adoption of fruit tree cultivation as a strategy to adapt to climate change. This indicates that these factors are crucial considerations in the decision-making process regarding fruit tree cultivation as a climate change adaptation strategy. Additional factors, including gender, education level, marital status, family size, occupation, type of tenancy, knowledge of the mitigation effect of fruit trees, membership in farmer organizations, services from agricultural extension officers, and credit availability, did not demonstrate a statistically significant influence on the adoption of fruit tree cultivation for climate change adaptation within the scope of this study.

4.5 Focus group discussion and key informant interview

4.5.1 Introduction

The study held two FGD involving fruit growers not covered by questionnaires, non-fruit growing farmers, community leaders, elders and other opinion leaders in the communities. The objective of the FGD was to gather viewpoints and insights to complement the findings of the quantitative survey and provide a thorough understanding of the variables that determine the adoption of fruit tree growing. The study also sought to gain further insight into perception of people towards fruit tree growing as a climate change adaption practice in Budaka district.

4.5.2 Participant Demographics

A total of 35 participants took part in the FGD. Among them, 14 were female and 21 were male. The age range of participants in the focus groups was from 18 to over 50. With the help of the leading questions in Appendix 2, these participated in an open-ended discussion session. Residents of the research area made up the FGD's participants.

4.5.3 Findings from the FGD

The focus group discussions (FGD) delved into various themes concerning the factors influencing the adoption of fruit tree cultivation as a climate change adaptation strategy. The main themes included engagement in fruit tree growing, land ownership, income management, types of fruit trees grown, livelihood effects, environmental benefits, constraints to adoption, and government intervention efforts in Budaka District.

The discussions revealed that both men and women are involved in fruit tree growing, although men constitute the majority. Kakule subcounty emerged as the leading area in fruit tree production due to the initiative taken by the local Member of Parliament at that time.

Both men and women own fruit trees; however, the income generated from selling these trees is predominantly managed by men. This is largely because men own the land and oversee family activities.

The dominant fruit tree species in the area are mangoes and citrus, which are typically grown separately. Few farmers practice intercropping. Other fruit trees, such as jackfruit and avocado, are gradually being adopted.

Participants had mixed reactions regarding the economic benefits of fruit tree growing. Women perceived the economic benefits to be largely controlled by men. Nevertheless, the income from fruit trees has enabled families to send children to school and meet other socioeconomic needs, such as improving housing conditions.

The environmental benefits of fruit trees discussed by participants include soil erosion control, providing shade for livestock, modifying climatic conditions, and supplying wood fuel needs for families.

Several constraints to the adoption of fruit tree growing were identified, like limited land Fruit trees are perennial and require large plots of land; Marketing challenges since the perishable nature of fruit produce poses significant marketing challenges.

Diseases and Pests present ongoing challenges to fruit tree farmers. The decline of Collapse of Cooperatives and Farmer Organization has discouraged many farmers from adopting fruit trees. There is a lack of government support and insufficient access to extension workers and climate change adaptation workshops.

Participants discussed the various intervention efforts by the government, highlighting the need for increased support and sensitization on climate change adaptation practices, including fruit tree cultivation.

These conclusions drawn from the FGDs highlight the complex factors that influence the adoption of fruit tree cultivation as a climate change adaptation strategy. While economic and environmental benefits are recognized, significant constraints hinder widespread adoption.

Enhanced government support and effective extension services are essential to overcoming these challenges and promoting the adoption of fruit tree cultivation.

4.6 Discussion of results

In the preceding section, an examination was conducted on the socioeconomic elements that govern the acceptance of cultivating fruit trees, while also assessing the perspectives held by farmers regarding the adoption of fruit tree cultivation as a proactive measure against climate change. Expanding upon these analyses, the subsequent subsection centers its attention on the discourse surrounding these findings.

4.6.1 Characterization of Fruit Tree Farmers and Farm Distribution

Exploring the characteristics of fruit tree farmers and the distribution of their farms provides essential insights into the determinants of adopting fruit tree growing as an adaptation strategy to climate change. This section discusses the demographic profile of the farmers, the spatial distribution of their farms, and the implications of these factors on the adoption of fruit tree cultivation in response to climate challenges.

Age distribution is another crucial factor influencing the adoption of fruit tree growing. The study revealed that young adults make up the smallest proportion of both adopters and non-adopters, while the majority are older individuals aged 40 years and above. This finding aligns with the study by Attar & Aski (2017) in India, where middle-aged and older farmers predominated among lime growers. The predominance of middle-aged and older farmers suggests that these individuals are at an economically stable stage in life, making them more resilient and better equipped to cope with the challenges of agricultural production. Their capacity to adopt fruit tree cultivation as a strategy for adapting to climate change is likely heavily influenced by economic stability.

However, this finding contrasts with the study by Bannister and Nair (2003), which suggested that decisions about tree planting are primarily influenced by family and farm attributes rather than age. This discrepancy indicates that while age and economic stability are significant factors in some regions, family dynamics and specific farm characteristics may play a more crucial role in others. Thus, understanding the local context is essential for developing effective adaptation strategies.

The spatial distribution of farms provides valuable insights into how land is utilized and managed in the context of adapting to climate change. The study found a diverse and widespread allocation of farms, indicating that fruit tree cultivation is significant agricultural practice in the region. This widespread distribution suggests that farmers recognize the potential benefits of fruit trees, such as providing shade, reducing soil erosion, and offering an alternative source of income, which are all crucial for building resilience to climate change.

Understanding the socio-demographic characteristics and spatial distribution of fruit tree farmers is crucial for developing targeted adaptation strategies. The predominance of middle-aged and older farmers suggests that interventions should consider the specific needs and capacities of this demographic group. For instance, providing technical training and financial support tailored to older farmers can enhance their ability to adopt and sustain fruit tree cultivation practices.

The findings underscore the significance of taking into account socio-demographic factors, including age and gender, in developing effective adaptation strategies. By leveraging traditional knowledge, advanced technologies, and participatory methods, researchers and policymakers can support smallholder farmers in building resilience through sustainable fruit tree cultivation practices. This comprehensive approach can enhance food security, biodiversity, and livelihoods, particularly in Budaka district which is vulnerable to climate change impacts.

4.6.2 Socioeconomic variables influencing adoption of fruit tree growing as adaptation practice to climate change

While the study by Khalwale et al. (2018) found that the age of the household head does not influence the practice of on-farm tree planting, the current study identified a significant correlation between age and the adoption of fruit tree cultivation as a climate change adaptation strategy. These findings are consistent with the research conducted by Esabu & Ngwenya (2019), who found that older individuals have a higher likelihood of adopting fruit tree growing due to their extensive farming experience and desire to engage in such activities. Age is a critical factor in shaping a farmer's comprehension of farming activities, thereby influencing the adoption of fruit tree cultivation as a climate change adaptation strategy in Budaka district. This is due to the fact that various age groups may experience differing levels of vulnerability to climate change. These findings emphasize the importance of considering age when promoting and supporting fruit tree growing among farmers. Customized interventions that cater to the distinct needs and abilities of various age groups can enhance the adoption of fruit tree growing practices, ultimately contributing to improved agricultural outcomes and sustainability.

Gender norms often shape roles and responsibilities related to natural resource management, agriculture and disaster response. The investigation further established that the determination of farmers to engage in fruit tree cultivation as an adaptation practice to climate change was not significantly influenced by gender. This revelation was made during the FGD, where both males and females were found to possess fruit trees.. Additionally, Badstue et al. (2020) discovered that both women and men within a household could effectively oversee various farming operations and assume decision-making responsibilities. In contrast, Ndayambaje et al. (2012) conducted research in Rwanda which found that households with women as the head tended to plant a greater number of trees on their farms compared to households with men as the head. By recognizing and addressing the diverse roles that men and women play in communities, agricultural interventions can be better tailored to support both genders. This could involve creating opportunities for women's participation in tree cultivation, addressing cultural barriers, and providing targeted support to enhance women's empowerment in agricultural practices.

Education is essential for increasing awareness and enhancing agricultural practices. However, this study found only a weak correlation between education level and the adoption of fruit tree farming. Most adopters had at least a primary education, but education was not a primary concern for those engaging in fruit tree cultivation. This finding contrasts with the studies by Weir (1999) and Nkamleu (2005), which concluded that farmers with education are more inclined to implement agroforestry practices due to their enhanced ability to acquire and analyze agricultural information effectively. Despite this, during the focus group discussions (FGDs), education attainment was not identified as a primary concern for individuals wishing to engage in fruit tree cultivation. This suggests that while education can enhance farming efficiency and potentially improve adoption rates of certain agricultural practices, it may not be the most critical factor influencing the decision to adopt fruit tree growing in Budaka district. Other factors may have a more substantial influence in this context. The weak correlation indicates that even those with lower levels of formal education are willing and able to adopt fruit tree farming if they perceive it as beneficial and feasible within their specific circumstances. This underscores the importance of addressing a broader range of socioeconomic factors when promoting fruit tree cultivation as an adaptation strategy to climate change, rather than focusing solely on educational interventions.

Marital status showed a limited correlation with the adoption of fruit tree cultivation in Budaka district, contradicting findings by Bomuhangi et al. (2016), who reported that marital dynamics significantly influence agricultural decisions. This discrepancy suggests that, in Budaka district, other factors may overshadow the impact of marital status on decision making concerning fruit tree growing. While marital status can affect household decision-making processes, particularly regarding labor division and resource allocation, its influence on adopting fruit tree cultivation appears minimal in this specific context. This could be due to the uniform importance of fruit tree cultivation across different household structures or a community-wide recognition of its benefits, which diminishes the relative impact of marital dynamics. Therefore, while marital status is a notable factor in some regions, in Budaka district, its role in influencing the adoption of fruit tree growing has limited significance. This insight underscores the need to consider local socioeconomic conditions when evaluating factors affecting agricultural practices.

Contrary to previous research by Dewees (1994), Godoy (1992), and Ekepu and Tirivanhu (2016), which suggested that larger households are more inclined to engage in tree-based agriculture due to labor availability, this study did not identify a significant relationship between household size and the adoption of fruit tree cultivation. This suggests that other factors, such as land size and access to resources, might be more critical in determining the feasibility of adopting fruit tree growing.

The availability of labor showed a significant positive correlation with the adoption of fruit tree cultivation, which aligns with the findings of Glover et al. (2013). This correlation emphasizes the critical role of having a steady and sufficient labor force in successfully implementing agricultural practices, especially those that demand intensive labor input, such as fruit tree planting and maintenance. In agricultural contexts like Budaka district, where manual labor is often necessary for various farming activities, including land preparation, planting, pruning, and harvesting, the availability of labor becomes a pivotal factor in the decision to adopt fruit tree cultivation. Farmers who have access to a reliable labor force are better equipped to undertake the labor-intensive tasks associated with fruit tree farming. Furthermore, the positive correlation between labor availability and adoption suggests that farmers recognize the importance of having sufficient manpower to effectively manage fruit tree orchards. This underscores the practical considerations involved in fruit tree cultivation, where the availability of labor directly impacts the feasibility and success of adopting this agricultural practice.

This research study examined the scale of agricultural plots owned by respondents, with the largest reported size being 1-2 acres. The results indicated a notable correlation between the adoption of fruit tree cultivation as a strategy to adapt to climate change and the size of the farm. Farms of greater size are more inclined to adopt such practices, suggesting a connection between farm size and climate resilience strategies. A key insight from this study is the potential reasons why farm size influences the adoption of fruit tree cultivation. Larger farms may have more resources, including financial capital, labor, and space, which enable the integration of diverse agricultural practices without compromising staple crop production. This concept is reinforced by Maluki et al. (2016), who found that larger landholders are more capable of implementing agroforestry due to these advantages.

Furthermore, this finding highlights the socioeconomic aspect of climate adaptation practices. Cattaneo (2001) and Dewees (1995a) both identified that land size is a crucial determinant of agroforestry presence, suggesting that wealthier farmers, who typically own larger plots, have more capacity to invest in long-term sustainable practices. This raises important questions about equity and access in climate adaptation strategies. Small-scale farmers, who frequently face greater vulnerability to the impacts of climate change, may not have equal access to the same opportunities to adopt beneficial practices like fruit tree cultivation. This insight aligns with the work of Place and Otsuka (2001), who argued that secure land tenure and larger farm sizes provide the necessary security and incentive for farmers to invest in long-term improvements such as tree planting. They emphasize that without adequate land rights and sufficient land size, farmers are less likely to adopt practices that do not provide immediate returns.

The implications of these findings are significant for developing inclusive and equitable agricultural policies. To promote the widespread adoption of fruit tree cultivation, it is crucial to tackle the inequalities experienced by small-scale farmers. This study contributes to a nuanced understanding of how farm size impacts the adoption of climate adaptation practices, situating its findings within a broader scholarly context including Maluki et al. (2016), Cattaneo (2001), and Dewees (1995a). By exploring the socioeconomic factors underlying this relationship, the study emphasizes the importance of inclusive policy measures that support all farmers in building climate resilience.

This study explored how income influences the choice to adopt fruit tree cultivation as a strategy for adapting to climate change. The findings revealed that 28.4% of respondents earned an annual income of two million shillings or more, the highest among all income brackets. The research showed a strong connection between household income and the adoption of fruit tree farming, indicating that households with greater incomes are more inclined to engage in this practice. This discovery addresses a significant research gap regarding the socioeconomic factors influencing the adoption of fruit tree cultivation for climate adaptation. By aligning with Franzel's (1999) research, the study underscores the important role of income in facilitating the uptake of new agricultural technologies. Similar conclusions were drawn by Deressa et al. (2009), who found that wealthier households are more capable of adopting climate adaptation strategies in Ethiopia. Additionally, Di Falco et al. (2011) highlighted that financial capacity significantly impacts the ability of households to implement adaptive measures in response to climate change. The implications suggest the need for financial support mechanisms and comprehensive extension services to promote fair adoption of climate-resilient practices. This research fills an important gap in the literature, highlighting the economic barriers to climate adaptation and proposing ways to overcome these challenges.

The analysis focused on access to credit and found that it did not have a significant impact on the adoption of fruit tree cultivation, contrary to expectations. This differs from the findings of Bhan and Behera (2014), who discovered that access to finance was crucial for enabling Indian farmers to buy the necessary inputs for conservation farming. One important insight from this study is that most farmers in Budaka district reported having no access to finance. This lack of credit creates a major gap, as farmers struggle to obtain the necessary agricultural inputs due to their limited financial resources. These inputs are essential for successful fruit tree cultivation, involving investments in seedlings, fertilizers, and other materials. Without access to credit, many farmers are unable to make these initial investments, hindering their ability to adopt this important climate adaptation practice. While previous studies, such as Bhan and Behera (2014), have highlighted the importance of credit access in other contexts, this study suggests that simply having financial services available is not enough. The effectiveness of these services in promoting the adoption of new practices depends on their accessibility and suitability to the local context.

This study examined the determinants of adopting fruit tree cultivation as a climate change adaptation practice, focusing on the role of agricultural extension services. The analysis revealed an insignificant correlation between the utilization of agricultural extension services and the adoption of fruit tree cultivation, suggesting a negligible impact of these services on farmers' decisions to adopt this practice. This finding is significant as it contrasts with previous research by Akudugu et al. (2012) and Sserunkuuma (2005), which highlighted the crucial role of agricultural extension workers in educating farmers about new technologies. Therefore, while extension services are theoretically important, their practical impact in this context appears limited. The study revealed that most farmers did not gain from agricultural extension programs, indicating a lack of access to or engagement with these services. This points to potential issues in the implementation and reach of extension services in the region. The implications of these findings are clear. To enhance the adoption of fruit tree cultivation, it is essential to improve the effectiveness and accessibility of agricultural extension services.

4.6.3 Perception of farmers towards adoption of fruit tree growing as a climate change adaptation practice

This study evaluated the adoption of fruit tree farming as a climate change adaptation strategy, focusing on respondents' perceptions of climate change. The assumption was that awareness of climate change impacts would influence the decision to adopt fruit tree farming. When asked about the major challenges faced due to climate change, respondents cited persistent droughts, severe storms, and irregular rainfall. A linear correlation analysis revealed a significant adoption of fruit tree farming in response to these climate variations. This finding aligns with Moinina (2018), who suggested that adaptation methods focused on climate change mitigation can enhance farmers' resilience to natural disasters and reduce future climate change-related costs. Similarly, Deressa et al. (2009) and Below et al. (2012) have emphasized the significance of perception and awareness in embracing practices to adapt to climate change. Furthermore, the study emphasized the role of farmers' perceptions of the mitigating effects of fruit trees as a crucial variable influencing their adaptation strategy. The results indicated a robust correlation between the adoption fruit tree farming and farmers' understanding of how fruit trees mitigate climate change. This is consistent with the work of Bryan et al. (2009), who found that farmers' knowledge and perceptions significantly impact their adaptation decisions.

This study highlights the significance of awareness about climate change and the perceived benefits of mitigation strategies in the adoption of fruit tree growing as an adaptation practice. Enhancing farmers' understanding of the positive impacts of fruit tree cultivation could further facilitate its adoption as a climate change adaptation practice.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

Based on the findings presented in the previous chapter, this study draws several important conclusions regarding the determinants of adopting fruit tree growing as an adaptation practice to climate change in the Budaka district.

5.1 Conclusion

Firstly, the study found that a significant proportion of the farmers were above the age of 40, indicating that the cultivators were predominantly in their middle years, a phase marked by economic productivity and the capability to manage agricultural challenges effectively. However, the overall educational attainment of the participants was found to be inadequate.

Various socioeconomic factors were analyzed to understand their influence on the adoption of fruit tree cultivation. The most significant determinants identified were age, type of labor, farm size, and income level, which are crucial for adapting to climate change, boosting economic growth, ensuring food security, promoting environmental sustainability, and addressing social and cultural issues. These factors substantially impacted farmers' decisions, highlighting the critical role of economic productivity, resource availability, and labor dynamics in adopting new agricultural practices. In contrast, factors such as gender, educational level, and household size had an insignificant impact on the adoption of fruit tree cultivation. This indicates that economic and resource-based factors are more pivotal in influencing farmers' adaptation strategies than demographic and social characteristics.

The study also concluded that there is a significant correlation between farmers' understanding of how fruit trees mitigate climate change and their willingness to engage in fruit tree cultivation. Farmers with higher awareness and knowledge about the mitigation benefits of fruit trees are more likely to adopt this practice. Additionally, those who directly experience the adverse effects of climate change, such as unpredictable weather patterns, are more inclined to adopt adaptive practices like fruit tree cultivation. These findings underscore the importance of increasing farmers' awareness and education about the benefits of fruit trees in climate change mitigation to enhance the adoption of this sustainable practice.

Furthermore, the independent variables used in this investigation accounted for 84.6% of the variability in the decision to adopt fruit tree cultivation as a climate change adaptation practice. This indicates that factors such as age, type of labor, farm size, and income level significantly influence farmers' decisions. The remaining 15.4% of variability is attributed to latent factors not considered in this study, highlighting the need for comprehensive strategies that address both identified and unmeasured factors.

In conclusion, this study underscores the importance of targeted interventions that consider key socioeconomic determinants to effectively promote fruit tree cultivation as a sustainable adaptation practice to climate change. By focusing on critical variables such as age, type of labor, farm size, and income level, the study provides a detailed understanding of the factors influencing fruit tree adoption, contributing to sustainable agriculture, food security, and economic opportunities in the face of climate change.

5.2 Recommendations

To promote the adoption of fruit tree cultivation, a comprehensive approach involving improved extension services, resilient tree varieties, pest and disease management, financial incentives, education, and policy support is necessary to address this gap effectively.

The implementation of specialized training programs focused on climate-smart agricultural practices like fruit tree cultivation, should be complemented with awareness initiatives to educate farmers about the impacts of climate change and the advantages of fruit tree cultivation. These targeted extension programs are crucial to ensure that farmers are adequately prepared with essential knowledge and skills. By providing practical training in fruit tree cultivation and management, and emphasizing their role in adapting to climate change, these programs can have a significant impact. The National Agricultural Advisory Services (NAADS) and the Parish Development Model (PDM) can play a vital role in implementing these initiatives, equipping farmers in Budaka district with the skills needed to adapt effectively to changing climatic conditions.

Encouraging the cultivation of fruit tree varieties that are resilient to climate fluctuations will lead to better yields and sustainability. Additionally, providing farmers with access to effective insecticides and herbicides is crucial for controlling pests and diseases that can significantly reduce productivity. This combined approach of resilient varieties and pest management support will improve the overall success of fruit tree cultivation.

The involvement of governmental institutions and non-governmental organizations (NGOs) is of paramount importance in the provision of monetary aid and the facilitation of access to capital resources, such as low-interest loans and subsidies, in order to incentivize farmers to engage in the cultivation of fruit trees. This is due to the fact that the acquisition of income has been identified as a crucial factor influencing the adoption of fruit tree cultivation as a strategy to adjust to the impacts of climate change.

The local government should advocate for policy measures that support sustainable agricultural practices, especially fruit tree cultivation, which is critical for long-term success. Developing infrastructure that facilitates better market access for fruit tree products will enhance the economic viability for farmers, making fruit tree cultivation a more attractive option.

By implementing these recommendations, the adoption of fruit tree cultivation as a feasible and enduring method of adapting to climate change can be significantly enhanced in the Budaka district. This will contribute to sustainable agriculture, improved food security, and economic opportunities for farmers.

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APPENDICES

Appendix 1: SURVEY QUESTIONNAIRE FOR FRUIT TREE FARMERS

This questionnaire is scheduled to assess the factors determining adoption of fruit tree growing as an adaptation strategy to climate change in Budaka district. The information obtained is specifically meant for study purposes and will be treated with utmost confidentiality. Your positive response will be valued.

1. **Personal profile.**

I Respondents' number ☐ Voluntarily participated in this study sign………..

a) Sub county ……………………
b) Parish………………………….
c) Village…………………………

c) Age: Less than 18 yrs ☐ 19- 29yrs ☐ 30- 39yrs ☐ 40+ ☐

d) Gender: Male. ☐ Female. ☐

e) Level of Education: None ☐ Primary ☐ Secondary ☐ Tertiary ☐

f) Marital status: Single ☐ Married ☐ widow(wer) ☐

g) Family size. ☐

h) Number of members of school going age ☐

2. **Occupation:**

Do you grow any fruit trees? yes ☐ No ☐

If yes what type of fruit trees do you grow?

Mangoes ☐ Citrus Mixed. ☐ Others ☐ specify ……………

…………….

…………….

3. **Farm Management system.**

- Do you use fertilizers Yes ☐ No ☐ if yes what type?

Organic (Home made) ☐ Inorganic (Factory made) ☐ Both ☐

If No how do you manage your farm?

…………………………………………

…………………………………………

…………………………………………

- How do you manage weeds?
  - Spraying ☐
  - Slashing ☐

Both ☐

What type of labour are you using. Family ☐ Hired ☐ Both ☐

4) What is your farm size ☐ Acres

5) Is your farm consolidated ☐ fragmented ☐

6) If fragmented state the number of plots ☐

7) What is the distance from home to the farm.

____

8) Tenancy type: Free hold ☐

Lease ☐

Customary ☐

Other ☐

9) What is the importance of fruit tree growing?

Commercial……………………………………………………

Food security……………………………………………………

Others ……………………………………………………

………………………………………………………………

10) How long have you stayed in fruit tree growing?

…………………………………………………………………

What is your likely annual output in:

a) Kilograms ☐ b) Bags ☐

What is the output from other sources if any specify?

……………………………………………………………

………………………………………………………………

………………………………………………………………

………………………………………………………………

………………………………………………………………

11) What is your main source of income?

……………………………………………

……………………………………………

12) Has fruit tree growing benefited any of the following aspects

a) Environment
b) Soil
c) Family welfare

Please specify ……………………………………...

……………………………………………….

……………………………………………….

………………………………………………..

13) Have you ever been a member of a community organization?

Yes ☐ No ☐ Why?

…………………………………………….

…………………………………………….

…………………………………………….

14) Do you have access to credit facilities?

………………………………………………..

15) Do you get services from Agricultural extension officers?

End

Thank you for your participation in this research.

Appendix 2: FOCUS GROUP DISCUSSION QUESTIONS FOR COMMUNITY ENGAGEMENT.

Focus group discussion plan.

The researcher will determine:

- How many focus groups to run,
- Composition of the focus group.
- How many participants we want in each group. Each focus group should have between fifteen and twenty participants.
- Secure names and contact information and send invitations.
- Time each focus group should run between 40 to 60 minutes.
- Generate questions based on the purpose and goals of the focus group.
- Conduct the focus group discussion session.
- Probe for more complete answers
- Thank participants.

The questions to the focus group.

1. Who is engage in fruit tree growing?
2. Which is the leading area in fruit tree growing.
3. Why are people engaged in fruit tree growing?
4. How is the income from fruit tree growing managed?
5. What are the environmental benefits of fruit tree growing?
6. Is there specific fruit tree growing practices that you engage in specifically during the rainy season? / During the dry season?
7. Do you know of any measures that have been or are being implemented by the government (Ministry of Agriculture) / Agricultural NGOs to foster adoption of fruit tree growing?
8. What are the problems facing the fruit tree farmers?

End and thank you for your time.

Appendix 3: INTERVIEW SCHEDULE FOR KEY INFORMANTS.

Dear sir/ Madam

I am ……………………. a student of Kyambogo University undertaking research. This questionnaire is scheduled to assess the factors determining adoption of fruit tree growing as an adaptation strategy to climate change in Budaka district. The information is precisely for study purposes and is highly confidential. Your positive response is highly appreciated.

1. What is your position in this area.
2. Who is engaged in fruit tree growing?
3. Which is the leading area in fruit tree growing?
4. Why are they engaged in fruit tree growing?
5. How have the people benefited from fruit tree growing in terms of gender

Men …………………………….

…………………………………..

Women………………………….

…………………………………..

What is the role of

a) Women
b) Men in management of the proceeds from fruit trees?

How are the benefits shared?

6. How has fruit tree growing affected the environment?
7. Are there any fruit tree farmer groups or organisations?
8. Are there any government initiatives on financial and technical support to foster adoption of fruit tree growing?
9. What other challenge are facing fruit tree farmers?

End

Thank you for sparing your time to answer my questionnaire.

Appendix 4: OBSERVATION CHECKLIST.

Subcounty…………………

Parish…………………….

Village …………………..

Aspect	**Description**
Who is engaged in fruit tree growing	
House type Permanent Semi-permanent. Grass thatched	
Location site conditions Slope condition Soil conditions Sandy Clay Soil Colour Texture Depth Drainage.	
Farm size	
Farm management practices	
Crop yield and quality	
On sight adaptation programs/ measures.	

Appendix 5: DOCUMENT REVIEW GUIDE.

Determinants of adoption of fruit tree growing as an adaptation practice to climate change in Budaka district.

Subject.

____

Researcher.

_________________________________.

Is there any information on the determinants of adoption of fruit tree growing as an adaptation practice to climate change?

Yes ☐ No ☐

If yes which documentary.

____

____

____

____

____

Brief information obtained from the subject.

____

____

____

____

Appendix 6: INTRODUCTORY LETTERS

KYAMBOGO UNIVERSITY

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Office of the Dean graduate School

4th June 2021

The Resident District Commission,
Budaka Distrct

Re Introduction of a Research Team from Kyambogo University

This is to introduce to you a researcher team from Kyambogo University which has successfully won and awarded funds by the University to conduct a research on the Theme" **Adoption of Fruit Tree growing as a Climate Change Adaptation Strategy in Budaka District"** The study is specifically for academic purpose. It is in line with principle of promoting the three major functions of any University; Teaching, Research and Community services. For any University worth its name teach should be based on research work and the research should be used to transform society.

The University will be grateful for any assistance that will be rendered to the team to enable it complete this study successful.

KYAMBOGO UNIVERSITY
★ 04 JUN 2021 ★
OFFICE OF THE
DEAN GRADUATE SCHOOL

Assoc. Prof. Nabalegwa Muhamud Wambede
Ag. Dean