

**ANALYSIS OF THE FACTORS INFLUENCING ACCESS AND AVAILABILITY OF  
FOOD AMONG RURAL HOUSEHOLDS IN GOGRIAL EAST COUNTY, SOUTH  
SUDAN**

**DENG CHAN DENG YUOT**

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**DECLARATION AND APPROVAL**

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**This research Dissertation is my original work and has not been presented for the award of a degree in any other University or institution of higher learning.**

**Signature.....**

**Date .....**

**DENG CHAN DENG YUOT**

**S21M43/007**

**APPROVAL**

**This research report has been submitted for examination with my approval as the University Supervisor.**

**Signature.....**

**Date .....**

**Dr. John Livingstone Mutyaba, PhD**

**Lecturer**

**Department of Agriculture, Faculty of Agricultural Sciences**

**Uganda Christian University**

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## DEDICATION

This work is dedicated to my late parents, Mr. Chan Deng and Mrs. Anyuat Apul who had the future ambition of having a potential educated son by playing an important role in my early life and educational needs.

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## LIST OF ACRONYMS AND ABBREVIATIONS

AU-NEPAD	: Africa Union New Partnership for Africa's Development
FAO	: Food and Agricultural Organization
FEWSN	: Famine Early Warning Systems Network
FFP	: Food for Peace
HLPE	: High Level Panel of Experts on Food Security and Nutrition
HNO	: Humanitarian Needs Overview
IFAD	: International Fund for Agricultural Development
IFPRI	: International Food Policy Research Institute
IFSS	: Integrated Food Safety and System
IPC	: Integrated Food Security Phase Classification
SADC	: Southern African Development Community
SPLA	: Sudan People's Liberation Army
STATA	: Statistics and data
UNCTAD	: United Nations Conference on Trade and Development
UNESCO	: United Nations Educational, Scientific and Cultural Organization
UNICEF	: United Nations International Children's Emergency Fund
WFP	: World Food Programme
WHO	: World Health Organization

## ABSTRACT

Food security remains a persistent challenge in rural communities of developing countries and is central to the Sustainable Development Agenda. Defined as a condition in which all individuals, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life, food security is shaped by four key dimensions: availability, accessibility, utilization, and stability. In South Sudan, the interplay of climate change, protracted conflict, and socio-economic instability has exacerbated food insecurity. Nationally, over 8.3 million people (75%) face acute food insecurity, while in Gogrial East County alone, 62% of households experience severe food deprivation, with food access and availability reported at just 20% and 17.5%, respectively. This study assessed the determinants of food security in Gogrial East County by examining the socio-demographic profiles, agricultural practices, and institutional and economic factors influencing food availability among cereal farmers. A cross-sectional survey was conducted among 285 randomly selected cereal-farming households out of 992 registered farmers. Data analysis employed both descriptive and inferential statistics, including multiple linear regression and marginal effects. Findings indicated that age ( $B = 0.266, p < 0.05$ ), education level ( $B = 0.422, p = 0.024$ ), and access to extension services ( $B = 2.024, p = 0.001$ ) were positively associated with crop productivity. In contrast, improper land preparation ( $B = -1.682, p = 0.041$ ) and premature planting ( $B = -5.504, p = 0.001$ ) were negatively associated with yields, largely due to poor agronomic timing and soil degradation. Additionally, weeding frequency ( $B = 0.662, p = 0.031$ ) and pesticide application ( $B = 0.564, p < 0.001$ ) significantly improved yields, whereas reliance on local seeds ( $B = -1.640, p = 0.027$ ) and crop rotation ( $B = -6.204, p = 0.051$ ) had short-term adverse effects. With regard to dietary diversity, as measured by the Household Diet Diversity Score, education ( $B = 0.2324, p = 0.014$ ), gender ( $B = 0.3662, p = 0.042$ ), farm size ( $B = 0.0065, p = 0.001$ ), and age ( $B = 0.214, p < 0.001$ ) had significant positive impacts. However, income ( $B = -0.235, p < 0.001$ ), education level ( $B = -0.640, p = 0.008$ ), and credit access ( $dy/dx = -0.620, p = 0.002$ ) revealed complex or counterintuitive effects. Based on the findings, the study recommends enhancing extension services, increasing access to certified seeds, promoting climate-smart agriculture, and tailoring credit and education interventions to foster sustainable food security in Gogrial East County.

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## CHAPTER ONE

### INTRODUCTION

#### 1.1 Introduction

This chapter provides a comprehensive introduction to the study. It outlines the background and context within which the research is situated, clearly articulates the problem under investigation, and delineates the specific objectives that guide the study. Furthermore, the chapter presents the justification for undertaking the research and discusses its anticipated significance in both academic and practical contexts.

#### 1.2 Background to the Study

Food security remains a persistent challenge in many rural communities within developing countries, particularly in sub-Saharan Africa. It is a central pillar of the Sustainable Development Goals (SDGs), specifically SDG 2, which seeks to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (Food and Agriculture Organization [FAO], 2020). Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life (FAO, 2019). This multidimensional concept encompasses four interrelated pillars: food availability, food access, food utilization, and food stability (FAO, 2019).

Globally, climate change has emerged as a significant threat to food security, particularly for countries that rely heavily on rain-fed agriculture. The Intergovernmental Panel on Climate Change (IPCC, 2021) reports that increasing climate variability and extreme weather events, including floods and droughts, are severely affecting agricultural productivity, exacerbating food insecurity in vulnerable regions. Despite global commitments to combat hunger, approximately 828 million people worldwide remain undernourished (FAO, 2023). High food prices and inflation, coupled with limited income-earning opportunities, continue to hinder access to sufficient food for many households (United Nations Economic and Social Council [UNESCO], 2020).

In sub-Saharan Africa, agriculture remains the primary source of livelihood for nearly 90% of the rural population, yet food insecurity persists due to low productivity, environmental degradation, and poor access to agricultural inputs (International Fund for Agricultural Development [IFAD], 2021). The African Union, through its Comprehensive Africa Agriculture Development Programme (CAADP), emphasizes the vision of universal access to nutritious

food across the continent (African Union-New Partnership for Africa's Development [AU-NEPAD], 2022). However, challenges remain in terms of consistent monitoring and evaluation of food security across many African countries.

South Sudan represents one of the most acute food insecurity contexts in the world. Since its independence in 2011, the country has experienced recurrent cycles of conflict, displacement, and economic instability that have severely undermined food production systems and household resilience. According to the World Food Programme (WFP, 2023), over 8.3 million people—approximately 75% of the population—are facing severe food insecurity. The compounded effects of climate change, conflict, the COVID-19 pandemic, and rising food prices have created a “ring of fire” of hunger in the country (United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2022).

Particularly, recurrent flooding and prolonged conflict have displaced communities, destroyed farmland, and disrupted markets, severely limiting food access and availability (Mbuya et al., 2021; Dzawanda et al., 2021). The FAO (2022) warns that the continued combination of poor harvests, economic decline, and insecurity may double the number of people experiencing acute hunger to over 18 million in the near future. During the 2022 lean season, over 70% of the population faced severe food shortages, with thousands at risk of starvation without humanitarian support (WFP, 2022; Badejo, 2022).

In response, humanitarian agencies such as WFP and FAO have implemented food aid and resilience-building programs, reaching over 5.9 million people in 2021 with food and nutrition assistance (Mbuya et al., 2021). However, limited resources and inaccessibility in isolated areas have hindered comprehensive support. This crisis has intensified in Gogrial East County, where food insecurity has worsened since 2014. The Integrated Food Security Phase Classification (IPC) has categorized the region at Phase 2 (Stressed), with projections reaching Phase 3 (Crisis) by 2025 due to recurrent flooding, economic collapse, and conflict (IPC, 2021).

Data from REACH Initiative (2022) and WFP (2022) highlight that 62% of households in Gogrial East County face food insecurity, with only 20% able to access food and a mere 17% reporting food availability. The Humanitarian Needs Overview (HNO) and other assessments attribute this to repeated climate shocks, water scarcity, displacement, and the breakdown of agricultural systems (OCHA, 2021; Saferworld, 2020). Alarming, approximately 85% of those leaving the country due to food insecurity are from Gogrial East County, including 63% children (Saferworld, 2020).

Various studies have identified several socio-economic and institutional factors influencing household food security. These include family size, land size, soil fertility, irrigation access, extension services, fertilizer use, improved seeds, and access to market information (Devereux, 2019; Nyariki et al., 2023). Similar findings were reported by Muzari et al. (2020) and Bogale (2012), suggesting that institutional support and socio-economic characteristics significantly impact food access and availability at the household level.

### **1.3 Statement of the Problem**

Gogrial East County in South Sudan is currently experiencing a critical food security crisis, with a significant proportion of the population facing severe food shortages. Household access to food and overall food availability are alarmingly low, contributing to widespread hunger and malnutrition. The situation has deteriorated markedly in recent years, with increasing numbers of children suffering from acute malnutrition, dropping out of school, and becoming vulnerable to chronic health conditions. The persistent lack of food has also fuelled social instability, including a rise in criminal activities such as cattle theft and poaching, which in turn has triggered violent communal conflicts. Although humanitarian agencies have initiated interventions such as emergency food aid, nutrition services, and child protection programs, these efforts have not adequately addressed the underlying vulnerabilities. Environmental shocks like flooding, drought, and disease outbreaks continue to undermine food systems in the area. Despite the severity of the crisis, there is limited empirical research that explores how socio-economic factors and institutional support mechanisms affect household food access and availability. This study therefore seeks to analyze the influence of socio-economic conditions and institutional support on food access and availability among households in Gogrial East County, South Sudan.

### **1.4 Objectives of the Study**

#### **1.4.1 Overall Objective**

The main objective of this study was to examine the multifaceted factors influencing food security in Gogrial East County.

#### **1.4.2 Specific Objectives**

1. To analyse the socio-demographic characteristics of cereal farmers in Gogrial East County, South Sudan.
2. To examine the relationship between selected agricultural practices and cereal crop productivity among rural households in Gogrial East County, South Sudan.

3. To assess the influence of socioeconomic and institutional Factors on food availability among rural households in Gogrial East County, South Sudan.

### **1.5 Research Questions**

1. What are the socio-demographic characteristics of cereal farmers in Gogrial East County, South Sudan?

2. What is the relationship between selected agricultural practices and cereal crop productivity among rural households in Gogrial East County, South Sudan?

3. How do socioeconomic and institutional factors influence food availability among rural households in Gogrial East County, South Sudan?

### **1.6 Justification of the Study**

Despite growing global efforts to combat hunger and promote food security, food insecurity remains a persistent and worsening challenge across many African countries (United Nations Economic and Social Council [UNESC], 2019). South Sudan, in particular, continues to face escalating levels of food insecurity, largely due to recurrent climatic shocks, prolonged conflict, and economic instability. According to the Food and Agriculture Organization (FAO, 2022), adverse weather events and rising food prices have pushed millions toward severe hunger. The World Food Programme (WFP, 2022) reports that successive and compounding shocks have left tens of thousands critically food-insecure, with many experiencing acute malnutrition.

The combined effects of climate change and ongoing conflict have resulted in large-scale displacement, loss of livelihoods, and widespread destruction of agricultural land and crops. These impacts have also led to increased food prices, further threatening the survival of communities, particularly in remote areas of South Sudan (Mbuya et al., 2021). Gogrial East County is one of the most affected regions, with an estimated 82,000 people facing acute food insecurity (WFP, 2022). Although the WFP has introduced resilience-building programs aimed at mitigating the impact of sudden shocks, projections indicate that food insecurity in the region will continue to rise through 2025 if current conditions persist.

An assessment conducted by REACH and WFP (2022) estimated that 8.3 million people—approximately 60% of South Sudan’s total population—were expected to face severe food insecurity during the 2022 lean season. This represented a 7% increase from 2021 levels, highlighting the rapidly deteriorating food security situation. Saferworld (2020) further

reported a significant displacement of people due to acute food shortages, noting that approximately 85% of those fleeing the country originated from Gogrial East County, with 63% of them being children. Within Gogrial East County, REACH (2022) found that approximately 62% of the population was affected by food insecurity. Of these, only 20% of households had regular access to food, while food availability stood at a mere 17.5%. These dismal figures are largely attributed to a series of recurrent shocks—including flooding, drought, communal violence, and disease outbreaks—that have severely undermined food systems in the region (FAO, 2022; REACH, 2022).

Despite the evident vulnerability of rural households in Gogrial East County, there remains a significant knowledge gap regarding the influence of socio-economic factors and institutional support on household food access and availability. Understanding these determinants is critical for designing targeted interventions to enhance food security. Therefore, this study seeks to assess the role of socio-economic characteristics and institutional support systems in shaping food access and availability among rural households in Gogrial East County, South Sudan.

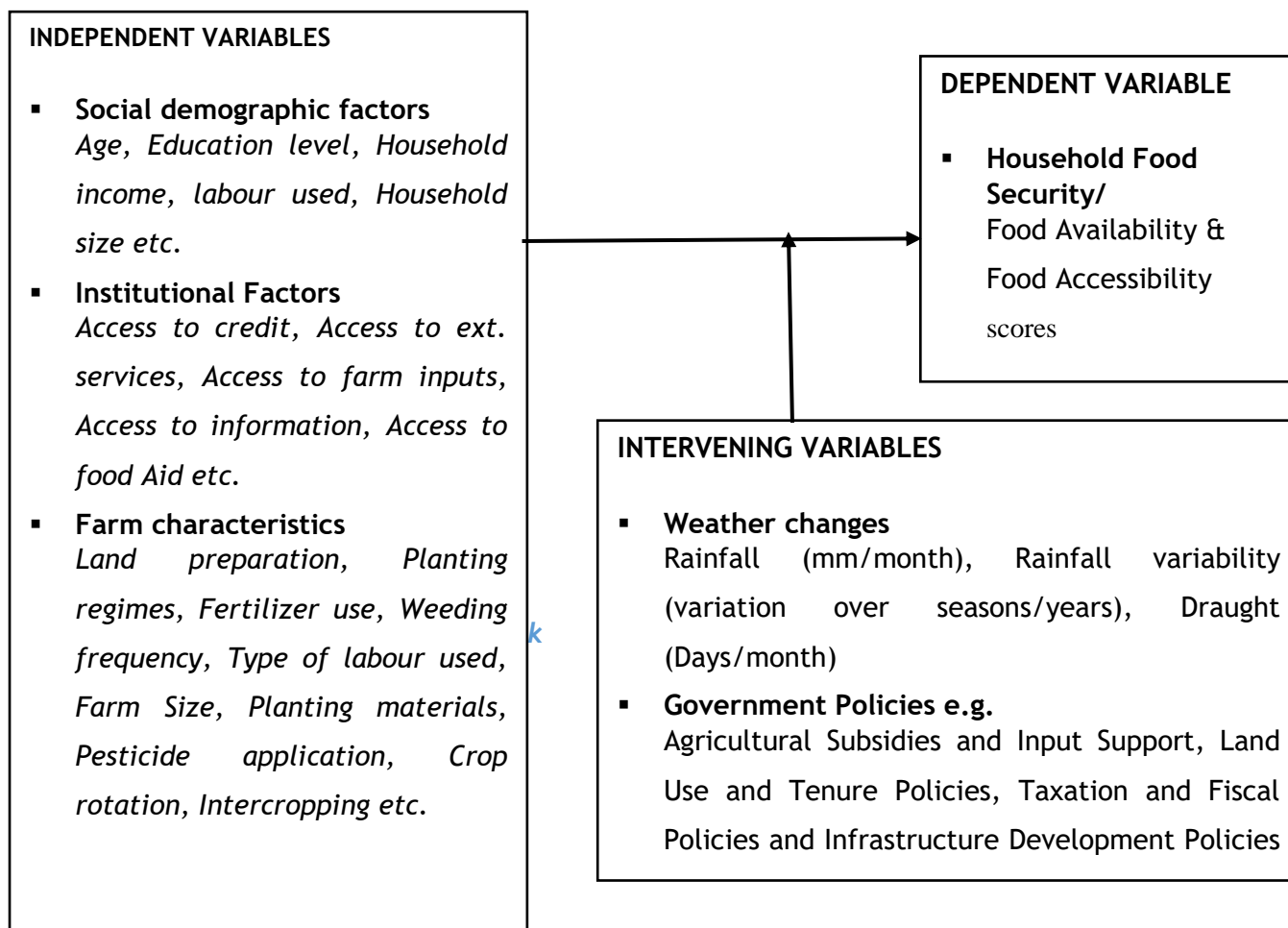
### **1.7 Scope of the Study**

This study was geographically and thematically limited to Gogrial East County in Warrap State, South Sudan. It investigated the key factors that influenced food access and availability among rural households in this region. Gogrial East County was selected due to its strategic location and persistent challenges related to food insecurity. The county borders Gogrial West County to the west, Twic County to the northwest, and Tonj North County to the southeast. It also adjoins Mayom County in Unity State to the northeast and shares a narrow boundary with Jur River County in Western Bahr el-Ghazal to the southwest (Craze, 2019).

The study specifically focused on three aspects. First, it examined the socio-economic factors that affected food access and availability among households, such as income levels, household size, education, employment status, land ownership, and livelihood strategies. Second, it assessed the role of institutional support, including governmental programs, humanitarian aid, and community-based organizations, in enhancing household access to food. Third, the study analysed the combined influence of socio-economic conditions and institutional support on household food security outcomes (FAO, 2023; World Bank, 2022).

## 1.8 Conceptual Framework

The conceptual framework provides a structured representation of the relationships between key variables that influence food security in rural households. It outlines the interplay between independent variables—such as household demographic characteristics, resource endowment, and access to institutional support and the dependent variables, specifically food availability and food accessibility. These two dimensions are recognized as core pillars of food security (FAO, 2008). Food availability in rural households is primarily determined by the potential for agricultural production, which is shaped by access to and utilization of key inputs such as land, labour, education, extension services, and technology. Additionally, livestock ownership, proximity to markets, the presence of food aid, household food stocks, and national food import capacity significantly influence food availability. Food accessibility, on the other hand, is influenced by factors that determine a household's ability to obtain food through production or market purchases. These include off-farm income, access to credit, purchasing power, efficiency in food distribution systems, own food production, and the availability of transport and market infrastructure. Furthermore, the framework recognizes the role of intervening variables such as government policies and environmental conditions, which may indirectly influence both food availability and access. These elements collectively form the basis for analysing the multifaceted nature of food security in rural settings.



## **1.9 Definitions of terms**

### **1. Socioeconomic factors:**

These are measurable social and economic conditions that directly influence an individual's standard of living and overall well-being.

### **2. Food security:**

A condition in which all individuals, at all times, have reliable physical access to sufficient, safe, and nutritious food to meet their dietary needs and preferences.

### **3. Food accessibility:**

Refers to the physical and economic capacity of individuals or households to acquire adequate and nutritious food on a regular basis.

### **4. Food availability:**

Refers to the consistent presence of adequate quantities of food from domestic production, imports, food reserves, or food aid to meet the nutritional requirements of a population.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter presents a critical review of relevant literature aligned with the focus of the study. The review is systematically structured to provide an in-depth examination of the key variables under investigation. Additionally, the chapter discusses the theoretical and conceptual frameworks that underpin the study, highlighting how existing theories and models inform the research. The literature reviewed offers both empirical and conceptual insights, forming the foundation upon which the study is anchored.

#### 2.2 Food security at global level

Food insecurity remains a pressing global challenge, threatening millions of individuals' fundamental human rights to adequate food. According to the United Nations (2020), the right to food is critical for realizing other human rights; yet, the consistent availability, accessibility, and quality of food continue to elude large segments of the global population. The situation is especially dire in developing nations and dryland ecosystems, where frequent food crises lead to hunger, malnutrition, and socio-economic instability (FAO, 2020). In sub-Saharan Africa, recurrent droughts, conflict, and inadequate infrastructure exacerbate food insecurity, worsening poverty and undermining resilience. The FAO (2022) defines food security as having consistent, sufficient, safe, and nutritious food access to meet dietary needs for a healthy life, emphasizing its multidimensionality. These dimensions—availability, accessibility, utilization, and stability—operate at different levels, from national production systems to individual consumption patterns, making food insecurity a complex and context-specific issue (HLPE, 2022; IFAD, 2021).

Recent scholarly focus on food security has expanded to include sustainability as a fifth dimension, highlighting the need to integrate environmental, economic, and socio-cultural considerations into food systems (FAO & WHO, 2021). Sustainable food systems are those that deliver food security and nutrition for all without compromising the ecosystems and resources required for future generations (FAO, 2018). However, global food systems contribute significantly to environmental degradation, accounting for 20-30% of human-induced greenhouse gas emissions, thus intensifying climate change, the very phenomenon that threatens long-term food security (FAO, 2020). Climate-related shocks, such as floods and droughts, disproportionately affect the most vulnerable populations, including migrants and displaced persons, who are often excluded from formal food security surveys (Smith et

al., 2019; Maxwell & Smith, 2020). Moreover, food insecurity does not only stem from lack of food but can also result from limited access due to economic hardship or social marginalization (WFP, 2023). As such, addressing global food insecurity requires a comprehensive, multi-sectoral approach that accounts for structural inequalities, improves social protection mechanisms, and strengthens the adaptive capacity of food systems (Johnson et al., 2020; Smith et al., 2022).

### 2.3 Food Security in Sub-Saharan Africa

Food insecurity continues to pose a significant threat to livelihoods and development across Sub-Saharan Africa. The drivers of food insecurity in the region are multifaceted, encompassing prolonged conflicts, climate variability, macroeconomic instability, and persistently low agricultural productivity. According to the Integrated Food Security Phase Classification (IPC), an estimated 18 to 21 million people in East Africa, including Ethiopia, Kenya, Somalia, and South Sudan are currently experiencing high levels of acute food insecurity (Akudugu et al., 2018). The World Food Programme (WFP, 2022) reports that approximately 81.6 million individuals, including internally displaced persons (IDPs), refugees, and host communities, face food shortages—a 39% increase from the 58.6 million reported in November 2021. These figures underscore a worsening food security situation, exacerbated by compounding shocks such as droughts, floods, civil unrest, and economic disruptions in countries such as Somalia, South Sudan, Sudan, and northern Ethiopia (Saferworld, 2020).

Agricultural challenges further aggravate the crisis. The region is characterized by low agricultural productivity, limited access to improved seeds and fertilizers, and the prevalence of unsustainable farming practices (Dzawanda et al., 2021). Countries that depend heavily on food imports are particularly vulnerable to global supply chain disruptions and price volatility (Kuwornu et al., 2018). Southern Africa is not exempt from this crisis, with approximately 40 million people experiencing food insecurity annually and nearly 19 million children affected by stunting due to chronic malnutrition (Dzawanda et al., 2021). In West Africa, the situation has been compounded by external shocks such as the war in Ukraine, which has disrupted global food supplies and driven an additional 7 to 10 million people into food insecurity (United Nations, 2023).

### 2.4 Food Insecurity in South Sudan

South Sudan continues to rank among the most food-insecure countries globally, with food insecurity affecting the majority of its population. As of 2022, approximately 7.7 million

people—representing 63% of the national population—were classified as severely food insecure, with several areas at risk of famine conditions (World Food Programme [WFP], 2022). The Integrated Food Security Phase Classification (IPC) places these regions under Phase 4 (emergency) and Phase 5 (catastrophe/famine), indicating extreme levels of acute food insecurity. The enduring civil conflict since 2013 has devastated livelihoods and forced widespread displacement, severely disrupting food systems and agricultural production across the country (Saferworld, 2020). The destruction of infrastructure and limited access to markets have compounded these effects, significantly diminishing households' capacity to produce or purchase food. Although humanitarian agencies have scaled up emergency interventions, insecurity and logistical barriers frequently delay aid delivery, particularly to remote or conflict-prone areas (Food and Agriculture Organization [FAO], 2022).

Climate variability and change present an additional layer of complexity in South Sudan's national food security crisis. The country has experienced increasingly erratic weather patterns, including prolonged droughts and sporadic flooding, both of which have adversely affected agricultural yields (Intergovernmental Panel on Climate Change [IPCC], 2021). These climate extremes disproportionately affect rural communities reliant on rain-fed subsistence farming, leaving them vulnerable to periodic food shortages and declining nutritional outcomes. The limited capacity for climate adaptation among farmers further exacerbates the situation, as traditional coping mechanisms are increasingly insufficient under current conditions. Moreover, seasonal displacements caused by environmental shocks contribute to disruptions in planting and harvesting cycles, resulting in further food system instability (USAID, 2023). Without sustainable investment in climate-resilient agriculture, the national food security outlook remains bleak.

Economic instability has further intensified food insecurity in South Sudan, undermining household purchasing power and access to essential commodities. The country has faced persistent macroeconomic deterioration, characterized by hyperinflation, currency depreciation, and fiscal deficits, which have rendered food and other basic goods prohibitively expensive for most families (United Nations Economic and Social Council [UNESCO], 2019). The economic crisis has also reduced the government's ability to invest in agricultural development, infrastructure, and social safety nets. Market volatility, coupled with insecurity-related trade disruptions, has led to inconsistent food supply and price inflation in both urban and rural markets. These dynamics have particularly affected

internally displaced persons (IDPs) and returnees, who often lack access to land, livelihoods, and social capital needed to rebuild their lives and ensure food access (FAO, 2022; WFP, 2023).

Efforts to mitigate food insecurity in South Sudan require a coordinated, multisectoral approach that integrates humanitarian assistance with long-term resilience-building. Strengthening agricultural value chains, improving rural infrastructure, and expanding access to extension services are critical steps toward enhancing domestic food production (International Food Policy Research Institute [IFPRI], 2022). In parallel, investment in peacebuilding initiatives is essential to ensure stability and facilitate the recovery of disrupted food systems. Regional and international actors must also support climate adaptation efforts through the provision of drought-resistant seeds, water management technologies, and early warning systems to mitigate climate-related shocks. Ultimately, sustainable solutions to South Sudan's food insecurity will depend on the intersection of peace, economic reform, and environmental stewardship requiring continued commitment from national stakeholders and the global community alike (United Nations Office for the Coordination of Humanitarian Affairs [UNOCHA], 2023).

## **2.5 Food Insecurity in Gogrial East County, South Sudan**

Gogrial East County, situated in Warrap State of South Sudan, grapples with acute food insecurity, reflective of national challenges yet distinct in its localized dimensions. As a rural area primarily reliant on subsistence agriculture and livestock production, the county is disproportionately affected by environmental and socio-political disruptions. Recurring climate shocks, including droughts and seasonal flooding, have significantly eroded agricultural productivity and destabilized traditional food systems (World Food Programme [WFP], 2022). These climatic extremes are compounded by persistent cattle raids and intercommunal violence, which not only threaten lives and livelihoods but also hinder farming activities and market access. As such, food availability and accessibility are undermined, leaving households increasingly dependent on humanitarian assistance that is itself challenged by logistical and security constraints.

Agricultural inefficiencies further exacerbate the food insecurity crisis in Gogrial East County. Most households depend on cereal crop cultivation, yet yields remain low due to poor soil fertility, lack of modern inputs, and limited adoption of improved farming methods (Dzawanda, Dzvimbo, & Mushunje, 2021). The absence of functional irrigation systems and dependence on rain-fed agriculture make local production highly susceptible to erratic

weather patterns. Additionally, the poor state of road infrastructure restricts the movement of goods and services, discouraging market participation and driving up food prices for the already vulnerable population. Although humanitarian agencies have attempted to alleviate these conditions, their efforts are frequently impeded by insecurity, bureaucratic obstacles, and underfunding (Food and Agriculture Organization [FAO], International Fund for Agricultural Development [IFAD], & WFP, 2018). Thus, the interplay of weak agricultural capacity and poor market connectivity continues to sustain food insecurity in the region.

Malnutrition is an alarming manifestation of food insecurity in the county, with widespread implications for public health and human development. Many households face daily challenges in meeting minimum dietary requirements, and food consumption patterns are often characterized by low diversity and inadequate nutrient intake (Kumar et al., 2021). Children and pregnant women are particularly at risk, as evidenced by high rates of stunting, wasting, and micronutrient deficiencies. Contributing factors include limited access to healthcare services, unsafe drinking water, and poor sanitation facilities, which collectively exacerbate vulnerability to food-related illnesses. Addressing this crisis requires a holistic approach that combines agricultural reform with social services delivery. Long-term food security in Gogrial East County depends on strategic investments in climate-resilient agriculture, conflict resolution, infrastructure development, and community-based nutrition programs (FAO, 2018).

## **2.6 Socio-Demographic Characteristics and Food Security**

Socio-demographic characteristics significantly influence household food security, particularly in vulnerable rural settings such as Gogrial East County. Variables such as household income, education level, family size, and gender roles shape access to food and determine how households respond to food scarcity (Peres et al., 2019). Income level, in particular, is a strong determinant of economic access to food, as it affects purchasing power and enables households to maintain dietary diversity even during food shortages (World Health Organization [WHO], 2020). Larger families are more likely to experience food insecurity, especially during lean seasons, because of the increased demand on limited resources (Dzawanda et al., 2021). Moreover, low education levels among household heads often correlate with poor agricultural practices and limited access to formal employment, further constraining household food availability (Muzari et al., 2021).

Gender disparities are another critical socio-demographic factor impacting food security. Women in rural communities like Gogrial East frequently face structural barriers that limit their control over productive resources, such as land and agricultural inputs (Bene et al., 2021). This disempowerment reduces their capacity to contribute meaningfully to household food production and decision-making, ultimately affecting food security outcomes. While men often have greater access to assets and markets, their decisions—such as the unplanned sale of food stock—may not always align with household nutritional needs (Worku & Ulku, 2022). Consequently, the intersectionality of gender and resource access underscores the need for inclusive agricultural policies that empower women as key agents in food systems (Kumar & Quisumbing, 2022).

Access to markets and transportation is equally important in determining food availability and affordability. In remote areas like Gogrial East County, the physical distance to markets limits household options and increases food prices due to higher transportation costs (Sanchez et al., 2021). Households without personal means of transportation face increased challenges in procuring sufficient and nutritious food (Jin, 2022). Similarly, the lack of proper food storage facilities exacerbates food insecurity by forcing farmers to sell perishable produce at low prices during harvest seasons, leaving them with limited reserves for subsequent months (Worku & Ulku, 2022). Employment status also correlates with food security, as stable sources of income facilitate both direct food purchases and investment in agricultural productivity (FAO, 2021; Smith et al., 2023).

Furthermore, regional studies reinforce the influence of local socio-demographic factors on food security. In Southern Africa, over half of rural households face food insecurity due to variables such as family size, soil fertility, and access to agricultural inputs (Mashau, 2021; Alemayehu et al., 2022). Off-farm income and livestock ownership have also been found to enhance household resilience to food shocks (Quaye & Owusu-Sekyere, 2023). However, in fragile settings like South Sudan, persistent challenges such as conflict, displacement, and climate variability intensify food insecurity (Akudugu et al., 2018). The scarcity of localized studies focusing on rural regions like Gogrial East County necessitates further research to understand context-specific socio-demographic determinants and to inform targeted, sustainable interventions that enhance food access and availability.

## 2.7 Institutional Factors and Food Security in Gogrial East County

Institutional support is fundamental to achieving food security in rural and conflict-affected areas such as Gogrial East County in South Sudan. Various institutions, including government agencies, non-governmental organizations (NGOs), and international development partners, provide key interventions that enhance agricultural productivity and household food access. These interventions encompass the provision of agricultural inputs such as seeds, planting tools, and extension services, in addition to food aid programs and household food vouchers (International Fund for Agricultural Development [IFAD], 2021). Furthermore, policy frameworks developed by government institutions directly influence commodity prices, land use regulations, and access to agricultural markets, which in turn affect food security outcomes (Yu & Wu, 2018). When these policies are supportive, they create an enabling environment for sustainable agricultural growth; conversely, restrictive or poorly implemented policies can undermine productivity and exacerbate food insecurity (Food and Agriculture Organization [FAO], 2023). Therefore, the collective role of institutions is critical in addressing both the immediate and structural causes of food insecurity in Gogrial East.

One of the most pressing institutional challenges in the region is the lack of a well-functioning and equitable marketing system. The marketing infrastructure in Gogrial East County is underdeveloped, with minimal market linkages and inadequate facilities, which severely limits the ability of farmers to sell their produce at fair prices (United Nations Conference on Trade and Development [UNCTAD], 2022). This inefficiency in the supply chain results in post-harvest losses and reduces incentives for farmers to increase production, thereby worsening the food security situation (World Bank, 2021). Limited access to market information and poor transportation networks further complicates the flow of goods and agricultural inputs, weakening the local food system (Dzawanda et al., 2021). These systemic inefficiencies create a dual burden: they restrict the availability of food for consumers and undermine the income potential of producers, reinforcing cycles of poverty and food insecurity.

The fragmentation of domestic markets in Gogrial East, alongside inadequate food supply chain infrastructure, poses a significant threat to food accessibility. Despite the region's potential for agricultural production, limited infrastructure and disorganized market systems impede the consistent supply of affordable, nutritious food (Yu & Wu, 2018).

Government-led strategies that aim to strengthen market integration—such as establishing food quality standards, enhancing transport infrastructure, and facilitating better coordination between producers and consumers—could greatly improve household food security (FAO, 2023). These initiatives would not only enhance the efficiency of food distribution but also improve consumer confidence in the quality and safety of food products. The promotion of value chain development and local agro-processing can also provide employment opportunities and stabilize local food prices, thereby improving food access in both rural and urban settings.

In addition to national and local efforts, international institutions play a vital role in sustaining food security in Gogrial East through humanitarian and development support. Agencies such as the UN World Food Programme (WFP), Food for Peace (FFP), and UNICEF are instrumental in delivering emergency food aid and supporting community resilience programs (Food for Peace, 2021). These organizations work closely with development partners like Catholic Relief Services and the FAO to provide essential agricultural inputs, nutrition support, and livelihood diversification tools (Nkonya et al., 2021). Despite these efforts, chronic food insecurity persists due to macroeconomic instability, production shortfalls, and conflict-related displacement (Kumar et al., 2021). However, ongoing collaborations between humanitarian actors and government agencies are helping to bridge the food gap, strengthen local capacities, and promote long-term food security. Institutional coherence, sustained funding, and policy alignment remain critical for addressing the multidimensional aspects of food insecurity in Gogrial East County.

## **2.8 Agricultural Practices and Food security**

Agricultural practices in Gogrial East County, South Sudan, are intricately tied to the food security status of smallholder farming households. The county's agriculture is predominantly rain-fed and marked by subsistence-level production, with farmers mainly cultivating sorghum, millet, and maize (FAO, 2022). These crops are grown using traditional practices such as mixed cropping, intercropping, and crop rotation, which are intended to preserve soil fertility and manage pests. However, due to low use of improved inputs, limited access to mechanization, and dependence on unpredictable rainfall, these practices often fall short in ensuring adequate food supply at the household level (Jayne et al., 2019). Consequently, food insecurity remains prevalent, particularly during lean seasons, as households struggle to produce enough food to meet consumption needs and mitigate seasonal hunger (World Bank, 2022).

Socioeconomic constraints in Gogrial East further limit the adoption of modern agricultural practices that could improve productivity and food availability. Most smallholder farmers in the county lack access to credit facilities, agricultural training, and essential inputs like improved seeds and fertilizers. The cost of farm inputs remains prohibitive for many, particularly female-headed households and youth, who typically have smaller landholdings and fewer productive assets (Doss, 2018). Additionally, low levels of formal education and extension support contribute to limited awareness of climate-smart and yield-enhancing technologies. These conditions hinder the ability of farmers to invest in sustainable farming and risk-reducing practices, resulting in low productivity and continued vulnerability to food shortages (Bene et al., 2021).

Institutional support in Gogrial East County is insufficient and fragmented, significantly affecting the ability of farmers to access vital agricultural resources. Government extension services are either weak or absent in many parts of the county, while donor and NGO programs, though occasionally available tend to be short-term and localized (FAO, 2021). Distribution of inputs such as tools, fertilizers, and certified seeds has not been systematic or equitable, creating disparities in productivity among communities. Furthermore, the absence of organized farmer cooperatives and market infrastructure limits the ability of farmers to commercialize their produce or store food for lean periods (World Bank, 2021). This institutional vacuum exacerbates the cycle of food insecurity, as farmers lack both the technical capacity and market incentives to produce beyond subsistence levels.

Cultural traditions and indigenous farming knowledge also influence agricultural decision-making in Gogrial East County. Many smallholder farmers continue to rely on ancestral techniques passed down through generations, which, while adapted to the local environment, are often not resilient enough to meet the demands of changing climate conditions. Practices such as use of local seed varieties, hand tillage, and reliance on community labour are still dominant, contributing to low yields and labour inefficiencies (FAO, 2023). Although some farmers have begun experimenting with conservation agriculture and drought-tolerant crops, widespread adoption remains minimal due to limited training and localized research. Promoting food security in the county thus requires an inclusive and participatory approach that integrates local knowledge with evidence-based innovations and ensures that farmers are equipped to adapt to a changing agricultural landscape (IFAD, 2021).

## 2.9 Crop production systems and food security

Cereal farming systems in Gogrial East County, South Sudan, are central to household food security and local livelihoods, particularly among rural smallholder farmers. The principal cereals cultivated in this semi-arid region include sorghum, millet, and maize, with sorghum being the most dominant due to its drought resilience and adaptability to harsh climatic conditions (Food and Agriculture Organization [FAO], 2022). These crops provide critical caloric intake and form the staple diet for the majority of the population. However, cereal productivity remains low, often undermined by the reliance on traditional farming methods, the absence of mechanization, and limited access to quality seed and fertilizer (World Bank, 2021). Despite the essential role of cereal crops in food security, these constraints limit their potential to meet both household consumption needs and income-generation objectives.

Traditional agricultural practices in Gogrial East are characterized by low input use, predominantly rain-fed systems, and manual labour-based cultivation on small plots. These systems are vulnerable to erratic rainfall patterns, soil degradation, and pest infestations—especially in maize, which is highly susceptible to fall armyworm and stem borers (Tadele, 2022). Fertilizer use is sporadic and remains unaffordable to most smallholders, while improved seed varieties are rarely adopted due to weak extension services and distribution networks (Béné et al., 2021). The prevalence of intercropping and mixed cropping, while beneficial for risk reduction, sometimes leads to suboptimal yields due to competition for nutrients and water. These constraints collectively exacerbate food insecurity, especially during lean seasons, when cereal stocks diminish and market prices spike, making food less accessible for vulnerable households.

The integration of climate-smart agricultural practices has been identified as a pathway to improving cereal productivity and ensuring long-term food security in the region. Practices such as conservation agriculture, agroforestry, water harvesting, and the cultivation of early-maturing and drought-tolerant cereal varieties offer significant potential to buffer against climatic shocks (FAO, 2021). When coupled with access to timely weather information, improved extension services, and input support systems, these innovations can enhance resilience and sustainability within cereal farming systems. Furthermore, strengthening market access and infrastructure could incentivize farmers to invest in productivity-enhancing technologies, thereby transforming cereal production from subsistence-oriented to market-driven. Ultimately, enhancing cereal production through

such integrated approaches will be pivotal in reducing food insecurity and improving the livelihoods of rural populations in Gogrial East County.

## 2.10 Sorghum production and food security in Gogrial East County

Sorghum (*Sorghum bicolor*) is the principal cereal crop cultivated in Gogrial East County, South Sudan, and plays a central role in household food security, nutrition, and rural livelihoods. Compared to other cereals such as millet (*Pennisetum glaucum*) and maize (*Zea mays*), sorghum is favoured for its superior resilience to drought, heat, and poor soil fertility, making it the most suitable crop for the county's semi-arid agroecological conditions (FAO, 2022; USAID, 2023). Recent regional data indicate that sorghum accounts for approximately 65% of total cereal production in Warrap State, with millet and maize contributing 20% and 15% respectively (FEWS NET, 2023). The dominance of sorghum is attributed to both environmental and socio-cultural factors. Agronomically, sorghum's deep root system and short growth cycle allow it to survive prolonged dry spells and irregular rainfall patterns, which are common in Gogrial East. It is also relatively tolerant to pests and diseases compared to maize, which has increasingly suffered from fall armyworm infestations and low productivity in recent years (FAO, 2022; World Bank, 2021). Millet, while also drought-tolerant, is often used as a supplementary crop due to its lower caloric yield per hectare and more demanding processing requirements (IFPRI, 2022).

Sorghum holds substantial importance in the local diet and culture. It is used for preparing staple foods such as *kisra* and *asir*, and is also valued for its storage stability, allowing households to preserve it for several months post-harvest. In contrast, maize is more perishable and often requires immediate consumption or sale after harvest (WFP, 2023). Moreover, sorghum stalks are used for thatching and animal fodder, further increasing its utility relative to other cereals. Despite its dominance, sorghum yields remain significantly below potential due to persistent constraints in the farming system. Most sorghum farmers rely on traditional methods, including the use of unimproved seed varieties, basic hand tools, and rain-fed cultivation. According to the World Bank (2021), fewer than 10% of cereal farmers in South Sudan have access to improved seeds or chemical fertilizers. In Gogrial East, the average sorghum yield is estimated at 0.9 metric tons per hectare—well below the regional potential of 2.5 metric tons per hectare under improved agronomic practices (FAOSTAT, 2024).

Farming systems are generally characterized by mixed cropping, with sorghum often intercropped with legumes or millet to manage risk and optimize land use. However, these

systems can lead to interspecific competition for nutrients and water, which may reduce the per-crop yield (Béné et al., 2021). Limited extension services, inadequate post-harvest handling facilities, and poor access to input markets further hinder productivity gains (AGRA, 2023). Overall, while millet and maize continue to contribute to household food supply, sorghum remains the most strategically important cereal in Gogrial East County. Strengthening sorghum value chains through improved seed systems, farmer training, and climate-smart agronomic practices presents a critical pathway for enhancing food security and agricultural resilience in the region.

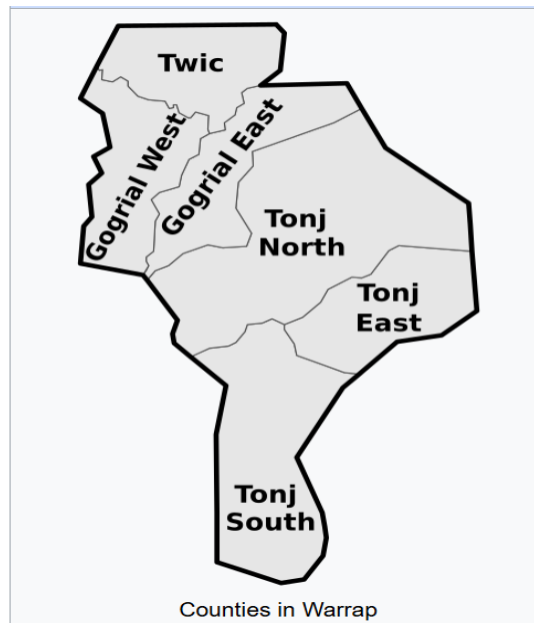
## CHAPTER THREE

### METHODOLOGY

#### 3.1 Study Area

Gogrial East County, located in Warrap State, shares its borders with several areas: Gogrial West County to the west, Twic County to the northwest, and Tonj North County to the southeast. It also borders Unity State (Mayom County) to the northeast and Western Bahr el-Ghazal (Jur River County) to the southwest. The county is primarily characterized by flat grasslands, where agro-pastoralist communities engage mainly in cattle rearing, farming, and fishing. In recent years, there has been a significant increase in agricultural participation and yields (Craze et al., 2016). According to UN-OCHA (2022), Gogrial East County has an estimated population of 131,128, predominantly made up of the Rek Dinka ethnic group.

Gogrial East County is located approximately 700 kilometres (430 miles) by road northwest of Juba, the capital and largest city of South Sudan. The geographical coordinates of Gogrial are  $8^{\circ} 31' 48.00''$ N latitude and  $28^{\circ} 6' 0.00''$  E longitude (Latitude: 8.5300; Longitude: 28.1000).



*Figure 2: Map of Warrap State with its Counties*

### 3.2 Sampling Procedure

The study adopted a multi-stage sampling procedure to select the respondent. First, Gogrial East County was purposively selected because of the associated increase in promotion of smallholder sustainable farming programmes by the Government to enhance farm productivity and integrated soil fertility management (ISFM). Second, Mayomchol, Pinydit, Yiikadoor, and Luonyaker Payams were also purposively selected since they are the major Cereal producing areas in the county. Subsequently, a random selection of three Bomas in each Payam was carried out. Finally, a simple random sampling method was used to select the required number of farmers from the selected Bomas. A list of farmers generated with the help of agricultural extension officers in the area acted as a sampling frame from which respondents were drawn. The sample was proportionately allocated to smallholder farmers growing mainly maize and sorghum since they are the staple food crops in the area with assistance from the agricultural extension officer in the selected Bomas.

### 3.3 Sample size determination

The required sample size was calculated using the formula for determining sample size as outlined by Yamane (1967:285). The study employed this formula due to its capacity to assume normal distribution among the members as expressed below:

$$n_0 = \frac{Z^2 P(1-P)N}{Z^2 P(1-P) + Ne^2} \dots\dots\dots (1)$$

Where:

$n_0$  = Sample size

$Z$  = confidence interval corresponding to a level of confidence

$P$  = population proportion

$N$  = Population size

$e$  = precision or error limit

Which is mathematically expressed as follows:

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

Where:

$n$  = Required responses

N = Population size

$e$  = Error term

Therefore, the study used a sample size of 285 respondents from total of 992 registered smallholder cereal farmers at a confidence interval of 95%. The sample size distribution is presented in Table 1.

**Table 1:** Sample Size and Distribution

S/N	Payams	No. of registered cereal Smallholder farmers (N)	Total sample size (n)
1	Mayomchol	249	73
2	Pinydit	232	66
3	Yiikadoor	213	62
4	Luonyaker	298	84
	<b>Total</b>	<b>992</b>	<b>285</b>

### 3.4 Study design

The existing literature on the multifaceted and interrelated factors contributing to household food insecurity in Gogrial East County, as well as the local responses to crises, is quite limited. Therefore, this study was designed to address this gap by empirically examining the household-level factors that influence food security. The findings will help inform the development of effective interventions to combat food insecurity. Specifically, the study employs linear regression analysis, using the household dietary diversity score (HDDS) and the household food insecurity access score (HFIAS) as indicators of household food security. Tables 1 and 2 outline the variables believed to influence household food security. The unit of analysis for this study was the smallholder cereal farmer in the study area.

### 3.5 Validity and Reliability

Reliability is the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects (Mbabazi, 2006). Data collection

instruments were pre-tested with at least 10 people playing the same role as those earmarked for the study. This helped to ascertain their dependability, accuracy and ability to elicit the necessary and adequate responses. The respondents were requested to make constructive criticisms, and positive changes and their suggestions were adopted for purposes of improving the final research instruments.

According to Sekaran (2001), Alpha values for each variable under study were not to be less than 0.6 for the statements in the instruments to be deemed reliable. Consequently, all the statements under each variable were subjected to this test, which if they proved to be above 0.6, and then they were declared reliable. But if they were not up to 0.6, they were refined for responsiveness. Validity is the extent to which an instrument measures what it is meant to measure (Mbabazi, 2006).

The instrument applied was valid, practical and free from bias. In this case, before the researcher applies the instruments, they were validated by examining their contents, whether they can measure to the assumed attributes, free from bias, contamination and deficiency. This therefore aided the researcher by minimizing bias as much as possible during the investigations. This also helped to ensure that biasness and deficiency were minimized as much as possible to set dependable responses for the study, where the ratio of 0.7 was based on to declare the instruments valid. If they didn't measure up to 0.7, the instruments were refined to make them valid.

### **3.6 Ethical consideration**

Initially, ethical approval was secured from the research ethics committee at Uganda Christian University, as the study included participants. Following this, permission was granted by the Course Coordinator at Uganda Christian University, along with an introductory letter intended for the local administrative office of Gogrial East County in South Sudan. This letter requested cooperation and assistance in conducting the research.

Before gathering data, consent was obtained from all participants. The study prioritized the rights of the participants, allowing them the freedom to choose whether or not to be involved. The researcher committed to maintaining confidentiality regarding the respondents' information and to respect their perspectives.

During the research, consent was collected from participants, assuring them that the study was conducted solely for academic purposes. The objectives, anticipated outcomes, and benefits of the research were communicated, and the sources of information utilized were

acknowledged. At each study site, focal persons were contacted beforehand to secure the necessary permissions and information. The purpose, overall content, and nature of the investigation were explained to each respondent to obtain both verbal and written consent before their inclusion in the study.

### 3.7 Scope and limitations of the study

Weather changes, particularly rain, hindered the researcher's ability to connect with some potential communities for interviews. Additionally, certain areas of the county were remote and difficult to access, impacting the movements of both the researcher and his assistants. Nevertheless, the researcher utilized motorcycles to navigate the challenging terrain.

Due to time constraints, the period allocated for the researcher was limited, which in turn restricted the scope of the study. However, this issue was addressed by the researcher communicating with the faculty research coordinator and the study supervisor to request an extension, enabling the researcher to complete the research properly.

### 3.10 Analytical Framework

**Objective One: To analyse the socio-demographic characteristics of cereal farmers in Gogrial East County.**

Chi-square statistics was used to analyse the socio-demographic characteristics of cereal farmers in Gogrial East County. The analysis incorporated percentages, means, standard deviations and *p*-values presented in tables.

**Objective Two: To investigate the relationship between agricultural practices in cereal farming and crop productivity among rural households in Gogrial East County.**

To analyze the relationship between agricultural practices and crop yields in Gogrial East County, a multiple linear regression model can be used. The general form of the regression equation is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \epsilon \dots\dots\dots (1)$$

Where:

Y = Crop yield (kg/feddan) (Dependent variable)

$\beta_0$  = Intercept (constant term)

$\beta_1\beta_2 \dots \beta_n$  = Coefficients representing the effect of each independent variable on crop yield

$X_1X_2 \dots X_n$  = Independent variables representing agricultural practices.

$\varepsilon$  = Error term (random variation not explained by the model)

Based on the variables listed earlier, the specific regression model can be written as:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \varepsilon.$$

Where:

$X_1$ = Land preparation method (Categorical, e.g., plowing, zero tillage)

$X_2$ = Planting regime (Categorical, e.g., early, late)

$X_3$ = Fertilizer use (kg/ha)

$X_4$  = Weeding frequency (number of times per season)

$X_5$  = Type of labor used (Categorical, e.g., family, hired)

$X_6$  = Farm size (hectares)

$X_7$ = Planting materials used (Categorical, e.g., improved, local seed)

$X_8$ = Pesticide application (Binary: 1 = Yes, 0 = No)

$X_9$ = Crop rotation (Binary: 1 = Yes, 0 = No)

$X_{10}$  = Intercropping (Binary: 1 = Yes, 0 = No)

**Table 2:** Description of Variables

Name of Variable	Description	Expected sign
<b>Dependent</b>		
Crop yield	Measured in kg/feddan	

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Independent		
Land preparation	Categorical (1= tilling, 0=zero tillage)	+
Planting regime	Categorical (1=early, 0=late)	+/-
Fertilizer use	Continuous (kg/feddan)	+
Weeding frequency	Continuous (number of times per season)	+/-
Type of labour used	Categorical (1=family, 0=hired)	+
Farm Size	Continuous (feddans)	+/-
Planting materials	Categorical (1=improved, 0=indigenous)	+/-
Pesticide application	Categorical (1=yes, 0=no)	+/-
Crop rotation	Categorical (1=yes, 0=no)	+/-
Intercropping	Categorical (1=yes, 0=no)	+/-

*(In South Sudan, the size of land is measured in feddan, which translates into 1.0378 Acres)*

**Objective Three: To determine socioeconomic and institutional factors affecting food availability among rural households in Gogrial East County.**

Household heads, use a variety of production techniques to be able to meet the needs of their families. They are faced with various challenges, which may have to be dealt with simultaneously and or sequentially as supplements, complements or substitutes. This implies that the number of strategies may not be independent but interdependent. Thus the household heads will choose a set of strategies that maximizes expected household food access (Kassie et al., 2013). Therefore, in the study, a multivariate linear regression was sought to be suitable:

$$Y = \beta_0 + \varepsilon_{j=1..p} \beta_j X_j + \varepsilon \dots \dots \dots (3)$$

Where.

$Y$  was the Dependent variable,  $\beta_0$  referred to the intercept of the model,  $X_j$  were the corresponding  $j^{th}$  explanatory variables applied in the model ( $j = 1$  to  $p$ ), and  $\varepsilon$  was the random error with expectation 0 and variance  $\delta^2$ .

**Table 3:** Description of Explanatory variables and Dependent variables

Variables	Description	Expected signs
<b>Dependent</b>		
Food Security	(Measured in terms of food availability/Household dietary scores HDDS)	
<b>Explanatory</b>		
AgeHH	Age of the household head in years	+/-
MarHH	1=married, 0=otherwise	+/-
EducHH	Years of schooling	+
GendHH	Gender of the household head 1=male and 0=female	+/-
EducHH	Number of years of schooling of household head	-
Farmexp	Farming experience in years	-
Farmsz	Farm size in acres	-
Extencon	Number of contacts with extension services	-
Extenvisit	Number of extension visits received in a month	+
Traingfood	Number of trainings on food production	+
CredAccess	Credit facilities towards food production in a year	+ /-
DistfoodMkt	Distance to the nearest food market in Km.	+/-
FoodAid	Number of food relief received in a year	+/-

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DistFarmlnp	Distance to nearest farm input market measured in Km.	+/-
Foodsources	Different food sources, 1=farm, 0=otherwise	+/-
Extenvisit	Number of extension visits received in a month	+
Traingfood	Number of trainings on food production	+

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## CHAPTER FOUR

### RESULTS AND DISCUSSIONS

#### 4.0 Introduction

This chapter presents the results and analysis of the study, guided by the stated research objectives. It comprises both descriptive and inferential statistical findings. The descriptive statistics provide an overview of the key characteristics of the study variables, while the inferential statistics offer insights into the relationships and effects among variables, thereby addressing the study hypotheses. The results are systematically organized and interpreted to reflect the research objectives and the analytical framework employed.

#### 4.1 Socio-Demographic Characteristics of Respondents

The results presented in Table 5 detail the socio-demographic characteristics of the surveyed respondents. The average age of the respondents was 39 years, with a relatively high standard deviation of 18.8 years, indicating a wide age range among them. In contrast, the sub-sample from Pinydit Payam had a slightly lower average age of 36 years and a standard deviation of 17 years, suggesting a somewhat younger demographic in this area. This age variation is an important factor to consider when assessing generational differences in farming practices. Older farmers may possess more experience but could have diminished physical capabilities, while younger farmers might be more inclined to adopt new technologies, albeit with less experience.

**Table 4:** Socio-demographic characteristics of sampled participants (*n*=285)

Payams	Mayomchol		Pinydit		Yiikadoor		Luonyaker		Overall	
	(n=73)		(n=66)		(n=62)		(n=84)			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age of the respondent	38	19	36	17	42	21	41	18	39.3	18.8
Number of Household Members	5.8	2.9	5.4	2.6	6.1	2.8	5.7	3.1	5.8	2.9
Experience in farming (years)	6.3	2.6	5.5	2.1	4.6	1.3	6.4	3.3	5.7	2.3

Number of extension contacts	2	0.16	3	1.2	1	0.2	3.6	1.3	2.4	0.7
Number of ext. visits in a year	4.1	1.7	3.4	1.9	2.2	0.6	3.2	1.4	3.2	1.4
Trainings received in a year	2	0.3	4.2	1.7	2.8	1.4	2.1	1.3	2.8	1.2
Credits received in a year	0.6	0.01	2.8	1.3	1.4	0.1	2.2	0.3	1.8	0.4
Distance to food market (km)	19.8	8.5	16.4	9.7	10.2	5.6	14	6.9	15.1	7.7
Distance to agro-farm shop (km)	13.9	9.3	8	3.5	11.6	7.2	23	11.8	14.1	8.0
Farm size (feddans)	3.6	1.1	2	0.9	2.3	1.2	2.4	1.3	2.6	1.1
Quantity harvested (kgs/year)	1400	756	1650	780	1380	580	1480	802	1478	730

The mean household size was 6 members, with a standard deviation of 2.9, which suggests that the typical respondent's household was relatively large. Large household sizes are often associated with a higher demand for resources, which may impact labour availability for farming activities and the overall economic dynamics within the household. This could have implications for the distribution of family labour in farming practices and the potential need for external support, such as agricultural extension services. Further, the sampled respondents reported an average of 6 years of farming experience, with a standard deviation of 2.3 years. This relatively short duration of experience indicates that the farmers in the sample might be relatively new to agriculture, which could influence their farming practices, including their openness to adopting modern agricultural techniques or technologies. The modest level of experience also underscores the potential benefit of targeted agricultural extension services to enhance the technical skills of these farmers.

In addition, the results show that respondents typically engage with at least one extension agent per year, with an average of  $2 \pm 0.7$  visits annually. This suggests a relatively moderate level of interaction with agricultural extension services, which are vital for farmers to access updated information on farming practices, pest management, and market trends. The

frequency of these visits could be indicative of either the availability or the need for more frequent guidance to improve agricultural productivity. In terms of access to training, respondents indicated they received an average of 3 training sessions annually, with a fairly low standard deviation of 2. This suggests that training is a fairly common, but not necessarily frequent, activity among the respondents. Given the central role of training in improving farming skills and knowledge, the relatively low frequency of training might indicate a gap that could be addressed to enhance agricultural productivity. Additionally, the respondents reported receiving credit support approximately 1.8 times a year, which could reflect the financial constraints they face, as credit is often critical for farmers to invest in inputs such as seeds, fertilizers, and equipment.

The average distance to the food market was 15 kilometres ( $\pm 7.7$  km), and the average distance to farm supply shops was slightly shorter, at 14 kilometres ( $\pm 8$  km). These distances indicate that access to essential markets and agricultural inputs may be a significant challenge for the respondents, particularly in terms of time and transportation costs. Long distances can limit farmers' ability to access fresh produce markets or essential supplies, thus affecting their profitability and productivity. In terms of land used for farming, the average respondent owned approximately 3 feddans of land, with a standard deviation of 1.1 feddans. This relatively modest landholding size is typical of many smallholder farmers. Despite this, the respondents were able to harvest an average of 1478 kilograms of cereals per season, with a substantial standard deviation of 730 kilograms. This variability could be due to differing farming techniques, input usage, or climatic conditions, underscoring the potential for improving land productivity through better farming practices, access to inputs, and extension services.

It is worth noting that while there is a considerable variation in age, household size, and farming experience, there are clear indicators that farmers face challenges related to limited training, access to resources, and relatively low levels of engagement with extension services. These results suggest areas for intervention, particularly in enhancing access to training, improving credit facilities, and reducing the distance to key market and supply centers to improve overall agricultural productivity and well-being for these farmers. The statistical analysis of gender distribution, as presented in Table 6, indicates that male respondents constituted 67.02% of the total sample, while female respondents accounted for 32.98%. Notably, Luonyaker Payam recorded the highest proportion of female-headed households at 46.4%, followed by Mayomchol, Yiikadoor, and Pinydit in descending order.

Regarding marital status, the overall distribution shows that 49.47% of respondents were married, followed by widowed individuals at 23.16%, divorced at 14.09%, and single respondents at 13.33%. A disaggregated analysis across Payams indicates that Luonyaker had the highest number of married household heads, with Pinydit reporting 53.0%, Yiikadoor at 45.2%, and Mayomchol registering the lowest proportion at 26.0%. Educational attainment among respondents varied significantly. The data reveals that 38.95% of the total sample had never received formal education, with Yiikadoor Payam having the highest proportion in this category (53.2%). The highest level of education attained by most respondents was primary education (40.35%), followed by secondary education (12.63%), tertiary education (5.61%), and university graduates comprising only 2.46%. These findings underscore the limited access to higher education within the study area.

The distribution of household heads by age group shows that 41.75% of the sampled population fell within the 0-17 year's category, followed by 34.39% in the 18-35 years age group. Respondents aged between 36-64 years comprised 19.65%, while those aged 65 years and above accounted for only 4.21%. The data further indicate that 23% of the sampled households had a high proportion of dependent, unproductive labor force, suggesting a high fertility rate within the region.

**Table 5:** Analysis of Categorical variables ( $n=285$ )

Categorical Variables	Mayomcho Pinydit YiikadoorLuonyake				Total	
	l (S=73) (%)	(S=66) (%)	(S=62) (%)	r (S=84) (%)	(n)	(%)
<b>Gender of Household Head</b>						
Male	67.1	77.3	74.2	53.6	191	67.02
Female	32.9	22.7	25.8	46.4	94	32.98
<b>Marital Status</b>						
Single	16.4	10.6	17.7	9.5	38	13.33

Divorced	23.3	15.2	11.3	7.1	40	14.04
Married	26.0	53.0	45.2	70.2	141	49.47
Widowed	34.3	21.2	25.8	13.1	66	23.16
<b>Education of Household Head</b>						
No formal education	19.2	43.9	53.2	41.7	111	38.95
Primary	71.2	25.8	32.3	30.9	115	40.35
Secondary	4.1	19.7	9.7	16.7	36	12.63
Diploma/Certificate	4.1	6.1	3.2	8.3	16	5.61
Degree	1.4	4.5	1.6	2.4	7	2.46
<b>Household Age Group</b>						
0 - 17 years	42.5	43.9	37.1	42.86	119	41.75
18 - 35 years	30.1	30.3	30.7	44.05	98	34.39
36 - 64 years	23.3	19.7	29.0	9.52	56	19.65
65 and above	4.1	6.1	3.2	3.57	12	4.21
<b>Household Food Sources</b>						
From farm	83.6	81.8	95.2	90.5	250	87.72
From other sources	16.4	18.2	4.8	9.5	35	12.28
<b>Household head income sources</b>						
Small scale trading	8.2	1.5	12.9	7.0	20	7.03
Causal Laborer	12.3	6.1	9.7	9.5	27	9.47
Farming	8.1	90.9	72.6	84.5	233	81.75
Retired Pension Earner	1.4	1.5	4.8	0	5	1.75

With respect to food sources, 87.72% of respondents identified farming as their primary source of food, whereas 12.28% relied on other sources. Similarly, in terms of income sources, the majority (81.75%) derived their earnings from farming activities, followed by casual labor (9.47%), small-scale trading (7.03%), and retired public servants constituting only 1.75%.

#### 4.2 Agricultural practices associated with crop productivity

The findings presented in Table 6 illustrate the agricultural practices adopted by households in Gogrial East County, South Sudan, and their implications for crop productivity. Regarding land preparation before planting, an overwhelming majority (98%) of the sampled respondents engage in tillage before sowing crops. This practice is vital for breaking up compacted soil, improving aeration, and facilitating root penetration, which in turn enhances nutrient and water absorption by crops. Given the predominantly sandy and clayey soils in the region, tillage plays a critical role in optimizing soil conditions for crop productivity. However, excessive tillage without soil conservation measures can lead to soil degradation, reducing long-term fertility and yield potential.

**Table 6:** Frequency of agricultural practices used in sampled households' fields (n=285).

No.	Agricultural Practice	Frequency (%)
1	Land preparation (1=tilling)	98%
2	Planting regime (1=early planting)	27%
3	Type of labour used (1=hired labour)	11%
4	Planting materials (1=improved seeds)	29%
5	Pesticide application (1=yes)	18%
6	Crop rotation (1=yes)	17%
7	Intercropping (1=yes)	84%

As regards to planting regimes, only 27% of the respondents reported practicing early planting. Early planting is a well-established factor in improving crop yields, as it ensures that crops receive adequate rainfall during the early growth stages. In Gogrial East County,

where rainfall is often unpredictable and unevenly distributed, delayed planting increases the risk of crop failure due to moisture stress. The low percentage of farmers practicing early planting suggests that many farmers may miss the optimal planting window, reducing overall productivity and heightening food insecurity in the region. Regarding labor utilization, findings indicate that only 11% of respondents rely on hired labour, while the vast majority (89%) depend solely on family labor for agricultural activities. The heavy reliance on family labor suggests financial constraints that limit farmers' ability to expand their cultivated land or intensify production. Consequently, farm sizes remain small, and productivity levels are often low due to the limited workforce available for timely planting, weeding, and harvesting.

In terms of seed selection, only 29% of respondents reported using improved seeds, while the majority continue to depend on traditional seed varieties. The low adoption of improved seeds, which often have higher yield potential, greater resistance to drought, and better pest tolerance, may be a key limiting factor in enhancing crop productivity. The limited access to quality seeds could be attributed to financial constraints, inadequate distribution networks, and a lack of agricultural extension services promoting improved seed varieties. Similarly, pesticide use remains low, with only 18% of respondents utilizing pesticides for pest and vector control. The low usage of pesticides suggests that many crops are highly susceptible to pest infestations, which can significantly reduce yields and threaten food security.

Furthermore, crop rotation is practiced by only 17% of respondents, whereas intercropping is widely embraced, with 84% of respondents engaging in this technique. The high prevalence of intercropping reflects an adaptive strategy used by farmers to maximize land use, improve soil fertility, and minimize crop failure risks. However, the low adoption of crop rotation suggests that many farmers may be over-relying on the same plots for repeated cultivation of the same crops, leading to soil nutrient depletion and increasing vulnerability to pests and diseases. The limited use of sustainable soil management practices, such as crop rotation, can contribute to declining soil fertility, ultimately reducing crop productivity over time. These findings underscore the need for targeted interventions to enhance agricultural productivity in Gogrial East County. Increased access to improved seeds, timely planting awareness, pest control measures, and sustainable farming practices such as crop rotation could significantly boost yields and improve food security in the region. Strengthening agricultural extension services and providing financial support for farmers

could play a crucial role in addressing these challenges and enhancing overall crop productivity.

**Table 7:** Pre-estimation test for correlation among selected variables

	Tilling	Early planting	Hired labour	Improved seeds	Pesticide use	Crop rotation	Intercropping
Tilling	0.450						
Early planting	0.037	0.146					
Hired labour	0.053	0.067	0.014				
Improved seeds	0.079	0.116	0.123	0.064			
Pesticide use	0.084	0.119	0.024	0.126	0.221		
Crop rotation	0.104	0.203	0.072	0.140	0.246	0.064	
Intercropping	0.130	0.062	0.092	0.542	0.044	0.042	0.234

Table 7 presents the results of a correlation test conducted to determine the strength and direction of the relationship between selected variables. Correlation analysis is a statistical technique used to assess whether changes in one variable are associated with changes in another and whether such associations are positive or negative. The results indicate that all correlation coefficients are positive and have values less than one. This implies that the variables under study exhibit a positive linear relationship, meaning that an increase in one variable corresponds to an increase in the associated variable. The fact that none of the correlation values exceed one confirms the statistical validity of the correlation coefficients, as correlation values range between -1 and +1. A correlation coefficient closer to +1 would suggest a strong positive association, whereas values near zero would indicate a weak or negligible relationship.

Table 8 shows the results of the linear regression analysis on crop productivity in Gogrial East County, South Sudan, and underscores the significant influence of socio-economic and farm management variables. The model exhibits strong explanatory power, with an R<sup>2</sup> value of 96.42%, indicating that the selected predictors account for most of the variations in crop

productivity. The Wald Chi<sup>2</sup> statistic of 49.64 and a p-value (Prob>Chi<sup>2</sup>) of 0.000 confirm the overall significance of the model, highlighting the importance of these factors in shaping agricultural output in the study area. These findings align with prior studies on sub-Saharan Africa, which emphasize the role of farmer characteristics and agronomic practices in determining productivity (Mango et al., 2018; Ouma et al., 2020).

**Table 8:** Factors associated with crop productivity among the sampled households (*n*=285)

Variables	Coefficients	S.E	<i>p</i> -Value
Age	0.266	0.141	0.003**
Gender	-0.376	0.024	0.603
Educ. Level	0.422	0.331	0.024*
Access to ext. services	2.024	1.032	0.001***
Land preparation	-1.682	0.482	0.041*
Planting regime	-5.504	2.448	0.001***
Fertilizer use	0.064	0.012	0.712
Weeding frequency	0.662	0.046	0.031*
Type of labour used	0.426	0.122	0.062
Farm Size	0.984	0.420	1.342
Planting materials	-1.640	0.612	0.027*
Use of Pesticide	0.564	0.026	0.000***
Crop rotation	-6.204	2.482	0.051*
Intercropping	0.864	0.004	0.614
Constant	0.004	0.010	
Obs=285			
R2 (%) = 96.42			

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Wald  $\chi^2 = 49.64$

Prob >  $\chi^2 = 0.000$

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Further, the study identifies age and education as critical determinants of crop productivity. Older farmers tend to have higher yields due to accumulated experience, indigenous knowledge, and adaptive farming techniques. The positive coefficient (0.266) for age suggests that with each additional year, crop productivity increases by 0.266 kg/feddan. Similarly, education level significantly influences productivity ( $p = 0.024$ ), with a positive coefficient of 0.422. Farmers with higher education levels are more likely to adopt improved agricultural techniques, utilize extension services effectively, and make informed decisions regarding input use and market access (Dercon & Christiaensen, 2011). These findings highlight the need for investment in farmer education and knowledge transfer programs to bridge the gap between traditional and modern farming methods.

As regards Extension services, they also play a significant role in enhancing crop productivity. A one-unit increase in access to extension services corresponds to a 2.024 kg/feddan increase in productivity ( $p = 0.001$ ). This underscores the importance of strengthening agricultural extension networks to disseminate modern farming techniques, enhance decision-making, and improve input utilization. Studies in developing countries have similarly documented the positive effects of extension services on farm yields, especially in areas with limited access to agricultural information (Ragasa et al., 2016; Danso-Abbeam et al., 2018).

Conversely, land preparation and early planting negatively impact productivity. Land preparation before sowing was statistically significant ( $p = 0.041$ ) but had a negative coefficient of -1.682, suggesting that excessive or improper land preparation leads to soil degradation and moisture loss. Conservation agriculture techniques, such as minimum tillage and organic mulching, should be promoted to maintain soil fertility (Tittonell & Giller, 2013). Similarly, early planting ( $p = 0.001$ ) had a negative coefficient of -5.504, indicating that erratic rainfall patterns may expose early-planted crops to prolonged dry spells, resulting in poor germination and reduced yields. Climate-informed planting calendars and improved meteorological forecasting are necessary to guide farmers on optimal sowing times (Cooper et al., 2008).

Weeding frequency positively affects crop productivity ( $p = 0.031$ , coefficient = 0.662), as timely and effective weed management reduces competition for nutrients and enhances crop growth (Norsworthy et al., 2012). However, planting materials had a statistically significant but negative effect on productivity ( $p = 0.027$ , coefficient = -1.640). The reliance on local seeds, which often have lower genetic vigor and are more susceptible to pests, negatively impacts yields. Access to certified high-yielding and drought-resistant seed varieties should be promoted to improve productivity (Abate et al., 2017). The study further highlights the impact of pest control and crop rotation on productivity. The use of pesticides significantly increases yields ( $p = 0.000$ , coefficient = 0.564), emphasizing the role of effective pest management in reducing crop losses. However, excessive pesticide use poses environmental and health risks, necessitating the adoption of integrated pest management (IPM) strategies (Ecobichon, 2001). Crop rotation, despite its long-term soil fertility benefits, had a statistically significant but negative coefficient (-6.204,  $p = 0.051$ ). This suggests that in the short term, shifting from staple crops to less productive rotations may temporarily reduce yields. Farmers in Gogrial East County may need improved access to fertilizers and soil amendments to mitigate short-term productivity losses associated with crop rotation (Vanlauwe et al., 2014; Snapp et al., 2010).

#### 4.3 Conceptualisation of food availability

The study utilized the Household Dietary Diversity Score (HDDS), which was calculated based on data collected from respondents through an open-recall method. Participants were asked to freely recall all food and beverages consumed within the preceding 24-hour period (Goshu et al., 2013; FAO, 2011). As a proxy indicator of food security, HDDS is traditionally measured by summing the number of distinct food groups consumed over a specified time frame. In this study, HDDS served as the dependent variable in the linear regression analysis conducted to address the first research objective. While the reliability and accuracy of the HDDS have been subject to methodological scrutiny, it remains a widely accepted and valuable proxy for assessing the nutrient adequacy of household diets and measuring food security in quantitative research.

**Table 9:** Mean frequency of household food consumption across the study locations ( $n=285$ )

Food groups	Household location				<i>p</i> -value
	Mayomchol	Pinydit	Yiikadoor	Luonyaker	

Cereals	3.65±1.65	4.12±1.60	2.19±1.13	5.11±1.83	0.005***
Roots & tubers	2.54±1.51	1.93±1.26	2.15±1.65	4.22±2.21	0.000***
Vegetables	2.71±1.72	2.49±1.33	3.67±2.31	2.88±1.23	0.556
Beef, Poultry & eggs	2.88±2.11	2.13±1.65	4.11±1.79	3.44±1.61	0.000***
Fish & Seafood	0.22±0.06	0.51±0.92	0.24±0.60	1.86±0.74	0.000***
Pulses, legumes & nuts	1.89±1.32	1.74±1.22	1.64±0.88	2.33±1.42	0.355
Milk & milk products	2.44±1.92	4.31±1.96	2.03±1.83	4.10±2.78	0.000***
Oils & fats	0.49±0.02	2.31±1.22	3.91±1.76	1.32±0.67	0.634
Sugar, honey & confectioneries	4.07±1.97	4.33±1.14	5.21±2.31	5.42±3.01	0.000***
Beverages & Species	6.80±0.94	6.94±0.40	7.22±1.24	6.44±0.88	0.005***
Salt & minerals	4.26±1.90	3.96±1.46	4.12±1.76	4.44±2.13	0.679

(\*\*\*1%, \*\*5%, \*10 %.)

**Table 10:** Distribution of household dietary diversity scores (HDDS) by location (n=285)

Variables	Payams				Overall score (n=285)	p-value
	Mayomchol (n=73)%	Pinydit (n=66)%	Yiikadoor (n=62)%	Luonyaker (n=84)%		
Low ( $\leq 5$ food groups)	32(43.8)	39(59.1)	28(45.2)	49(58.3)	51.93%	0.000***
Medium (6-8 food groups)	27(37.0)	17(25.8)	31(50.0)	24(28.6)	34.74%	
High ( $\geq 9$ food groups)	14(19.2)	10(15.1)	3(4.8)	11(13.1)	13.33%	

(\*\*\*1%, \*\*5%, \*10%)

The results presented in Table 9 indicate that the consumption of food groups categorized under cereals; roots and tubers; beef, poultry, and eggs; fish and seafood; milk and dairy

products; sugar, honey, and confectioneries; beverages; and spices was statistically significant at the 1% level across the four Payams included in the study. Furthermore, the findings in Table 10 demonstrate that all three categories of household food scores were also statistically significant at the 1% level.

**Table 11:** Factors influencing household dietary diversity among the responses

Explanatory Variable	Coefficient	Standard Error	p-value
Age-HH	0.0670	0.3066	0.664
Mar-HH	-0.0163	0.0122	0.034*
Educ-HH	0.2324	0.0852	0.014**
Gend-HH	0.3662	0.1180	0.042**
Inco-HH	-0.2264	0.2464	0.062*
Farm-Size	0.0065	0.2563	0.001**
Farm-expe	0.4022	0.2624	0.016**
Offfarm-inc	0.8294	0.3466	0.793
Constant	5.2640	0.7466	0.000***

*n=285; F (9.211); R<sup>2</sup> =35.79. \*\*\*1%, \*\*5%, \*10%.*

The linear regression analysis presented in Table 11 identifies several socio-economic and demographic factors significantly associated with the Household Diet Diversity Score (HDDS). These findings offer valuable insights into the determinants of dietary diversity among households participated in the study. The marital status of the household head is statistically significant ( $p = 0.034$ ) with a negative coefficient (-0.0163), indicating that certain marital statuses are associated with lower dietary diversity. This aligns with studies suggesting that household structure influences eating behaviors and diet quality among older adults in rural China (Zhang et al., 2024). The negative association may be attributed to increased financial constraints in larger households, limiting the ability to diversify food consumption.

In addition, education exhibits a positive and statistically significant relationship with HDDS ( $p = 0.014$ ,  $\beta = 0.2324$ ). This finding is consistent with research indicating that higher

educational attainment enhances nutritional knowledge and access to diverse foods, thereby improving dietary diversity (FANTA, 2006). Educated household heads are more likely to make informed dietary choices and adopt agricultural innovations that enhance food variety.

Further, status of gender variable of the household head is statistically significant ( $p = 0.042$ ) with a positive coefficient (0.3662), suggesting that male-headed households have higher HDDS. This observation is supported by a study in Ghana, where male-headed cocoa households exhibited higher dietary diversity and food security compared to female-headed households (Agyapong et al., 2023). The disparity may stem from differences in resource access, decision-making power, and cultural norms affecting food distribution within households. Additionally, the income status of the household head shows a marginally significant ( $p = 0.062$ ) negative coefficient (-0.2264), suggesting that higher income is associated with lower HDDS. This counterintuitive result may reflect a shift towards the consumption of less diverse, convenience foods as income increases, a trend observed in urbanizing populations (Gupta et al., 2020). Alternatively, higher-income households might allocate more resources to non-food expenditures, such as education and housing, thereby reducing the budget for diverse food items.

Furthermore, farm size is highly significant ( $p = 0.001$ ) and positively associated with HDDS ( $\beta = 0.0065$ ). Larger landholdings provide opportunities for diverse crop cultivation, enhancing food variety available for household consumption. This relationship is corroborated by studies demonstrating that increased farm production diversity correlates with improved dietary diversity, particularly in rural settings (Sibhatu et al., 2015). Lastly, farming experience is significantly associated with HDDS ( $p = 0.016$ ) with a positive coefficient ( $\beta = 0.4022$ ). Experienced farmers are likely to possess better agricultural knowledge and skills, leading to efficient food production and diversified diets. This finding aligns with research highlighting the role of agricultural experience in enhancing household food security and nutrition (Jones et al., 2014).

#### **4.4 Analysis of household food security among the sampled respondents**

The regression analysis (Table 12) provides insights into the factors with effects on household food security. The findings highlight the significance of demographic, economic, and structural variables, with an overall model estimation indicating a pseudo- $R^2$  of 0.165 and a Prob >  $\chi^2$  of 0.000, suggesting that the model is statistically significant in explaining

variations in household food security. The implications of each significant explanatory variable are discussed below.

**Table 12:** Effect of socioeconomic and institutional factors on food security.

Associated factors	$\beta$	$\partial y / \partial x$	P   >   Z
Age of the respondent	0.214 (0.016)	0.890 (0.418)	0.000***
Gender (1=male, 0=otherwise)	0.005 (0.664)	0.053 (0.466)	0.936
Marital status (1=married, 0=otherwise)	0.265 (0.480)	-0.476 (0.082)	0.878
Education level of the respondent	-2.641 (0.844)	0.001 (0.060)	0.008**
Household size (in numbers)	-0.640 (0.428)	-0.038 (0.072)	0.072*
Credit Access received	0.003 (0.001)	-0.620 (0.072)	0.002**
Food aid received	0.516 (0.468)	-0.624 (0.413)	0.248
Household head's income	-0.235 (0.464)	0.580 (0.068)	0.000*
Food sources (1=farm, 0=otherwise)	-2.860 (1.143)	0.531 (0.378)	0.062*

Farm size (in feddans)	0.251	0.413	0.006**
	(0.231)	(0.254)	
Constant	5.418		
	(2.513)		
Pseudo R <sup>2</sup>	0.165		
Prob>Chi <sup>2</sup>	0.000		

The age of the household head was found to be highly significant ( $p = 0.000$ ), with a  $dy/dx$  of 0.890 and a positive coefficient of 0.214. This indicates that as the age of the household head increases, the likelihood of food security improves. This finding aligns with previous studies that suggest older individuals have greater farming experience, accumulated wealth, and enhanced social capital, which positively contribute to household food availability (Ngema et al., 2018). Additionally, older household heads often have diversified income sources, such as pensions and remittances, which further support household food security (Abegaz, 2019). However, it is important to consider that in extreme old age, declining productivity and health may reduce food security, making age a non-linear determinant (Kassie et al., 2014).

The education level of the household head was statistically significant ( $p = 0.008$ ) but had a negative coefficient (-0.640) and a  $dy/dx$  of 0.001. This counterintuitive result suggests that as education levels increase, food security declines. While numerous studies argue that education improves food security by enhancing income-earning opportunities and nutrition knowledge (Sibhatu & Qaim, 2017), the negative association in this study could be explained by migration effects. More educated individuals may engage in non-agricultural employment that does not necessarily translate into higher food security, especially if urban employment is unstable or food costs are high (Abdulai & Huffman, 2014). Furthermore, better-educated individuals may prioritize non-food expenditures such as education and housing, reducing immediate food consumption diversity (Omonona & Agoi, 2007).

Credit access was statistically significant ( $p = 0.002$ ) with a negative  $dy/dx$  (-0.620) but a positive coefficient (0.003). The mixed sign suggests a complex relationship: while access to credit can theoretically improve food security by enabling investments in agricultural

production and income-generating activities (Wossen et al., 2017), the negative marginal effect may indicate that credit is often used to smooth consumption rather than for productive investment. Additionally, high interest rates and unfavorable repayment conditions may create financial burdens that reduce household disposable income for food purchases (Abdulai & Huffman, 2014). This finding is consistent with research indicating that poorly structured credit programs may worsen food insecurity among vulnerable populations (Barrett & Maxwell, 2005). Household income was highly significant ( $p = 0.000$ ), with a negative coefficient (-0.235) and a positive  $dy/dx$  of 0.580. This suggests that while an increase in income is associated with improved food security, the negative coefficient indicates a potential diminishing return or non-linear relationship. Research suggests that at lower income levels, food expenditure is a priority, but as income increases, spending shifts towards non-food items, potentially reducing dietary diversity (Pingali, 2015). This aligns with Engel's Law, which states that as income rises, the proportion of income spent on food decreases (Sibhatu & Qaim, 2017).

Food sources were statistically significant ( $p = 0.062$ ), with a negative coefficient (-2.860) and a  $dy/dx$  of 0.531. This suggests that households that rely on fewer or unstable food sources are more likely to experience food insecurity. Diverse food sourcing strategies, such as home production, markets, and social networks, contribute to food security by reducing reliance on a single supply channel (Sibhatu & Qaim, 2017). The negative coefficient may reflect the vulnerability of households that depend on external food aid or unstable markets rather than self-sustaining food production (Barrett, 2010). Farm size was significant ( $p = 0.006$ ), with a positive coefficient (0.251) and a  $dy/dx$  of 0.413, indicating that larger landholdings contribute positively to food security. This finding is supported by studies showing that larger farms provide greater opportunities for food production, income generation, and agricultural diversification, which enhance food availability and access (Kassie et al., 2014). However, farm size alone may not be sufficient factors such as soil fertility, irrigation access, and market integration play critical roles in determining whether larger farms translate into improved food security outcomes (Pingali, 2015).

## **4.5 Summary of the findings**

### **4.5.1 Determinants of Crop Productivity**

The regression analysis identifies age, education, and access to extension services as critical positive determinants of crop productivity. Age has a positive and significant effect ( $\beta = 0.266$ ), suggesting that older farmers produce more per unit area due to their accumulated

experience and indigenous knowledge. Education also significantly enhances productivity ( $p = 0.024$ ,  $B = 0.422$ ), likely through increased adoption of improved practices and informed decision-making, consistent with Dercon and Christiaensen (2011). Similarly, extension services show a strong positive influence ( $p = 0.001$ ,  $B = 2.024$ ), underscoring their value in disseminating modern farming technologies (Ragasa et al., 2016; Danso-Abbeam et al., 2018).

In contrast, land preparation ( $p = 0.041$ ,  $B = -1.682$ ) and early planting ( $p = 0.001$ ,  $B = -5.504$ ) negatively affect productivity. These findings highlight the risks of improper tillage and vulnerability to climatic variability, necessitating conservation agriculture and climate-informed planning (Tittonell & Giller, 2013; Cooper et al., 2008). Weeding frequency positively impacts yield ( $p = 0.031$ ,  $B = 0.662$ ), supporting evidence that effective weed control enhances growth (Norsworthy et al., 2012). However, the use of local planting materials negatively affects output ( $p = 0.027$ ,  $B = -1.640$ ), suggesting the need to promote certified, high-yield seed varieties (Abate et al., 2017). Pest control significantly improves yields ( $p = 0.000$ ,  $B = 0.564$ ), though the study cautions against overuse, recommending integrated pest management (Ecobichon, 2001). Notably, crop rotation is associated with a negative short-term impact ( $p = 0.051$ ,  $B = -6.204$ ), potentially due to temporary yield reductions when shifting to non-staple crops (Vanlauwe et al., 2014).

#### **4.5.2 Determinants of Household Dietary Diversity (HDDS)**

Using the Household Dietary Diversity Score (HDDS) as a proxy for food security, the study explores dietary patterns using regression analysis. Education ( $p = 0.014$ ,  $B = 0.2324$ ) significantly enhances dietary diversity, consistent with literature linking education to better nutritional knowledge and food choices (FANTA, 2006). Gender of the household head also shows a positive effect ( $p = 0.042$ ,  $B = 0.3662$ ), suggesting that male-headed households in the study area may have better access to diverse foods (Agyapong et al., 2023).

Interestingly, marital status ( $p = 0.034$ ,  $B = -0.0163$ ) and income ( $p = 0.062$ ,  $B = -0.2264$ ) exhibit negative associations with HDDS. These results may reflect resource constraints in larger households or changing consumption patterns among higher-income earners toward less diverse diets (Gupta et al., 2020). Farm size ( $p = 0.001$ ,  $B = 0.0065$ ) and farming experience ( $p = 0.016$ ,  $B = 0.4022$ ) both positively influence HDDS, indicating the role of land access and agronomic skill in improving household nutrition (Sibhatu et al., 2015; Jones et al., 2014).

### 4.5.3 Determinants of Household Food Security

The logistic regression analysis of food security reveals a statistically significant model (pseudo- $R^2 = 0.165$ ,  $p < 0.001$ ). The age of the household head emerges as a strong positive predictor ( $p = 0.000$ ,  $B = 0.214$ ), with increasing age linked to enhanced food security through accumulated wealth and diversified income (Ngema et al., 2018; Abegaz, 2019). However, education presents a paradox: although theoretically associated with improved outcomes, it shows a negative coefficient ( $p = 0.008$ ,  $B = -0.640$ ). This may be due to migration effects or competing non-food expenditures by educated individuals (Abdulai & Huffman, 2014).

Access to credit is significant ( $p = 0.002$ ), with a positive coefficient but negative marginal effect, implying that while credit access can support productivity, its misuse or high repayment burdens may undermine food access (Barrett & Maxwell, 2005). Household income ( $p = 0.000$ ,  $dy/dx = 0.580$ ) also shows mixed effects, supporting Engel's Law—higher incomes reduce the proportion of food spending (Pingali, 2015). Food sources ( $p = 0.062$ ,  $B = -2.860$ ) and farm size ( $p = 0.006$ ,  $B = 0.251$ ) further underscore the importance of diversified and self-sufficient production systems (Sibhatu & Qaim, 2017; Kassie et al., 2014).

### 4.6 Conclusion

The results of Chapter Four underscore the multifaceted nature of crop productivity and food security. Key socio-demographic factors such as age, education, gender, and farm characteristics play instrumental roles. Importantly, the findings call for integrated policy approaches that invest in farmer education, strengthen extension services, promote climate-smart practices, and improve access to quality inputs. A nuanced understanding of credit, income use, and food sourcing behaviours is also essential for developing effective interventions tailored to the rural context of Gogrial East County.

## CHAPTER FIVE

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.0 Introduction

This chapter synthesizes the key conclusions derived from the study's empirical findings in relation to the stated research objectives. It further offers evidence-based recommendations aimed at informing policy and practice within the context of agricultural productivity and household food security. In addition, the chapter identifies pertinent areas for further scholarly inquiry, with the goal of extending and deepening the contributions of the present study.

#### 5.1 Conclusion

This study provides robust empirical evidence on the determinants of crop productivity, dietary diversity, and household food security, affirming the complex interplay of socio-economic, institutional, and agronomic variables. Age, education, and extension services significantly enhance crop productivity, highlighting the importance of experiential knowledge, formal education, and timely access to technical information. Conversely, factors such as improper land preparation, early planting, and the use of local planting materials negatively affect yields, reinforcing the need for context-specific agronomic interventions such as conservation agriculture and certified seed systems. Similarly, the analysis of dietary diversity and food security reveals that while education, gender, farming experience, and farm size foster improved outcomes, the roles of income, credit, and marital status are more nuanced, requiring careful interpretation. These findings align with established literature (e.g., Dercon & Christiaensen, 2011; Sibhatu & Qaim, 2017), yet offer localized insights that reflect the socio-agroecological realities of Gogrial East County.

From a policy and development perspective, the results point toward the need for holistic, inclusive strategies that enhance both productivity and well-being. Prioritizing farmer education and strengthening extension services remain pivotal for increasing yields and nutritional outcomes. At the same time, access to credit and income-generating opportunities must be accompanied by financial literacy and supportive institutions to prevent adverse effects on food access. Recognizing the positive role of experience and land access, programs targeting youth and land tenure reform should also be pursued. Moreover, the negative short-term effects of crop rotation and income on dietary diversity and food security suggest the need for complementary programs such as nutrition education and market access facilitation. Overall, the study recommends a systems-based, data-driven

approach to rural development interventions, ensuring that agricultural growth is both equitable and sustainable.

## **5.2 Recommendations**

Given the positive effects of farmer age, education, and extension services on crop productivity, policymakers and development practitioners should invest in strengthening farmer education and adult learning programs tailored to local contexts. Agricultural extension systems should be revitalized through decentralized, demand-driven models that employ participatory approaches, allowing experienced older farmers to serve as peer mentors. Continuous training should emphasize modern agronomic techniques, appropriate land preparation methods, and the use of certified seed varieties. Furthermore, it is essential to institutionalize climate-smart agriculture by integrating climate advisory services and weather-based decision tools into extension packages, particularly to address the negative impacts observed with early planting and improper tillage. Development partners can support the establishment of farmer field schools and demonstration plots to showcase integrated pest management and proper weeding practices that sustainably boost yields.

To improve household dietary diversity and food security outcomes, stakeholders should adopt a multisectoral approach that connects agriculture, nutrition, and financial inclusion. Targeted interventions should promote equitable access to farmland and agricultural inputs for both male- and female-headed households, while simultaneously fostering nutrition education to help translate increased production into improved diets. Programs designed to enhance household incomes must incorporate financial literacy training to avoid non-productive consumption and credit misuse, which can jeopardize food access. Policymakers should also re-evaluate food sourcing strategies and support local food systems through community seed banks, kitchen gardens, and farmer cooperatives to increase resilience and reduce reliance on external markets. Finally, empirical evidence from this study suggests the need for targeted social protection schemes that prioritize vulnerable households, particularly those with low education and smaller farm sizes, to strengthen their long-term food security.

## **5.3 Areas for Further Research**

This study has highlighted several critical determinants of crop productivity, household dietary diversity, and food security; however, it also revealed important research gaps that

warrant further academic inquiry. First, while the findings suggest strong associations between socio-demographic factors and productivity or food outcomes, the study was cross-sectional in nature, limiting its ability to capture changes over time. Therefore, future research should consider longitudinal studies to track seasonal or annual fluctuations in crop yields, food access, and dietary patterns, especially in the context of climate variability and economic shocks. Additionally, the unexpected negative relationship between early planting and productivity, as well as between education and food security, calls for qualitative follow-up studies to explore underlying behavioural, institutional, and contextual factors influencing these outcomes.

Another important area for future research involves evaluating the effectiveness of specific agricultural interventions, such as extension models, seed improvement programs, and credit utilization strategies. Comparative studies using mixed-method approaches could provide deeper insights into how local innovations or indigenous practices interact with introduced technologies. Further studies should also explore intra-household dynamics, including gender roles and decision-making power, which were only partially addressed in this analysis. Incorporating geospatial analysis and remote sensing could enhance understanding of environmental and spatial determinants of productivity and food access. Finally, research focusing on the impact of nutrition-sensitive agriculture and food system diversification on long-term household resilience would provide a valuable contribution to the growing field of sustainable rural development.

#### **5.4 Final Remark**

This study underscores the critical interplay between socio-economic factors, agronomic practices, and institutional support in determining crop productivity and household food security in rural areas. Key findings highlight the transformative role of education, extension services, and climate-smart practices in improving agricultural outcomes. The results call for context-specific, inclusive interventions that integrate both indigenous knowledge and modern innovations. These insights provide a strong foundation for policymakers to design targeted strategies that promote sustainable rural livelihoods and food security.

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## APPENDIX 1: QUESTIONNAIRE

### ADMINISTERED QUESTIONNAIRE FOR HOUSEHOLDS

Dear participant,

My name is Deng Chan, a post graduate student at Uganda Christian University, pursuing a Master of Science in agricultural and rural development. I am currently undertaking research as one of the pre-conditions. The topic of the research is **“FACTORS INFLUENCING ACCESS AND AVAILABILITY OF FOOD AMONG RURAL HOUSEHOLDS IN GOGRIAL EAST COUNTY, SOUTH SUDAN”**. The study is purely for academic purposes and all your responses will be treated with at most confidentiality.

Kindly, complete the questionnaire and return it to the researcher.

### SECTION A: BIO-DATA OF FARMERS

*(Tick the right option or fill the right answer in the spaces provided)*

#### **Sub section 1: Personal Information**

A1. Respondent's name \_\_\_\_\_ Telephone contact \_\_\_\_\_

a) Location (state) \_\_\_\_\_ b) County \_\_\_\_\_

c) Sub location: i) Majok payam  ii) Pinydit payam  iii) Yiikadoor payam   
iv) Luonyaker payam

d) Geographical setting of the area (***Tick where appropriate***):

i) Urban  ii) Peri urba  iii) Rural

A2. What is the age of the respondent? .....

A3. Gender: i) Male  ii) Female

A4. Marital status of respondent; i) Married  ii) Not marriage

A5. Highest Education level of respondent (***Tick the most appropriate***)

i). Primary  ii) Secondary  iii) Certificate  iv) Diploma  v)  
Degree  vi) Masters  vii) none of the above

A6. What is the number of members in your Household?.....

A7. What is your employment status? i) Salaried  ii) Non-salaried

**SECTION B: ECONOMIC FACTORS**

*(Tick the right option or fill the right answer in the spaces provided)*

**Subsection 2: Household Income and Credit Access**

B1. What is the average monthly Household Income? .....(\$)

B2. Do you have access to credit? i) Yes  ii) No

**Subsection 3: Food Security and Production**

B3. How do you access food in your Household?

i) Production  ii) Market  iii) Relief food   
iv) Others (specify).....

B4 If production, how long can food stock last?

i) 1 months  ii) 1 to 2 months  iii) 3months  iv) 4 to 6   
v)  no food stock at all

B5. If market, what is the average price of food? ..... (\$)

B6. How would you rate the affordability of food in your area?

a) Very affordable  b) affordable  c) Neutral  d) expensive   
e) very expensive

B7. How many meals do your Household consume in a day?

i) Less than 2 meals a  meals a day ii) 2 meals  iii) 3

B8. How many foods group do you consume? .....(Cereal, milk, vegetable& fruit)

B9. How would you describe the accessibility of food in your household?

a) Abundant       b) Adequate      c) Insufficient      d) Severe   
shortage

B10. Do you own or have access to land for farming) Yes  ii) No

If yes, what is your farm size? ..... (Acres)

B11. Do you or any member of your household have income from sources other than farming?

i) Yes       ii) No

If yes, what is your average off-farm income monthly?  
.....(\$)

B12. Do you own the land for farming? i) Yes      ii) No

If yes, what is your land ownership status? a) Own land       b) rented la

c)Others (specify).....

B13. What type of farming do you practice?

a) Crop production only       b) Livestock production only       c) Both crop  
and livestock production       d)

#### ***Subsection 4: Market and Infrastructure***

B14. What is the distance to your nearest food market? ..... (Km)

B15. How would you rate the availability of transportation facilities for reaching markets or processors?

a) Excellent       b) Good       c) Avera       d) Lim       e)   
Poor

B16. Are there adequate value addition and agro-processing facilities food storage, processing and packaging in your  Yes  No

B17. What is the distance to your nearest value addition and agro-processing facility?  
..... (Km)

If yes, how would you rate the availability of value addition and agro-processing facilities in your area? i). Very good  ii) Good  iii) Average  iv) Limited   
 v) Very limited

**SECTION C: RELATIONSHIP BETWEEN INSTITUTIONAL SUPPORT AND FOOD AVAILABILITY AMONG RURAL HOUSEHOLDS IN GOGRIAL EAST COUNTY**

**Institutional Support for Food Production**

**C1.** What agricultural activities are done by your Households?  
 .....

**C2:** Do you have access to farming technologies? Yes  No

If yes, list the farming technologies accessed by your Household:.....

- i) Own ox-plough ii) Hired ox-plough iii) Own tractor iv) Hired tractor.

**C3.** How would you rate the availability of seeds for agricultural activities in your community?  Very good  ii) Good  i) Average  iv) Poor  v) Very poor  Not applicable

**C4.** How would you rate the availability of planting tools (e.g., hoes, shovels) in your community?

- i). Very good  ii) Good  iii) Average  iv) Poor   
 v) Very poor  Not applicable

**Access to Transfer Food Aid**

**C5.** Have you received any food aid from external sources (e.g., NGOs, government programs) in the past year  i) Yes  ii) No

**C6.** If yes, how would you rate the accessibility of food aid in terms of timely distribution and fair allocation?

- i). Very accessible       ii) Accessible       iii) Average   
 iv) Inaccessible       v) Very inaccessible       iv) Not applicable

**Technical Support for Food Production**

**C7.** Have you received any agriculture training or extension services related to food production and market access in the past year?  i). Yes     ii) No

**C8.** If yes, please rate the effectiveness of the training or services received

- i). Highly effective       ii) Effective       iii) Somehow effective   
 iv) Ineffective       v) Not applicable

**Household Food Vouchers**

**C9.** Are you familiar with household food vouchers?      i) Yes       ii) No

**C10.** Have you ever received household food vouchers to access food?    i) Yes       ii) No

**C11.** If yes, please rate the usefulness of household food vouchers in improving your access to food:    i) Very useful        Useful       Neutral        
 iv) Not useful       v) Not applicable

**Policy Related Support to Food Availability**

**D1.** Are you aware of any government policies or programs related to food access and availability in Gogrial East County?

- a) Yes       b) No       c) Not sure

If yes, please specify the existing policies or programs in your area.

.....

**D2.** Have you or your household directly benefited from any of these government policies or programs?

a) Yes                       b) No                       c) Not su

If yes, please describe the specific benefits you have experienced.

.....

**D3.** In your opinion, how effective are the existing policies and programs in ensuring food access and availability in Gogrial East County?

1) Very effective                       2) Effectiv                       3) Neu                       4) Not   
effective

5) Do no know existing policies

**Recommendations and Improvements**

**D4.** What suggestions do you have for improving existing policies or implementing new ones to enhance food access and availability in Gogrial East County?

.....

**D6.** Are there any specific challenges or issues that you believe should be addressed to enhance the effectiveness of existing policies?

.....

**Additional Comments**

Please provide any additional comments or suggestions regarding institutional support and access to food in your community

.....

**Thank you for taking the time to complete this questionnaire.**

**Your feedback is valuable for my research.**

**APPENDIX ii: PICTURES DURING DATA COLLECTION**



**APPENDIX III: REC CLEARANCE LETTER**



Deng Chan\_REC  
Approval.pdf