STATISTICAL ANALYSIS OF AGRICULTURAL PRODUCTION AND INCOME PER CAPITA GROWTH RATE IN UGANDA 1988-2022

BY

SAKARIYE ABDULLAHI ABDI

2022-08-12626

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF STATISTICS DEGREE FROM KAMPALA INTERNATIONAL UNIVERSITY, THE RESEARCH DISSERTATION WAS SUBMITTED TO THE SCHOOL MATHEMATICS AND COMPUTING.

OCTOBER 2024

DECLARATION

As a student at Kampala International University in Uganda, I, Sakariye Abdilahi Abdi, thus certify that the information contained in my research dissertation is entirely original with no submissions to other Universities or Colleges.

Signature: .... Date: 16-10-2024

APPROVAL

This acknowledgment partially fulfills the requirements for the Master of Statistics degree at Kampala International University. The dissertation, completed under my close supervision and titled "Statistical Analysis of Agricultural Production and Income per Capita Growth Rate in Uganda 1988-2022," is now prepared for submission to the School of Mathematics and Computing.

Supervisor: Dr. Anumolu Goparaju

Signature: .... Date: 16/10/2024

DECLARATION

Many thanks to the Almighty Allah for giving me life, strength, wisdom, and health. I dedicate this research to my parents, who I love and appreciate the most for their love, support, and material and moral assistance.

ACKNOWLEDGMENTS

I give thanks to the All-Powerful Allah for allowing me to go through all of the difficult and challenging circumstances I have faced in my life. Without His direction, defense, and reassurance that all is possible if you believe in him, my dream of receiving this honor would never have come true. I thank the Faculty and Staff at Kampala International University, particularly my Supervisor, Dr. Anumolu Goparaju, I also thank all of my lecturers for giving up their time and energy to make sure I succeeded in my studies and all of my panels for their advice.

I would also like to express my gratitude to my parents for their moral, emotional, and financial support throughout my studies. May you be blessed by Allah Ta'ala. With sincere gratitude, I send my best wishes and support to my family, who have always been there for me. There are not enough words to express my gratitude to you, but please know that I always appreciate what you have done for me and that I pray to Allah to fulfill all of your desires.

TABLE OF CONTENTS

LIST OF ACRONYMS/ ABBREVIATIONS

AGR	Agricultural
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GOU	Government of Uganda
IMF	International Monetary Finance
IPP	Income Per Capita
MAAIF	Ministry of Agriculture Animal Industry Fisheries
NRM	National Resistance Movement
OLS	Ordinary Least Squared
OWC	Operation Wealth Creation
PMA	Plan for the Modernization of Agriculture
SDG	Sustainable Development Goals
UBOS	Uganda Bureau of Statistics
UN	United Nations
UNDP	United Nations Development Program
USD	United States Dollar

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The relationship between Uganda's agricultural output and income per capita growth rate between 1988 and 2022 is examined using Statistical analysis. Multiple linear regression is used in the study to examine the data gathered during the designated time frame. The results show that agricultural output has been trending downward over time, but per capita income has been steadily rising. Table 4.2 in the analysis shows that agricultural production has a moderate impact on Uganda's income per capita growth rate, despite the country's diminishing agricultural output. These results are consistent with earlier studies, demonstrating the critical role that agriculture plays in the economic growth of countries, especially those with lower per capita incomes. Furthermore, the study shows a causal relationship—albeit one with a limited effect on total economic growth—between agricultural productivity and income per capita growth rate. These variables have statistically significant short- and long-term correlations, highlighting the long-lasting impact of agricultural activities on income levels throughout time. The study concludes by highlighting the significance of policies targeted at improving agricultural production, assisting the agricultural industry, and controlling variables like labor availability and interest rates to guarantee sustained income development and the decrease of poverty in Uganda. These findings offer insightful information for stakeholders, researchers, and politicians looking to advance the well-being and economic growth of agricultural economies.

CHAPTER ONE
INTRODUCTION

1.0 Introduction

This chapter focuses on the background, problem statement, purpose, objectives, research questions, hypothesis, scope, and importance are all presented in this chapter.

1.1 Background of the Study

The background of the study was based on four perspectives historical, theoretical, conceptual, and contextual perspectives.

1.1.1 Historical Perspective

The agriculture industry is often regarded as the cornerstone of any economy, providing essential nutrients and raw materials crucial for industrialization and societal sustenance. According to recent analyses, agriculture is acknowledged for its significant contributions to overall economic development and growth (Smith, 2000).

Praburaj (2018) claims that the development of industrialized nations' economies has been significantly aided by agriculture. The history of England provides evidence that the Industrial Revolution came before the change in agriculture. A greater degree of industrialization has resulted from agricultural development in the US and Japan. Furthermore, the agricultural sector continues to play a crucial role in the economic development of developing nations. Many developing nations involved in the process of economic development have placed a strong emphasis on agriculture and other primary industries to increase per capita income (Praburaj, 2018).

This renewed interest in the unique role that agriculture plays in the development process, as economic growth depends not only on the rate of general economic growth but also on the ability of the poor to participate in that growth (Luc et al. (2018) The expansion of the non-agricultural sector of the economy is aided by the improvement in farmers' purchasing power brought about by the agricultural sector. Because they are the ones who rely on agriculture for their livelihood, the majority of impoverished people in developing nations must have the means to purchase the items produced. It was observed that while GDP growth from other sectors would increase GDP per capita, the poor stood to benefit considerably more from GDP growth originating from the agriculture sector. Throughout most of Sub-Saharan Africa, agriculture has a significant impact on economic growth. (Xinshen et al. (2010) state that it accounts for more than 30% of GDP and

60% of total employment in Sub-Saharan Africa, excluding South Africa, and that it contributes to major priorities of the continent, such as the eradication of poverty and hunger, promoting trade and investment in Africa, rapid industrialization, and economic diversification, maintaining resource sustainability and environment, opportunities for employment creation, and human security. It appears that Sub-Saharan nations have a comparative advantage in terms of agricultural output. Specializing in agricultural output can have a favorable impact on the growth of GDP per capita if agriculture is a driving force behind economic expansion.

As the majority of Zimbabweans are still rural people who depend on agriculture and other related rural economic activities for their livelihood, the Food and Agriculture Organization (FAO) (2020) notes that agriculture is the foundation of Uganda's economy. 75% of the world's impoverished live in rural areas and are heavily reliant on farming and fishing, according to United Nations Development Program (UNDP) statistics from 2012. Agriculture supplies raw materials and inputs to other economic sectors in addition to giving people the food, jobs, and income they need to survive. As a result, (Osabohien et al (2022) how well the agricultural sector performs when looking at agro-credit intervention. Different countries have progressed with different strategies; therefore, this is not the only way to transform agriculture. According to this perspective, it is imperative to evaluate how well agricultural policy frameworks support the transformation of the agricultural industry, considering its impact on subsequent programs like the National Agricultural Advisory Services, Uganda's early 2000 adoption of the Plan for the Modernization of Agriculture (PMA) cannot be understated. Preceding the National Resistance Movement (NRM), administrations implemented policies between 1960 and 1980 that experienced difficulties and were said to have introduced the PMA as a comprehensive policy to address such issues.

1.1.2 Theoretical perspective

The theory of contemporary population-resource dynamics examines the intricate relationship between resource availability and population growth in the modern context. Unlike Malthusianism, which posited a linear growth of resources versus exponential population growth, contemporary views acknowledge technological advancements and socio-economic factors that influence these dynamics. According to this theory, while global resources may not grow linearly, advancements in technology and innovation have significantly expanded the capacity to produce food and other resources. However, population growth patterns, particularly in regions with limited access to these advancements, can still exert pressures akin to those described by Malthus. In today's world, rapid population growth in areas lacking infrastructure and access to modern agricultural practices can lead to localized resource scarcity. This scenario often manifests in food insecurity, exacerbated by climate change impacts, political instability, and economic inequalities. The resulting strain on resources can lead to social unrest, migration pressures, and humanitarian crises. Moreover, the theory highlights the concept of carrying capacity within ecosystems and regions. Even with technological advancements, there are limits to how much a particular area can sustainably support a population. Overshooting these limits can lead to ecological degradation, loss of biodiversity, and long-term declines in resource availability, affecting both human well-being and environmental health. Critics of the theory argue that it sometimes overlooks the potential for technological innovation and global cooperation to mitigate resource constraints. They emphasize the importance of sustainable development practices, equitable distribution of resources, and investments in education and healthcare to manage population growth effectively (Kates et al. (2007).

Schultz hypothesis of Traditional Agriculture: Theodore William Schultz created this hypothesis in 1953. Traditional agriculture, according to the notion, is any circumstance in which the agricultural sector or agriculture itself works below or short of equilibrium. According to the argument, impoverished nations cannot advance economically in the modern era unless they can satisfy their basic requirements. Additionally, according to the idea, a lot of developing countries have what he called a "high food drain," which is a condition in which a sizable amount of the revenue is needed for food due to the low-income levels of the population. According to this hypothesis, for economies to meet their subsistence needs, they must first generate the majority of their food. To do this, developing nations should identify the kind and amount of agricultural investment required to turn their agriculture sector into one that is extremely productive. According to Schultz, an economy's ability to develop requires an agricultural surplus. This hypothesis is predicated on the following premises: limited goods and resources that can be exchanged for food; high prices associated with food importation; and a significant labor and resource requirement in food production. Because of the low level of technological advancement in the agricultural sector, nations that have a comparative advantage in agriculture output can be relegated to single-sector economies with low levels of advancement. In addition to being less expensive than agricultural imports, the idea is pertinent to this study because it raises individual disposable incomes and promotes productivity and health, allowing individuals to participate in the process of economic growth and development.

Johnston and Mellor (1961) proposed the Johnston-Mellor Theory. They described five general equilibrium impacts that arise from agricultural productivity and expansion, and they provided a framework for thinking about the links between production and consumption from agriculture. The welfare of farmers and the impoverished in rural areas will improve as a result of increasing farm revenues and enhanced profitability. Lower food prices as a result of an adequate supply of food benefit impoverished customers in both rural and urban areas, as well as farmers who may be net buyers of food. Consequently, improves discretionary income. Thirdly, raises savings, which makes it possible to mobilize capital and provide labor for the development of non-farm sectors. Fourth, raise domestic demand for products from the non-farm sector. Lastly, boost foreign exchange profits by increasing exports of agricultural products. Accordingly, their concept maintained that the expansion and development of an economy heavily dependent on agriculture depends on the productivity and growth of the agricultural sector. This theory operates under the presumptions that agriculture dominates the economy and that there is a minimum consumption requirement for food.

1.1.3 Conceptual perspective

A product that will eventually be sold at retail is the end result of a set of operations known as agricultural production. The process of producing agricultural products starts with the preparation of the soil and the purchase or breeding of a suitable animal. When your grain is ready to be sold or mixed, you put it in the finished goods inventory along with any packaged or unpackaged livestock or crops. The annual growth rate of agricultural value added, expressed in constant local currency, is known as agricultural performance. Forestry, hunting, and fishing are all included in agriculture, along with agricultural cultivation and the raising of cattle. Agricultural (AGR): This definition of agriculture covers fishing, cattle production, and crop cultivation. Following the addition of all outputs and the subtraction of intermediate inputs, the value added is the net output.

Income per capita: A person's average income in a certain area (city, region, country, etc.) for a specific year is measured by their per capita income (PCI), also known as total income. By dividing the total income of the region by the whole population, it is computed. Divided by the size of the population, per capita income is the national income. Per capita, income is a metric used to express how much money is earned in a country or geographic area per individual. The average per-person income for a certain area is calculated using per capita income, which is also used to assess the population's standard of living and contentment. By dividing a country's national income by its population, one may get its per capita income. GDP: GDP per capita yearly growth was used in this investigation. The value added by all of its producers is totaled and expressed as GDP. Value added is calculated by deducting the cost of intermediate goods and services from the gross output of producers and then accounting for the use of fixed capital in the manufacturing process. Technology, capital, labor, and loan rates were all taken into account when conducting this study IMF. (2021)

Work refers to any kind of effort, either mental or physical. Labor, as used in economics, refers to the efforts made in the production of any products or services. It encompasses all human endeavors—physical labor, mental training, intellectual application, etc.—that are performed in exchange for monetary compensation (Kanamori et al. (2006).

The physical tools, factories, and equipment that enable higher job productivity are referred to as capita. Land, labor, and entrepreneurship are the other three main components of production, of which capita is one. According to Chen (2012), common examples of capita include computers, vehicles, assembly belts, tractors, hammers, and railroads. The basis for it was the rates of gross fixed capita formation.

The interest rate is the bank rate that typically satisfies the private sector's short- and medium-term financing demands. Typically, this rate is adjusted based on the financing goals and the creditworthiness of the borrowers.

Technology is the application of knowledge to accomplish useful objectives in a repeatable manner. The term "technology" can also refer to the end products of these endeavors, encompassing both material instruments like machinery or utensils and immaterial ones like software. Science, engineering, and daily living all heavily rely on technology (Dietrich et al. (2017).

1.1.4 Contextual perspective

This study focuses on Ugandan major agricultural productions that generate income and per capita through exports and inland sales such as coffee, tea, cotton, and fisheries. The fifth Sustainable Development Goal (SDG) aims to "Empower all women and girls and achieve gender equality." Its indicator 5.a.1 calculates the following: a) the "share of women among owners or rights-bearers of agricultural land, by type of tenure" and b) the "proportion of total agricultural population with ownership or secure rights over agricultural land, by sex" (UN, 2022).

According to Uganda's 2019 Agricultural Survey, 41% of adults (those over the age of 18) residing in agricultural households either owned or held tenure rights over the land they farmed. However, when the data is broken down by gender, it becomes clear that men had a higher percentage of this value (52%) than women (30%). In 2019, women made up 39% of those who owned or had rights (UBOS, 2022).

"End hunger, achieve food security and improved nutrition and promote sustainable agriculture" is the second Sustainable Development Goal. "Doubling the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers by 2030" is aim 2.3 (UN, 2022).

The 2019 Ugandan Annual Agricultural Survey gathered information to track this goal. The volume of production per labor unit per firm size is taken into account in SDG indicator 2.3.1. According to the survey results, major producers produced approximately 14 thousand Ugandan Shillings (UGX) per person-day, while smallholders produced about 8 thousand UGX (Ugandan shilling) per person-day (UBOS 2022). The average income of small-scale food producers is broken down by sex and indigenous status in SDG indicator 2.3.2. Large producers earn 2.6 million UGX annually on average, whereas small producers earn an average of 0.9 million UGX, according to the poll results. An average yearly farm income for small producers is 0.8 million UGX for females and 0.9 million for males, while for large producers it is 2.5 million UGX for females and 2.6 million UGX for males, broken down by the sex of the household head. (UBOS 2022).

The primary focus of this study is Uganda's high productivity in coffee, tea, and cotton, along with fish. Worthy of notice as well, since it is Uganda's main export (MAAIF, 2019). Countrywide, Robusta and Arabica are the two primary varieties of coffee farmed. By 2019, approximately 21% of agricultural households grew Arabica coffee, and 7% grew Robusta coffee, more than 30% said they could not be found nearby, and almost 30% said the land was sufficiently fertile and hence they weren't required. Roughly 25% said they were unaware of their uses and advantages. Given that Uganda's economy is performing poorly and that the average citizen earns less than $1 per day, it is understandable that the country's per capita income is still relatively low. In Uganda, the gross domestic product per person was last measured in 2022 at 934.90 US dollars. Uganda has a GDP per capita that is 7% higher than the global average, By the end of 2023, Uganda's GDP per capita is predicted by Trading Economics global macro models and analysts to be 990.99 USD. Over an extended period, our econometric models predict that the GDP per capita of Uganda will hover between 1055.41 USD in 2024 and 1129.29 USD in 2025. Because Uganda's income per capita is so low, it is implied from the current study that the cause of income per capita is agricultural productivity (UBOS 2022).

1.2 Statement of the Problem

Despite growth in the economy of Uganda and efforts aimed at ensuring agricultural mechanization, the income per capita growth rate remains low. The last 5 years have witnessed a sluggish in the income per capita with 2018 having 810 increasing by 3.8%, 2019 was $823, a 3.77% increase from 2018, 2020 was $847, a 2.9% increase from 2019, 2021 was $883, a 4.32% increase from 2020 and 2022 was $964, a 9.14% increase from 2021 (World Bank, 2022). Despite registering some increases, the per capita income increase is far from that of the developed countries since it is 7% world average. The GDP (PPP) per capita criterion of at least US$22,000 is a widely used indicator of a developed nation. Fifty nations met all four of the criteria in 2023, while fifteen more met three of the criteria (IMF, 2023). The income per capita of Uganda, therefore, is too low compared to that of the developing world, this is despite Uganda being known as an agricultural country whose basis 85% of people survive on agriculture, the per capita statistics for Uganda could therefore be affiliated to the income agricultural production in Uganda, the government of Uganda has been undertaking initiatives aimed at developing the agricultural such as Plan for modernization of agriculture, The Parish Development Model aims to organize Ugandans who are currently operating in the subsistence economy to access quality inputs, tailored technical assistance, guaranteed markets, and subsidized credit to develop the agricultural sector (UBOs, 2021). All of these efforts are yet to enhance agricultural productivity, which is why the study is done to test the capability of agricultural production on income per capita growth rate in Uganda from 1988–2022. National agricultural advisory services, Operation Wealth Creation (OWC) intervention to efficiently facilitate national socio-economic transformation, with a focus on raising household incomes and wealth creation by transforming subsistence farmers into commercial farmers to end poverty.

1.3 Purpose of the Study

The purpose of the study is to conduct a statistical analysis of agricultural production and income per capita growth rate in Uganda from 1988 to 2022.

1.4 The Specific Objectives of The Study

1) To determine the trend of agricultural production composition and its effect on income per capita growth rate in Uganda between 1988 and 2022.

2) To establish the causal relationship between agricultural production and income per capita growth rate from 1988 to 2022.

3) To examine the short-term and long-term relationship between agricultural production and income per capita growth rate in Uganda from 1988 to 2022.

1.5 Research Questions

1) What is the trend of agricultural production composition and its effect on the income per capita growth rate in Uganda between 1988 and 2022?

2) What is the causal relationship between agricultural production and income per capita growth rate from 1988 to 2022?

3) What are the short-term and long-term relationships between agricultural production and income per capita growth rate in Uganda from 1988 to 2022?

1.6 Research Hypothesis

The study tested the following hypotheses

H_{01}: There is a positive trend of agricultural Production composition and its effect on income per capita growth rate in Uganda 1988-2022.

$H_{02:}$ There is a causal relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022

H_{03}: There is a short-run and long-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022.

1.7 The Scope of Study

1.7. 1 Geographical scope

Uganda, which borders Kenya to the east, Tanzania and Rwanda to the south, the Democratic Republic of the Congo to the west, and South Sudan to the north, is home to 34.85 million people (Population Secretariat 2012; UBOS 2016). The study was carried out in Uganda, which is located in East Africa and has an area of 241,038 square kilometers including water where the land area covers 197,323 square kilometers.

1.7.2 Subject Scope

The study was conducted on assessment of agricultural Production composition and its effect on income per capita growth rate, secondly to examine the causal relationship between agricultural Production and income per capita growth rate, and thirdly to determine the short-run and long-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022.

1.7.3 Time Scope

This study used time series data from 1988 to 2022. The time chosen is the period when the Uganda economy has experienced lows and highs in economic growth with challenges in the economy being live in the existence of the economy.

1.8 Significance of the Study

The study will offer recommendations for important steps to take to carry out this kind of research, which will ultimately result in higher agricultural output in Uganda, which would raise foreign exchange earnings and improve the country's balance of payments, which should raise per capita income. It should be remembered that no nation has advanced without first changing its main export-oriented products.

As more literature on this subject becomes available, understanding agricultural productivity and its effects on the economy as a whole, particularly about per capita income, will also improve as a result of the study. The research will hold significance for individuals who aspire to conduct investigations in the same area of study or subject matter.

To put it briefly, the study will help close significant gaps related to issues with agriculture that affect the agricultural sector overall, agricultural output, and per capita income. To boost per capita income, other analysts will utilize the recommendations made after the investigation to address issues related to other bilateral trade concerns in the agriculture sector.

CHAPTER TWO
REVIEW OF LITERATURE

2.0 Overview

The study reviewed scholarly works on the key study variables, such as theoretical review, which is presented in this chapter together with a conceptual evaluation and a review of related literature based on calculations of the relationship between per capita income and agricultural productivity.

2.1 Overview of Theory

2.1.1 The Economic Growth Theory of Malthus

Malthusian Theory (1992). Malthusianism suggests that while food and resource supply tends to increase at a linear rate, population growth can be exponential. This disparity can lead to a situation where population growth outpaces agricultural production, resulting in starvation, conflict, poverty, and depopulation—an event termed a Malthusian catastrophe. Such crises force the population to swiftly return to a sustainable level due to the severity and unpredictability of mitigating factors.

According to Malthusian theory, population growth is triggered whenever income exceeds the basic sustenance level. Malthus argued that the main constraint on population growth is the limited capacity to produce enough food. As the population continues to expand, per capita income eventually decreases, potentially leading to famine and mortality. Malthus described this phenomenon by noting that while the population can grow exponentially, food production increases at a much slower, linear rate Malthusian Theory (2022).

According to him, population growth must keep up with gains in food production for equilibrium to be reached. The correlation between economic development and population growth can be explained by the Malthusian population trap. Because there wouldn't be enough resources to maintain such population expansion, the Malthusian trap shows the point at which population growth was certain to end. However, many argue that this theory is flawed since it fails to acknowledge the relationship between technical advancement and increased output and productivity. Malthus consequently makes the false assumption that any plot of land will always be productive. Growing populations can be supported in situations where a country's production function shifts upward due to technological advancements. Along with the industrialization of nations, the rise of capitalism led to economic prosperity and an agricultural revolution, wherein improved technology was applied to raise agricultural yield. Malthus does, however, make a good point when he points out that, in a capitalist system, there is no way for more output to benefit all social strata equally. Malthus contends, therefore, that the result of the capitalist system was the separation between the rich and the poor. Although nations strive to combat income disparity, this argument may still be relevant today "Malthusian Theory (2022).

An intriguing alternate narrative is presented by Bernasconi (2010), who claims that countries and consumers with high per capita incomes consume a wider variety of commodities, which boosts northern commerce. Trade volumes and per capita income as well as trade volumes and income inequality have a strong and positive association, with the latter being stronger for more sophisticated items.

According to Martinez et al. (2010). These findings are consistent with the model used below. There is no integration of production and consumption, nor explicit modeling of the production side of general equilibrium, as in several of the articles already described.

Traditional Agriculture According to Schultz Theory

Theodore William Schultz introduced the concept that traditional agriculture operates below its potential equilibrium. Schultz argued that impoverished nations cannot achieve economic progress unless they first fulfill their basic needs. He identified a phenomenon he termed "high food drain," where a significant portion of national income is spent on food due to the low-income levels of the population. According to this hypothesis, for developing economies to advance, they must initially focus on self-sufficiency in food production "Schultz, William."(2022).

To do this, developing nations should identify the kind and amount of agricultural investment required to turn their agriculture sector into one that is extremely productive. According to Schultz, an economy's ability to develop requires an agricultural surplus. This hypothesis is predicated on the following premises: limited goods and resources that can be exchanged for food; high prices associated with food importation; and a significant labor and resource requirement in food production.

Conversely, opposing schools of thought like Lewis (1954) assert that industrialization—rather than agricultural surplus—is the primary force behind economic expansion and progress. They argue that it is essential to work toward economic development, growth, and the creation and expansion of jobs in the contemporary industrial sector. Dercon and Gollin (2014) contend that agricultural imports can serve as a substitute for agricultural productivity. They argue that economies that have established port infrastructure and have access to international markets may feed their people with imported food rather than just food produced domestically.

However, of these economies can reallocate resources to other economic sectors, like manufacturing, them to the availability of imported food, which promotes economic growth and development. Furthermore, Mustafaa, et al. (2016) contend that because the agricultural sector has not advanced technologically, nations that have a comparative advantage in agriculture output can be simply reduced to single-sector economies with low levels of advancement. Therefore, compared to nations with a comparative advantage in the industrial sector, these countries are less developed. The hypothesis is pertinent to this research because, in addition to being less expensive than agricultural imports, agricultural productivity raises individuals' disposable incomes and promotes their health and productivity, allowing them to participate in the process of economic growth and development.

2.1.2 Principle of Johnston-Mellor

Johnston and John (2022) supported the idea that agricultural productivity and expansion have significant general equilibrium impacts on an economy. They identified five key effects: increased farm revenues and profitability improve the welfare of farmers and rural poor; lower food prices benefit both rural and urban impoverished consumers, as well as farmers who are net buyers of food, thus increasing discretionary income; higher savings facilitate the mobilization of capital and labor for non-farm industries; growth in agricultural exports raises foreign exchange earnings; and increased domestic demand for non-farm sector output stimulates broader economic growth. Their framework posits that the development and expansion of economies heavily reliant on agriculture are contingent on the productivity and growth of the agricultural sector. This theory assumes that agriculture is the dominant economic activity and that there is a minimum food consumption requirement that must be met (Johnston and Muller) (2022).

On the other hand, Prebish et al. (1949) contend in their theory that economies must go from the subsistence or agricultural sector to the manufacturing or industry sector to expand and flourish. They argue that because manufactured goods have a higher income elasticity than primary products, primary commodities typically have lower pricing. As a result, the conditions of trade drastically worsen for nations that depend on the subsistence sector, depriving them of the chance to advance economically. According to Matsuyama (1992), increases in agricultural production might have a negative relationship with economic expansion. Dercon (2009) made similar remarks, arguing that since the agricultural sector has poor productivity—particularly in emerging nations—expanding it cannot be the means of promoting economic growth and development. Gollin (2010) further contended that increases in agricultural production are neither a prerequisite nor an adequate means of achieving economic expansion and advancement. As a result, this school of thinking supports an export-oriented manufacturing sector as a vital avenue for advancement.

However, it promotes agricultural productivity increase and growth for economic development, the Johnston-Mellor theory is pertinent to this study. The three facets of human development get better as a result of increased agricultural productivity and expansion. Food security is achieved because agricultural productivity and expansion lead to sufficient amounts of high-quality food production. Due to reduced food prices brought on by an ample or surplus supply of food, citizens also have higher incomes and more disposable income. As a result, they are better equipped to pay for high-quality medical treatment as well as other necessities like education. Improved living standards, health, and education thus lead to improved human development overall. These three measures of human development are also higher. Johnston-Mellor theory (2022).

2.2 Conceptual Framework

Numerous economists have expressed concern about the correlation between agricultural output and per capita income, as evidenced by numerous studies. This concern grew following the decline in global primary commodity prices throughout the 1980s. This study was started with the variables indicated in the study in mind. As a result, the conceptual framework's illustration of the study's focus is shown in Figure 2.1. In this instance, economic growth is the dependent variable, and income per capita (IPC) serves as a proxy. The explanatory variables of interest comprise Income per capita as the dependent variable, Agricultural production (in shillings/ Dollars), Labour, per capita, technology, and interest rates.

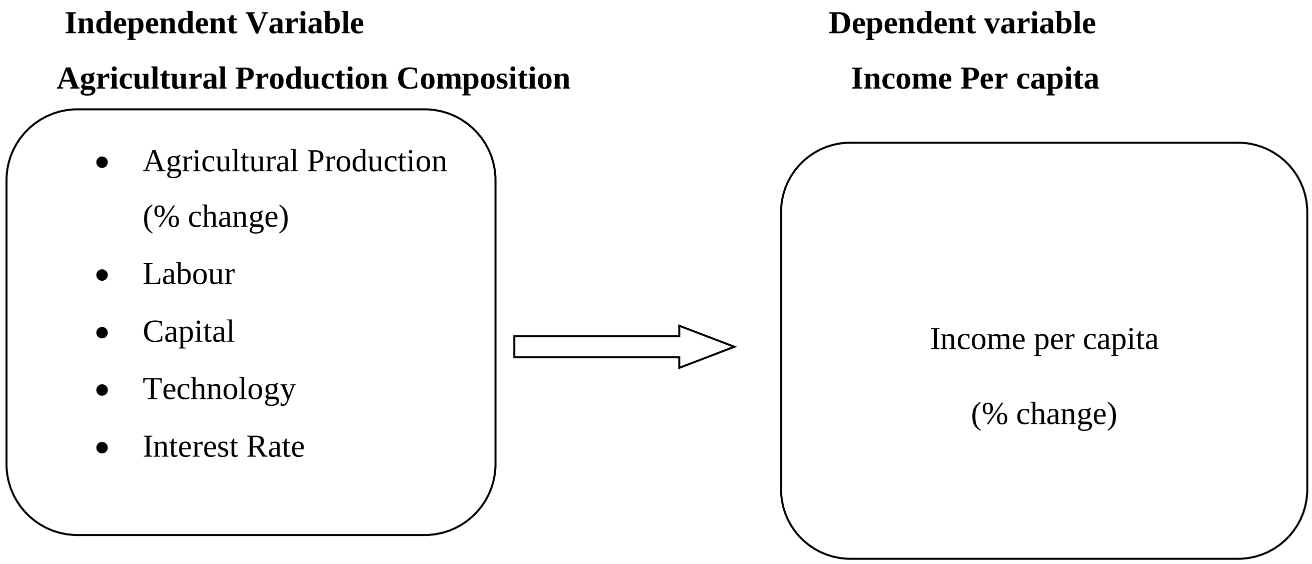

Figure 2.1: Conceptual Framework diagram

2.3 Trend of Agricultural Production and Income Per Capita Growth Rate

2.3.1 Agricultural Production and Income Per Capita

With temperatures ranging from 15 to 30 degrees Celsius, Uganda is an equatorial country. 2,500–1,000 meters above sea level is where the majority of the nation is situated. Much of Uganda experiences a fairly consistent rainfall pattern, ranging from 750 mm annually in some areas of the northeastern Karamoja pastoral areas to 1,500 mm in high-rainfall areas around Mt. Elgon's eastern highlands and the Southwest Highlands However, most of Uganda experiences consistent rainfall. Though the remainder of the country experiences a single, extended rainy season, areas near the equator, such as those around Lake Victoria Crescent and some highland regions, experience two different rainy seasons. The size of the nation is 241,000 square kilometers. Of this property, about 75% can be used for pasture, farming, or both. Lakes, wetlands, and forest zones make up the remaining 25%. Approximately 5 million hectares, or less than 30% of all arable land, are cultivated out of the area that is accessible for agriculture. Due to the country's rapidly growing population, land is increasingly becoming a constraint on agricultural output in some areas, particularly in the south and east. Each household has 2.2

hectares of land on average. In the nation, common and officially recognized types of land tenure include customary, freehold, and mailo (MAAIF, 2016).

The agriculture industry continues to play a major role in Uganda's economy. Approximately ninety percent of the population receives a living from agriculture, which also accounts for twenty-seven percent of GDP and produces about ninety percent of export earnings. The majority of agricultural production, however, is produced by small-scale subsistence farmers who operate under several production and post-production restrictions and produce primarily for non-market markets. In order to address the challenges faced by regular farmers, multi-sectoral interventions were implemented as part of the Plan for the Modernization of Agriculture (PMA), which was created as a strategic framework for reducing poverty. PMA specifically seeks to improve household food security, income, and quality of life, create gainful work, and sustainably manage resources. The Government of Uganda (GoU) is expanding on the Plan for Zonal Agricultural Production, Agro-processing, and Marketing to support PMA key actions by implementing the Prosperity for All development frameworks, which include rural enterprise and foster industry. PMA seeks to enlighten and advise local governments and private farmers on agricultural investments through the use of zoning and enterprise selection criteria for Uganda to become a middle-income nation, the government has identified agriculture as a crucial economic sector and has emphasized the significance of value-addition and commercialization However, the nation will need to overcome several obstacles to the expansion of agricultural productivity if it is to realize the potential of agriculture. Over the past five years, the country's agricultural output has only increased by 2% annually, far less than the population growth rate and the 3-5% growth rates of neighboring East African nations. The government has responded to this by enacting several new laws and regulations that cover everything from irrigation and seed policies to the creation of new agricultural finance institutions. On the other hand, these actions have not been enough and have occasionally even backfired. These themes—agricultural productivity, the resilience of agricultural systems and rural livelihoods to weather and climatic shocks, producer arrangements and value chain competitiveness, and the regulatory and institutional environment—reflect a variety of structural and institutional challenges that remain to be addressed (UN, 2022).

It is necessary to solve important policy flaws and enhance institutional coordination to accelerate the transformation of Uganda's agri-food sector. High-quality agricultural inputs must be adopted and made accessible to increase primary production's productivity. For this to happen, it will be necessary to fully implement ongoing extension reforms to place more of an emphasis on knowledge transfer, reinforce regulatory measures, secure land tenure, and improve input quality controls (UBOS, 2022). The resilience of agricultural systems and rural livelihoods must be strengthened in light of Uganda's growing climatic variability and insect outbreaks. To do this, farmers should have access to information about climate change and catastrophe risk, as well as climate-smart land, water, and animal management techniques.

In Uganda, almost 7 million families farmed land or kept animals in 2019 (UBOS 2022). In Uganda, they accounted for 80% of all households (UBOS, 2022). For the majority of those heads of agricultural households, agriculture served as their primary source of income. Compared to male household heads, who said that agriculture was their primary economic activity at 74 percent, the proportion for female household heads was greater, at 87 percent. Twenty-two percent of all agricultural households were headed by women (UBOS 2022). Out of all agricultural households, 99 percent were involved in crop production, making it the most common activity. Produced mostly for personal use, crops are grown by 14% of agricultural families, and another 68% of households cultivate primarily for personal use but also sell some (UBOS 2022).

Income Per Capita

The amount of money earned by each individual in a certain geographic area—such as a nation, state, city, or other—is measured by the per capita income of that area. It establishes the mean personal income within a nation, a state, or a locality. This aids in our assessment of the living conditions and standard of living of the inhabitants of the area. It was predicted that Uganda's GDP per capita would rise steadily between 2023 and 2028, totaling 377.6 US dollars (+32.47 percent). The GDP per capita is predicted to reach 1,540.65 US dollars in 2028, marking a new peak, following eight years of growth (UBOS, 2022). At current prices, the gross domestic product per capita is represented by this metric. The process involved converting national currency to US dollars at current exchange rates and then dividing the resulting amount by the total population. The productivity of a nation is gauged by its gross domestic output. In this case, a year's worth of goods and services created is referred to as the total value of the production. The GDP Per Capita measures a nation's economic output divided by its population. A country's total economic domestic production must be divided by its population. GDP Per Capita is computed using the following formula: GDP Per Capita = Gross Domestic Product / Population.

In 2022, Uganda's Gross Domestic Product (GDP) was approximately $45.57 billion. The population of Uganda in 2022 was around 47.25 million people (UBOS, 2023). To calculate the GDP Per Capita, we use the formula:

GDP Per Capita=GDP/Population

GDP Per Capita= 45,570,000,000/ 47,250,000 = 965 USD

This aligns closely with reported figures, which state the GDP Per Capita for Uganda in 2022 was about $935 Worldmeter. (2022).

Gross National Product Per Capita and the value produced by a nation's citizens residing abroad must be taken into consideration to calculate Gross National Income per Capita. The GDP distribution of Uganda is highly skewed in terms of per capita income. The number of districts with GDP per capita values higher than the national average is just 14. This translates to about 29 million people, or 4 out of 5 individuals, residing in districts with estimated GDP per capita lower than the federal average (UBOS, 2021).

Trend Analysis

Trend analysis in agriculture involves examining historical data to identify patterns and predict future trends. According to Chatfield (2003), it helps policymakers and stakeholders make informed decisions regarding resource allocation, agricultural planning, and policy formulation. In the context of developing countries like Uganda, trend analysis can reveal critical insights into the effects of agricultural policies, climate change, and market dynamics on agricultural production.

Several methodologies are commonly used in trend analysis. These include moving averages, linear and polynomial regression, and exponential smoothing. Hyndman and Athanasopoulos

(2018) suggest that each method has its strengths and is suitable for different types of data patterns.

Moving Averages: This method smooths out short-term fluctuations and highlights longer-term trends. It is particularly useful in volatile agricultural markets (Makridakis et al., 1998).

Linear and Polynomial Regression: These techniques fit a line or curve to the data, providing a model that can be used to predict future values. Linear regression is straightforward and interpretable, while polynomial regression can capture more complex relationships (Montgomery et al., 2012).

Exponential Smoothing: This method gives more weight to recent observations, making it suitable for data with trend and seasonal components. Holt-Winters exponential smoothing is commonly used in agricultural time series data (Gardner, 1985).

Trend analysis has been widely used to study agricultural production trends globally. For instance, Goyal (2010) analyzed the trend of agricultural production in India using time series data and found significant improvements in productivity due to technological advancements and policy interventions. Similar studies in African countries have highlighted the role of government policies and climate variability in shaping agricultural trends (FAO, 2015).

In Uganda, trend analysis has been applied to various agricultural sectors. A study by UBOS (2019) examined the trends in crop production from 1988 to 2018 and identified significant growth in maize and coffee production, attributed to favorable government policies and market conditions. Another study by Nalunga et al. (2020) used trend analysis to explore the impact of climate change on agricultural yields, emphasizing the need for adaptive strategies.

Income per capita is a crucial indicator of economic well-being. Trend analysis in this area helps to understand the long-term economic performance and the impact of economic policies. According to Barro et al. (2004), analyzing trends in income per capita can reveal the effectiveness of development strategies and highlight areas needing policy intervention.

Studies have shown mixed trends in income per capita growth in developing countries. For example, Pritchett (2000) found that while some countries experienced rapid growth, others showed stagnation or decline, influenced by factors such as governance, economic policies, and external shocks. In Uganda, income per capita has shown positive growth trends in recent decades, driven by economic reforms and increased agricultural productivity (World Bank, 2020).

Understanding the relationship between agricultural production and income per capita is essential for holistic economic planning. Trend analysis can reveal how agricultural growth translates into economic well-being. Timmer (1995) suggests that growth in agricultural productivity can lead to higher incomes, improved food security, and poverty reduction.

In Uganda, studies have demonstrated a positive correlation between agricultural production and income per capita growth. For example, Kappel et al. (2005) found that increased agricultural output significantly contributed to rising incomes and poverty reduction in rural areas. However, challenges such as market access, climate change, and infrastructural deficiencies continue to affect this relationship (Mugagga, 2017).

2.3.2 Casual Relationship between Agricultural Production and Income Per Capita

The impact of agricultural productivity on Panama's long-term economic growth was examined by Secondary data gathered between 1980 and 2015 was used in the study. The study employed the Granger causality test, the vector error correction model, and the Johansen cointegration technique to address the objectives. The study's findings indicate that there is no meaningful correlation between imports and exports and Panama's economic growth. Furthermore, a bidirectional causal relationship between imports and GDP growth and exports and economic growth was verified by the findings of the Granger causality test. The report suggested that to speed up economic growth, the Panamanian government should create laws that encourage imports and exports (Bakari et al. (2017).

The relationship between Nigeria's GDP growth and agricultural exports was examined by Ojo et al.(2019). The time series data collected between 1980 and 2012 were used in the study. The analysis in the paper made use of the HWA (1988) model. To verify stationarity, the study used the traditional Philip-Perron time series test. The cointegration test and the vector error correction model were used in the study to see whether there were any short- and long-term relationships. The analysis's conclusions revealed that Nigeria's long-term economic growth is determined by net capital flows, exports of agricultural production, and the prices of Nigeria's major agricultural products abroad. Therefore, to boost the economy, the report suggested that the government focus more on enhancing agricultural commodity exports.

According to Tiffin et al.(2006), the majority of the time, the relationship between GDP per capita and agricultural value added per worker is causative, meaning that agriculture is the main driver of growth. However, their study is broad in scope and does not concentrate on any one nation. Although several supporting arguments indicate a positive effect of agricultural productivity on economic development.

According to Rahman et al. (2017), the authors took into account the growth performance, profitability, and production efficiency of jute as well as its potential as an agricultural crop to compare it with agricultural GDP and GDP growth. The research findings indicate that there has been a notable expansion in the jute industry concerning area, productivity, prices, exports, and production. Additionally, the authors stated that although jute cultivation is a customary agricultural commodity that is globally competitive, the financial profitability of jute was comparatively higher. The production of crops like jute depended heavily on labor, irrigation, and land, and farmers were often inefficient. This has an impact on GDP growth and agriculture GDP in comparison.

Green economic growth, FD (Financial Development), and institutional quality are all co-integrated (Ahmed et al., 2022). ED (Economic Development) and financial inclusion are moderated by governance. Innovation and ED have a complicated relationship (Mtar et al. 2021). Institutions and financial markets also influence ED, FD, and human capita. Through the ownership of animals and the sale of assets, agricultural commercialization helps rural Ethiopians escape poverty.

Using a standard regression method (OLS) methodology, the study "Achieving the Impact of Agriculture and Industry on economic growth in India" (Sahoo & Sethi, 2019) aims to explore the relationship between economic activity and the production of each of the agricultural and industrial sectors. The results demonstrate that industry and agriculture play a major role in India's economic growth and prosperity. The analysis indicated that the expansion of both sectors was necessary given their continuous growth.

In a 2019 study by (Bashir et al., 2019) titled The Causality between Agriculture, Industry, and Economic Growth: Evidence from Indonesia, the interdependence of China's industrial and agricultural sectors was examined. Labor and other conventional inputs are still vital to China's economic growth. Capita investment resulted in significant growth in China's industrial sector but not in its agriculture sector. The results also suggest that global trade has had a big impact on China's economic development.

Xuezhen et al. (2010) conducted a study titled "The Relationship between Economic Growth and Agricultural Growth: The Case of China," which used econometric model analysis to look at China from 1952 to 2007 to analyze how agriculture contributes to economic growth. It demonstrates that there has always been a strong correlation between economic expansion and agriculture. Enhancing agricultural contributions is essential to maintaining the rapid and orderly growth of the national economy.

2.3.3 Effect of Agricultural Production and Income Per Capita

A nation's economic development process is fundamentally influenced by its agricultural sector. Remarkably, agriculture has made a far greater contribution to the progress of developed nations and is essential to the growth of developing nations' economies. Said another way, nations with low per capita income tend to prioritize agriculture and primary industries (Chikwama, 2019). Agriculture contributes significantly to economic growth by generating the foreign exchange needed to import capital goods and industrial raw materials needed for industry expansion. One major impediment to the growing process is the absence of foreign exchange, rural areas are home to the majority of impoverished people in developing nations. Developing rural populations is a major goal of any plan aimed at increasing agricultural growth. Growth in the agricultural sector boosts employment and pay for agricultural workers while also increasing productivity and income for small and marginalized farmers. So, by lowering poverty and hidden unemployment, it contributes to bettering lives. Additionally, decreasing food prices and controlled inflation are made possible by increased agricultural productivity, both of which lower poverty (Gollin, 2019).

Grusson Predicts that droughts will become more regular and severe and that Sweden's growing season will get drier. Climate change-related variations in precipitation patterns are primarily responsible for this. According to their findings, the majority of Sweden's growing season precipitation may decrease by 5-25%, with the southern and eastern regions of the nation likely to see the largest declines. The yields of crops and general agricultural output may be significantly impacted by these rain deficiencies. Additionally, they discovered that in some regions of Sweden during the same period, irrigation needs could rise by as much as 50% Grusson (2021).

According to Morel et al. (2021), climate change will likely have an impact on Sweden's agricultural production in both positive and negative ways. According to the study, rising temperatures are expected to benefit agricultural production across most of Sweden, especially for rapeseed and barley. They do, however, point out that in some areas, greater water stress, pests, and illnesses may cancel out the beneficial impacts of temperature increases. The study also shows that because increased carbon dioxide (CO2) has a beneficial effect on photosynthesis and water usage efficiency, it is expected to have a positive impact on agricultural yields throughout most of Sweden.

The agriculture industry in Uganda is vital to the country's economy and has room to grow in the future. About a quarter of GDP, over half of all exports, and 70% of employment are derived from it. The demand for agricultural products, both locally and regionally, is rising quickly, and more and more city people are requesting diets high in protein and processed foods. Uganda's population is expected to reach 102 million by 2050. For Uganda's agriculture industry and larger agri-food system, these estimates present enormous prospects. All phases of the food value chain—production, acquisition of inputs, handling, processing, marketing, transportation, and retail—require labor, both skilled and unskilled, and can support equitable economic growth. The country's largely youthful population, who reside primarily in rural areas, may have more work options in Uganda's agri-food system. With the development of many agribusinesses in recent years, especially throughout the value chains of dairy, maize, and coffee, farmers now have better access to markets, financing, and inputs, as well as improved rural livelihoods. But to fully capitalize on the sector's special prospects, Ugandan agriculture must support this emerging agribusiness dynamism and keep moving away from low-value smallholder farming and toward a higher-value agri-food industry (UBOS, 2020).

2.4. Short-Run Relationship between Agricultural Production and GDP Per Capita

By analyzing Uganda's agricultural GDP, this study adds to the body of knowledge already available on the production of cereals including rice, maize, and wheat. Employing statistical tests, I utilize time series data spanning from 1988 to 2022. Optimal lag length selection analysis and co-integration are used to verify both short- and long-term shocks between the chosen variables and outcomes. Applying the Johansen causality test reveals the relationship between the variables. The results of positive shocks demonstrate that grains have a considerable impact on GDP, and the results validate co-integration. (Huo and Zhang, 2020). Cereal production has a long-term relationship with economic growth, both in the short and long terms, according to a study on the impact of cereal production on GDP growth in Gambia. The elasticity of GDP to cereal production was (0.079) for the long term and (0.071) for the short term, respectively (Gambia Bureau of Statistics, 2018), This suggests that the elasticity won't essentially alter over time. Additionally, these results suggest that the production of cereals given to farmers would help the country's economy grow. They also show that the government allocates resources well and that the country's sizable agricultural sector contributes to economic growth over the long term, albeit with very little elasticity In their study on the relationship between food production and consumption trends in sub-Saharan Africa: prospects for the transformation of the agricultural sector on Economic growth.

Chauvin et al.(2018) used time series data from Cameroon and discovered that there is a short-term positive relationship between government expenditure, economic growth, and cereals, as well as a short-term negative relationship that has a significant impact on the latter.

The agriculture sector's slow expansion has contributed to fluctuations in global food prices since 2007 (Sosoo et al. (2021). This problem has affected the rate of overall world development in a variety of nations and regions, albeit to differing degrees. According to Besada et al. (2015), for instance, most populations that are vulnerable may be located on the African continent; Sub-Saharan Africa (SSA) is the only region where chronic food shortages and undernourishment are still frequent.

Wale et al. (2021). With the human population expected to increase at an average annual rate of 80 million, the agriculture sector is expected to continue playing a crucial role in the world's food supply chains.

In his study, Muricho 2019 attempted to identify the factors that influence agricultural commercialization as well as look at how they affect the welfare of smallholder farmers. This study examined the factors that influence home agricultural commercialization decisions and intensity using a double hurdle model based on a comprehensive household commercialization index created from the value of all crops produced on the farm. Using endogenous switching regressions, the study examined how agricultural commercialization affects smallholder welfare, namely food security and poverty. Correlated random effects, a hybrid framework combining fixed and random effects, were employed in both models. He also took into account the size of the farm, the fertility of the land, the possession of a cell phone, the availability of local transportation, and financial availability. The findings demonstrated that larger farms and more fertile soil had a positive impact on households' decisions to commercialize their agricultural output.

In their study, Mustafaa, et al (2020) aimed to evaluate how the well-being of households in the existing agricultural production systems might be affected by climate change. Decreased rainfall and rising temperatures were employed as markers of climate change, while well-being was quantified in terms of net farm returns, per capita incomes, and poverty. Future anticipated climate change scenarios for the mid-century period of 2040–2070 were downscaled using climate models. Agricultural Production Systems IMulator (APSIM) and Decision Support System for Agro-technology Transfer (DSSAT) crop models were also used for maize crop modeling. The Trade-off Analysis Multidimensional (TOA-MD) effect assessment tool was used to conduct economic analysis. According to the findings, between 36% and 66% of households in agroecological zones (AEZs) with little rainfall are probably going to suffer as a result of climate change. However, crop models showed inconsistent findings for net farm returns, per capita income, and poverty levels in various AEZs; for example, poverty declines for APSIM ranged from 0.6% to 3.8%, whereas those for DSSAT ranged from 0.7% to 11%.

2.5 Long-Run Relationship between Agricultural Production and GDP Per Capita

The long-term effects of agricultural output on per capita income in Nigeria were empirically investigated by Obayagbona and Eboiyehi (2020). The precise goals were to ascertain the effects of domestic investment, agricultural exports, agricultural output, and human capital (measured by the percentage of secondary school enrolment) on Nigeria's per capita GDP. The ordinary least squares (OLS) econometric technique was employed to estimate the correlations using annual time series data spanning the years 1980 to 2011. In line with earlier methods, Nigeria's economic growth was estimated using per capita income. The findings indicate that, over time, agricultural productivity in Nigeria does not raise per capita income by itself. This may be because small, inefficient farms have produced low yields due to the industry's low productivity: Nigeria's economy is growing significantly better to agricultural exports, once more, although human capita investment does not directly contribute to Nigeria's economic growth, physical investment significantly boosts agricultural output in the country.

The average growth rate of agricultural production was 5.4%, according to Lawal and Atte's (2017) study on the impact of the agricultural sector on per capita income in the Nigerian economy. The study used statistical analysis and descriptive statistics in its empirical analysis, and the main factors influencing domestic agricultural production were the GDP growth rate, population growth rate, and the Consumer Price Index. Nonetheless, the study suggests that Nigerian agriculture should use better technology to raise per-capita output.

In his investigation into the long-term effects of agriculture on poverty and per capita income in rural Vietnam, Nguyen (2019) used fixed-effects regressions from 2002 to 2004 and discovered that estimates of the effects of crop and forestry production on per capita income and consumption expenditures are not statistically significant. For per capita income, impact estimates of livestock production are positive and statistically significant; but, for per capita expenditure, they are not statistically significant. On the other hand, the production of aquaculture has favorable and statistically significant effects on revenue and expenses. Thus, the aquacultural output contributes 4.3 percentage points to the producing households' reduction of poverty incidence. Moreover, it reduces the producing households' poverty severity and gap indices by about 15% and 13%, respectively, Employed bivariate Granger causality tests to investigate the causative links between agricultural value-added and economic growth for a panel of nations. The results showed that aquaculture production also, albeit to a very small extent, reduces the disparity in rural expenditures. For emerging nations, they discovered compelling evidence linking agriculture to economic growth; however, the findings on industrialized nations' causal relationships were equivocal.

The subject of whether agriculture could eventually act as a growth engine for per capita income is examined by Awokuse (2018). The empirical analysis's findings offer compelling evidence that trade openness boosts GDP growth and that agriculture is a major contributor to economic expansion. His focus was on how the GDP per capita of a sample of fifteen developing nations changed about the US over the last three decades (1975–2016). Over the past three decades, the GDP per capita of the majority of the countries in Latin America and Africa (such as Senegal and Nigeria) has been quite low and quite disappointing. On the other hand, within the last thirty years, several Asian economies—including China and Thailand—have had phenomenal growth. It's interesting to note that even in many countries with weak development histories, the agriculture sector accounts for a sizable portion of GDP. Over 20 percent of GDP is derived from agriculture in the majority of African countries.

To determine whether financial development in agricultural production, exports, and remittances are important for economic growth, Kumar (2017) conducted research, The annual time series data were used in the study's analysis. The short- and long-term effects of each research variable on per capita income were examined using the bound test model. The results demonstrated the importance of exports in the short and long terms, while remittances have a negative short-term impact and only a favorable long-term impact on the economy.

2.6 Research Gaps

The study reviewed different studies on agricultural production and income per capita. Several studies done on the topic were vast though limited as many were done outside Uganda presenting a geographical gap, furthermore, there exists a gap in the time of the reviews as many were done before 2021 hence presenting a time research gap that needed to be addressed by conducting timely research. Furthermore, the state of the impact provides are extensive on a theoretical basis, and there is a need for a new theoretical foundation not well addressed by this study, several reviews were also article reviews based on single research methods and tools while the current study was be done based on purely secondary data to analyze time series data.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The research design, model specification, variable measurement, data sources, data analysis for preliminary, actual, diagnostic, and stability testing, as well as ethical issues in the study, all form the basis for this.

3.1 Research Design

The plan and process for conducting research that ranges from making general assumptions to selecting specific techniques for gathering and analyzing data is known as research design. Utilizing a time series format, the study employed a longitudinal research methodology. This is because no alteration was made to the data utilized in the study. This study aims to examine how Uganda's per capita income is impacted by agricultural production. The non-experimental research approach was employed in this study to elucidate the relationship between per capita income and agricultural output. The following variables were secondary time series data collected for the years 1988–2022, including Labor, capital, technology, interest rates, per capita income, and agricultural production.

3.2 Data Types and Sources

Time series data on income per capita, agricultural productivity (measured in shillings and dollars), labor, per capita, technology, lending, interest rates, and rates were used to collect the data. As a result, the study used secondary data from the Food and Agriculture Organization of the United Nations Database (FAOSTAT) and the World Bank database. Numerous academics classify these institutions as among the leading stewards of genuine data, which when aggregated or processed can produce high-quality reports useful for researchers, economists, and policymakers.

3.3 Source of Data

A combination of descriptive and inferential statistical analysis using Eviews software. Inferential and descriptive statistics were used to assess and show the data. Doing the descriptive statistics was crucial since a time series, by definition, is a collection of observations arranged chronologically. Fundamentally, this was done to determine whether or not the data behaved regularly and what kind of data they were. This means that all of the variables' means, variances, and standard deviations were accurately determined throughout the investigation. The main purpose of these is to offer basic summaries and metrics regarding the information. The model estimated to test the hypotheses is what inferential statistics is all about.

3.4 Trend Analysis

Trend analysis is a statistical technique used to identify patterns or trends in data over time. When analyzing the trend of agricultural production and income per capita growth rate in Uganda from 1988 to 2022, Calculate basic descriptive statistics such as mean, median, standard deviation, and variance to summarize the data as the graphical representations for line graphs to visualize the overall trend of agricultural production and income per capita over the years.

3.5 The Model of Statistics

Multiple Regression Model

The study uses the multiple linear regression model in econometric form using the Ordinary Least Squares Method (OLS) method, which helps in determining the relationships between endogenous variables and exogenous variables. The method becomes efficiently helpful in understanding the relationships between variables, especially in the long term. In data analysis, the Ordinary Least Square analysis is usefully implemented as it uses data very effectively and is often clearly understandable and interpretable for statistical values. Besides, the OLS is an effective approach to understanding the relationship between exogenous and endogenous variables, keeping other variables stable (constant), and producing optimized results (Gujarati et al. (2008).

The general form of the multiple regression models is as follows

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$$

Y is the dependent variable

X_1 and **X_2** are the independent variables

β_0 is the Y-intercept

β_n slope coefficients for each explanatory variable

ε the model error term (also known as the residuals)

The stipulated Model for this study is given as;

$$Y = \beta_0 + \beta_1 Agri + \beta_2 Cap + \beta_3 Lab + \beta_4 Tech + \beta_5 Inters + \varepsilon$$

Y per capita income

β_0 is the Y-intercept

β_1, β_2, β_3, β_4, β_5 are slope of variables

X_1 = Agricultural production, X_2 = Capita, X_3 = Labour, X_4 = Technology, X_5 = Interest rate

3.6 Causality Test

Whether lags in one variable's values aid in the prediction of another is investigated using the Granger Causality test. Granger causality indicates that, in our study, agricultural production is one variable that can be used to predict income per capita if it is the Granger cause of income per capita. However, when past agricultural production values are taken into account, agricultural production cannot be used as a predictor of income per capita. Through the Granger Causality test, I can thus determine if agricultural production predicts income per capita rate in the VAR model. It is typical to employ the Impulse Response Function and Forecast Error Decomposition of the variables because it is difficult to read the VAR model's parameters directly.

$$X_t = \alpha_0 + \alpha_1 X_t - 1 + \cdots + \alpha_k X_t - p + \beta_1 Y_t - 1 + \cdots + B_p Y_t - p + ut.$$

3.7 Distributed Lag with Auto Regression (ARDL)

The autoregressive distributed lag model (ARDL) was used in the final analysis to reconcile the long-run dynamics and the short-run dynamics of the variables under study. The ARDL technique shall be put forth by Pesaran and Shin (1999) and developed by Pesaran et al. (2001). Because the long run and the short estimations can be estimated simultaneously, the method is better than the techniques of Engle and Granger (1987) and Johansen and Juselius (1990). According to the model's specifications and using the data produced by the production function modeling, this procedure was carried out in two steps. To determine that the dependent variable is I (1), the model first needed the optimal lags to be chosen. Then, the unit root was tested. This procedure is then followed by the error correction estimation and the long-run ARDL modeling. Following this procedure, a cointegration ARDL bound test is performed to see if the variables have a long-term relationship. The error correction estimation results were to be interpreted if a long-term association was found. The ARDL model at levels was interpreted if the long-run relationship fails. This procedure was followed in the study, and it was discovered that the variables had a long-term association, leading to the interpretation of the error correction estimates.

ARDL models both the short-term and long-term dynamics of variables.

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-I} + \sum_{j=0}^{q} \beta_j + X_{tj} + \epsilon_t$$

- Y_t: Dependent variable
- X_t: Independent variable
- p and q: Lag lengths
- α, β: Coefficients
- ϵ_t: Error term

3.8 Test for Unit Roots

Because it determines whether a data series is stationary or non-stationary, the unit roots test is significant. For time series modeling to prevent erroneous regression, the data must be steady. This is contingent upon the reality that the data typically employed in macroeconomics tend to show volatility tendencies, which typically lead to non-stationarity. Therefore, the study used the Phillips-Perron (1988) and Augmented Dickey-Fuller (ADF) unit-root tests to establish the order of integration of the variables. By examining the characteristics of the relevant variables in this investigation, guaranteed the validity of the test statistics (t, f statistics, and R^2).

3.8.1 Augmented Dickey-Fuller Tests

The alternative that a time series Y_t is integrated of order I (0) is tested against the null hypothesis that it is integrated of order I (1) by use of the ADF test. For every series, the ADF test is based on predicting the test regression.

The equation can be expressed as;

$\Delta y_t = \beta_0 + \beta_{1t} + \delta\ y_{t-1} + \Sigma \alpha i \Delta\ y_{t-1} p_i = 1 + \varepsilon_t$

Y_{t-1} are the lagged levels of the series, p is the lag, is the first difference operator, β_0 is the intercept term, β_{1t} is the coefficient on time trend, and Final Prediction Error (FPE) is the information criterion that is typically determined before conducting cointegration analysis using a variety of information criteria. The lag was calculated to guarantee that none of the roots lie outside, thereby maintaining the stability of the model in use. In this instance, it was presumed that the error term was homoscedastic. The deterministic terms' specification is contingent upon the behavior of Y_t as assumed under the alternative hypothesis of trend stationarity. As a general rule, reject H_0 and accept H_1 if the ADF test statistic value is greater than the crucial value at the significance level in absolute terms. This indicates that the data is stagnant and lacks a unit root.

3.9 Diagnostic Tests

3.9.1 Time Series Normality Tests

The purpose of the normality test on the data was essentially to validate the descriptive statistics and enable the final analysis before the final time series operations were carried out. The Sample Skewness and Kurtosis tests were two of these normalcy tests. There are several statistical tests and graphical methods available to assess normality, including:

- Shapiro-Wilk test
- Histogram

A summary of the data's symmetry-based structure is called skewness. This is typically depicted by a histogram's form. It can alternatively be expressed as the cube of the standard deviation divided by the third central theorem. The distribution is symmetric about the mean if skewness = 0. The distribution is skewed to the right or has a positive skew if skewness is greater than zero. The distribution has a negative skew or is tilted to the left if the skewness is less than zero. The relative placements of the mean and mode provide another way to describe skewness. The skewness is positive for a mean larger than the mode and negative for a mean less than the model (Panofsky and Brier, 1968).

When compared to a normal distribution, kurtosis indicates whether the data are heavy- or light-tailed. The implication is that heavy tails or outliers are more common in data with high kurtosis. Few outliers or light tails are characteristics of data sets with low kurtosis. At the extreme, there would be a uniform distribution. A useful tool for displaying kurtosis is the histogram, much like skewness.

3.10 Heteroskedasticity Test

Heteroskedasticity is a case where the error term has no constant variance. For accurate analysis and to ensure that no classical assumption is violated heteroskedasticity test was conducted in this study. This will be done to ensure the residuals are dispersed throughout the range of the dependent variable. The study therefore will test heteroskedasticity using the Breusch-Pagan-Godfrey test to asses heteroscedasticity.

The equations can be expressed as:

$$\varepsilon_t^{\,2} = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 + \alpha_2 X_{2t} + \alpha_k + \alpha_1 X_{kt} + u_t$$

- ε_t : residuals from the regression model
- X_{it}: independent variables
- α_i : coefficients
- u_t : error term

3.11 Stability Test

Stability tests (Ramsey RESET Test)

In order to select a correct estimated model, the study has carried out the Ramsey-RESET Test to check on the model specification. This is very helpful to test if there is information about model misspecification. In doing so, if the F-statistic or t-statistic value is more than 0.05, it is possible to conclude that, the model is correctly specified. The hypothesis of the model specification test is formulated as follows; H0: The model is correct. H_0 is not true. Decision Rule: Reject H_0 if the correlation coefficients are less than the significant level of 0.05. Otherwise, do not reject H_0. The equation can express as;

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \cdots + \beta_k X_{kt} + \varepsilon_t$$

Y_t : dependent variable

X_{it}: independent variables

β_i : coefficients

ε_t : error term

3.12 Ethical Consideration

The study adhered to the following ethical guidelines when doing the study: - Authorship attributions: In an attempt to honor the contributions of earlier academics and intellectuals, the study correctly cited the information's sources. This made sure that there was no plagiarism.

Scientific Judgment: The study was conducting their work in compliance with generally recognized research standards.

3.13 Limitations of the Study

Despite the availability of numerous sources, the data is supplied based on time series data obtained from the release of economic indicators, which is very restricted. To provide information for the study, however, the World Bank—a global data firepower—was leveraged.

Although the review of the literature was conducted using a variety of sources, it was presented following pertinent field data and, consequently, the validity of the data presented in the study.

CHAPTER FOUR

PRESENTATION, INTERPRETATION AND ANALYSIS OF FINDINGS

4.0 Introduction

The study was to conduct a Statistical analysis of agricultural production and income per capita growth rate in Uganda from 1988-2022. The data is presented in Appendix I. The objectives of the study were; (1) To determine the trend of agricultural Production composition and its effect on income per capita growth rate in Uganda 1988-2022 in Table 4.2, (2) To establish the causal relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022 and (3) To examine the short run and long-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022. The findings in the study are provided based on the descriptive statistics of the study, stationarity analysis, and co-integration tests, to determine the state of the effect of agricultural production and income per capita growth rate in Uganda 1988-2022.

4.1 Trend of agricultural Production composition and its effect on income per capita growth rate in Uganda 1988-2022.

The study's primary goal was to ascertain the agricultural production composition trend and how it affected Uganda's income per capita growth rate between 1988 and 2022. The relationship between the composition of agricultural production and its impact on income per capita was then tested using ARDL to assess the trends in both agricultural production and income per capita using eviews, in table 4.1 is descriptive statistics of the variables

Table 4.1: Descriptive statistics of the variables

	AGRICULTURAL _PRODUCTION	INCOME _PER_CA PITA	CAPIT AL	INTEREST _RATE	LABOUR_FO RCE_PARTIC IPATI	TECHNOLO GY
Mean	32.344	2.099	20.757	11.136	69.704	4.001
Median	27.170	2.040	20.920	15.050	69.750	3.490
Maximum	54.370	14.990	31.460	22.990	71.130	9.700
Minimum	21.380	-10.12	11.130	-35.01	68.210	1.330
Std. Dev.	10.994	5.997	4.598	12.996	0.543	1.885
Sum	1132.070	73.491	726.500	389.770	2439.660	140.020
Sum Sq. Dev.	4109.736	1222.998	718.941	5743.042	10.034	120.759
Observations	35	35	35	35	35	35

Table 4.1 shows that the agricultural production and income per capita were compared with the means, and standard deviation of the variables in the study, which included labor, capital, interest rate, and technology. The result indicates that the mean for labour was 69.704, the one for capital was 20.575, and then interest rates had 11.136, while technology level had 4.001, agricultural production was 32.344 and income per capita was 2.099. In this study therefore the contends that agricultural production on average percentage rate of change is 32.34 and then the income per capita was 2.099. The standard deviations for agricultural production and income per capita were found to be 27.170 and 2.040, respectively.

Each series' maximum and minimum values are also listed under the corresponding row maximum and minimum. By looking at the standard deviation, one may measure the dispersion in a series around the mean. When interpreting the series' standard deviation in absolute terms, a distribution with a smaller standard deviation is thought to have less dispersion, whereas one with a bigger standard deviation is thought to have more.

4.1.1 Trend of Agricultural Production

The below figure indicates the trend of agricultural production trend between 1988 and 2022, The study found that agricultural production trends over time have been in decreased in terms of the percentage changes

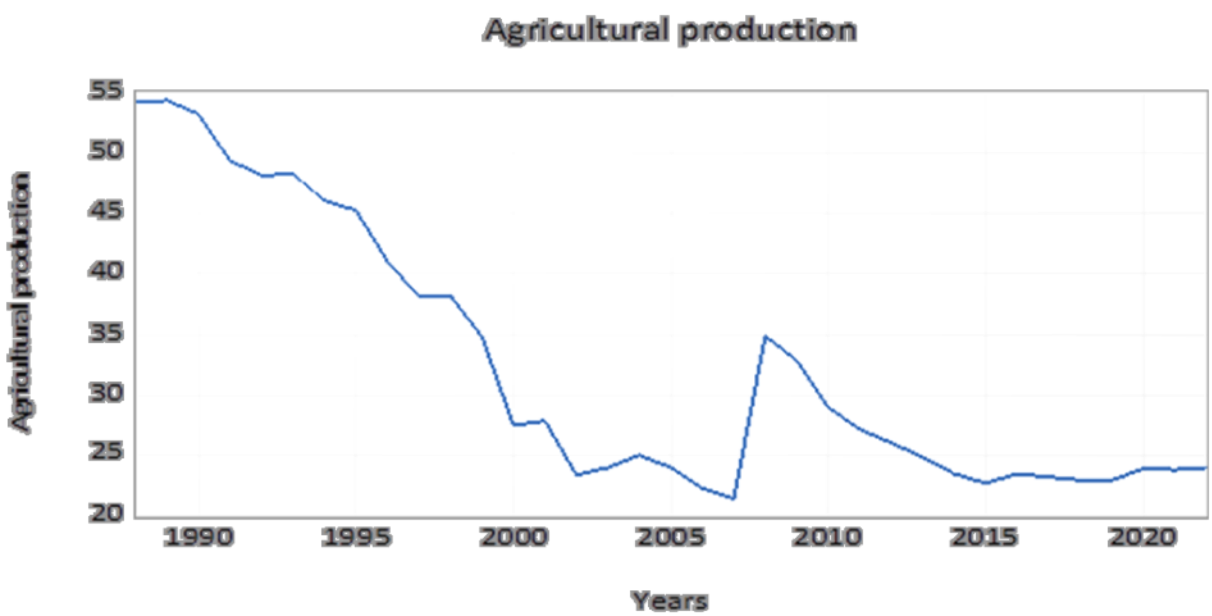

Figure 4.1: Line graph showing the trend of agricultural Production in Uganda 1988-2022

Figure 4.1 shows the line graph showing the trend of Agricultural Production in Uganda from 1988-2022 indicating the trend of agricultural production in Uganda since 1988 has been generally reducing. It's indicated that there has been a general decline in agricultural production in Uganda in the 1990s with a declining stake in the agricultural production especially starting to pick since 2010. The trend indicates that agricultural production systems have been on the decrease over time.

4.1.2 Trend of Income per capita

The income per capita has been increasing over time in Uganda and agricultural production has a moderate effect on the income per capita growth rate in Uganda 1988-2022. The below figure indicates the trend of income per capita in 1988- 2022.

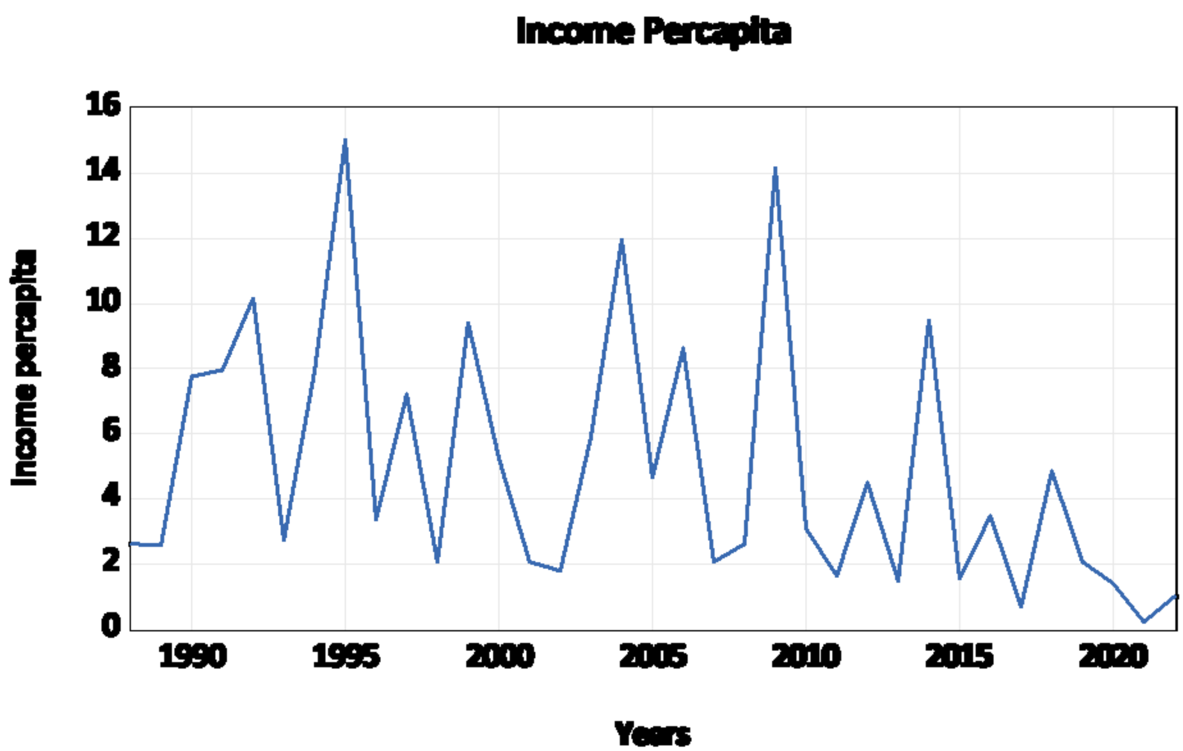

Figure 4.2: Trend of income per capita (% change) in Uganda 1988-2022 Income per capita

Figure 4.2 indicates the trend of income per capita in Uganda from 1988-2022; it was found that the income per capita growth levels of Uganda since 1988 have been generally increasing and decreasing at the same time. 1994 had a high income per capita, these could be affiliated to pragmatic economic policies undertaken by the government in the realization of the economic goals. It was followed by increases and decreases in the economic stances although in a reduction in 2014 continued to reduce over time. Therefore, generally, the economy of Uganda has been faced with income per capita deviances.

4.1.3 Agricultural Production composition and its effect on income per capita growth rate in Uganda 1988-2022

Agricultural Production Composition and its effect on income per capita growth rate in Uganda 1988-2022 The period from 1988 to 2022 has seen notable changes in the composition of agricultural production in Uganda. The outcome of the result a presented in Table 4.2

Table 4.2: Agricultural Production composition and its effect on Uganda's income per capita growth rate 1988-2022.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Income Per capita	-0.231	0.156	-1.474	0.1551
Agricultural Production	2.779	0.706	3.931	0.0008
Labour	29.012	25.417	1.141	0.2665
Labour(-1)	48.870	33.422	1.462	0.1585
Labour(-2)	66.414	30.822	2.154	0.0429
Capital	-0.926	1.038	-0.892	0.3822
Interest Rate	-0.827	0.291	-2.840	0.0098
Interest Rate(-1)	-0.632	0.271	-2.327	0.0300
Technology	0.456	0.434	1.049	0.3060
technology(-1)	1.881	0.453	4.147	0.0005
Ltechnology(-2)	-1.161	0.478	-2.425	0.0244
C	-615.267	158.528	-3.881	0.0009
R-squared	0.754	Mean dependent var		1.267
Adjusted R-squared	0.626	S.D. dependent var		0.948
S.E. of regression	0.579	Akaike info criterion		2.023
Sum squared resid	7.064	Schwarz criterion		2.567
Log-likelihood	-21.390	Hannan-Quinn criter.		2.206
F-statistic	5.875	Durbin-Watson stat		1.883
Prob(F-statistic)	0.000263			

Table 4.2 shows the agricultural Production composition and its effect on income per capita growth rate in Uganda 1988-2022. The adjusted r-square was 0.623, meaning that the composition of agricultural production has had a 62.3% impact on Uganda's growth in income per capita. These findings show that agricultural production has a statistically significant impact on Uganda's growth in income per capita. According to the study's p-value of (0.0008), which is less than the 95% confidence interval, agricultural production in Uganda has a positive impact on the growth rate of income per capita between 1988 and 2022. Accordingly, the findings show that between 1988 and 2022, Uganda's trend and growth have been somewhat influenced by agricultural production.

4.2 Casual relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022

The first research objective was to establish the causal relationship between agricultural Production and income per capita growth rate in Uganda from 1988-2022. To fulfill the objectives and address the research objective, the study employed the Granger causality test to determine the causal relationship between the variables, and the result is presented in Table 4.3

Table 4.3: Casual relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022.

Null Hypothesis:	Obs	F-Statistic	Prob.
LCAPITAL does not Granger Cause LLABOUR	33	0.470	0.6297
LLABOUR does not Granger Cause LCAPITAL		0.242	0.7861
LINTEREST_RATE does not Granger Cause LLABOUR	33	0.688	0.5105
LLABOUR does not Granger Cause LINTEREST_RATE		5.514	0.0096
LTECHNOLOGY does not Granger Cause LLABOUR	33	1.195	0.3176
LLABOUR does not Granger Cause LTECHNOLOGY		2.896	0.0719
LAGRICULTURAL_PRODUCTION does not Granger Cause LLABOUR	33	0.114	0.8920
LLABOUR does not Granger Cause LAGRICULTURAL_PRODUCTION		0.539	0.5890
LINCOME_PERCAPITA does not Granger Cause LLABOUR	33	0.216	0.8063
LLABOUR does not Granger Cause LINCOME_PERCAPITA		2.858	0.0742
LINTEREST_RATE does not Granger Cause LCAPITAL	33	2.103	0.1410
LCAPITAL does not Granger Cause LINTEREST_RATE		3.933	0.0312
LTECHNOLOGY does not Granger Cause LCAPITAL	33	0.230	0.7960

LCAPITAL does not Granger Cause LTECHNOLOGY		1.214	0.3119
LAGRICULTURAL_PRODUCTION does not Granger Cause LCAPITAL	33	1.141	0.3340
LCAPITAL does not Granger Cause LAGRICULTURAL_PRODUCTION		1.350	0.2755
LINCOME_PERCAPITA does not Granger Cause LCAPITAL	33	0.975	0.3896
LCAPITAL does not Granger Cause LINCOME_PERCAPITA		4.640	0.0182
LTECHNOLOGY does not Granger Cause LINTEREST_RATE	33	0.187	0.8303
LINTEREST_RATE does not Granger Cause LTECHNOLOGY		0.812	0.4540
LAGRICULTURAL_PRODUCTION does not Granger Cause LINTEREST_RATE	33	2.563	0.0951
LINTEREST_RATE does not Granger Cause LAGRICULTURAL_PRODUCTION		2.361	0.1128
LINCOME_PERCAPITA does not Granger Cause LINTEREST_RATE	33	0.069	0.9329
LINTEREST_RATE does not Granger Cause LINCOME_PERCAPITA		1.435	0.2550
LAGRICULTURAL_PRODUCTION does not Granger Cause LTECHNOLOGY	33	0.096	0.9084
LTECHNOLOGY does not Granger Cause LAGRICULTURAL_PRODUCTION		2.447	0.1048
LINCOME_PERCAPITA does not Granger Cause LTECHNOLOGY	33	0.246	0.7838
LTECHNOLOGY does not Granger Cause LINCOME_PERCAPITA		5.046	0.0134
LINCOME_PERCAPITA does not Granger Cause LAGRICULTURAL_PRODUCTION	33	0.724	0.4933
LAGRICULTURAL_PRODUCTION does not Granger Cause LINCOME_PERCAPITA		3.601	0.0406

The results shown in Table 4.3 above have been utilized to investigate the relationship between agricultural productivity and per capita income. The two null hypotheses are set up in the following table to prove this. The study rejects the null hypotheses above if any of the null hypothesis values in Table 4.3 have a p-value less than 0.05. This is the rejection criteria. Based on the Granger causality test results with a p-value of 0.724, the current study is unable to reject the initial null hypothesis and concludes that agricultural production is not Granger caused by wealth per capita. But based on the second null hypothesis's p-value (0.040) in Table 4.3 above, the study rejects it and concludes that, at the 5% level of significance, agricultural production Granger causes income per capita rate. In summary, given the research variable, this study can conclude that agricultural production raises income per capita in Uganda; nevertheless, the data also suggest that agricultural production has a small impact on economic growth. The study shows that there is a correlation between Uganda's agricultural production and income per capital growth rate between 1988 and 2022, based on the data.

4.3: Regression Analysis

Table 4.4 summarizes the results of the regression analysis. It provides insights into the relationship between the dependent variable (income per capita growth rate) and the independent variables (agricultural production, capital, labor, technology, and interest rate). The R-squared and adjusted R-squared values indicate the proportion of the variance in the dependent variable that is explained by the model.

Table 4.4: Regression analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Agricultural Production	1.114	0.812	1.372	0.1803
Capital	0.452	1.123	0.402	0.6902
Labour	-0.898	1.408	-0.638	0.5283
Technology	0.744	0.316	2.353	0.0253
Interest Rate	-0.406	0.293	-1.388	0.1754
R-squared	0.302	Mean dependent var		1.249
Adjusted R-squared	0.208	S.D. dependent var		0.923
S.E. of regression	0.821	Akaike info criterion		2.576
Sum squared resid	20.244	Schwarz criterion		2.798
Log likelihood	-40.082	Hannan-Quinn criter.		2.652
Durbin-Watson stat	2.479			

Table (4.4) when the study shows the regression analysis between the study's variables, the r-square value of the variables is 0.302, meaning that agricultural production has a 30.2% impact on per capita income. The results showed that agricultural output had a favorable impact on per capita income. A positive but non-significant effect of agricultural production on income per capita was revealed by the data.

4.4 The short- and long-term relationships between Uganda's income per capita growth rate and agricultural production, 1988–2022.

The third objective was to evaluate the long-run and short-run relationship between agricultural production and income per capita growth rate in Uganda (1986-2022). To analyze short-run relationship between agricultural production and income per capita growth rate in Uganda (1986-2022) to achieve this after establishing a co-integration relationship between the series, Autoregressive Distribution Lag (ARDL) model can be established to determine long run and short-run relationships using the Autoregressive Distributed Lags (ARDL) approach. The results obtained from the analysis are presented in Table 4.5

Table 4.5: Short-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022.

ARDL Error Correction Regression

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Income Per capita	1.099	0.239	4.583	0.0004
Income Per capita	0.468	0.131	3.549	0.0029
Agricultural production)	0.954	0.784	1.216	0.2425
Agricultura production	-1.600	0.885	-1.807	0.0907
Labour)	17.814	18.023	0.988	0.3386
Labour	-65.427	23.380	-2.798	0.0135
Llabour	36.103	20.601	1.752	0.1001
Ltechnology)	0.787	0.309	2.547	0.0223
Technology(-1)	0.135	0.385	0.350	0.7308
Technology(-2)	-0.853	0.349	-2.443	0.0274
CointEq(-1)*	-2.611	0.321	-8.143	0.0000

R-squared	0.921	Mean dependent var	-0.063
Adjusted R-squared	0.883	S.D. dependent var	1.196
S.E. of regression	0.407	Akaike info criterion	1.310
Sum squared resid	3.492	Schwarz criterion	1.814
Log likelihood	-9.964	Hannan-Quinn criter.	1.477
Durbin-Watson stat	2.072		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.767	10%	2.080	3
K	5	5%	2.390	3.380
		2.5%	2.700	3.730
		1%	3.060	4.150

At the 5% level of significance, the coefficient of error correction term in Table 4.5 results is (0.954), which is positive and statistically significant. About 95.4% of the disequilibrium brought on by the shocks of the previous year appears to converge back to the short-run equilibrium of the current year, based on the magnitude of the coefficient. According to the results, Uganda's income per capita growth rate from 1988 to 2022 has a statistically significant short-term link with agricultural productivity. For every correlation coefficient, the 95% confidence interval was not exceeded. It can be claimed that historical variations in agricultural output are a reliable indicator of per capita income by analyzing the ECM data, which shows that the coefficient is substantial. According to the study, there is a short-term correlation between Uganda's income per capita growth rate and agricultural production from 1988 to 2022.

4.5 Long-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022.

The third objective was to evaluate the long-run and short-run relationship between agricultural production and income per capita growth rate in Uganda (1986-2022). To achieve this to evaluate the long-run relationship between agricultural production and income per capita growth rate in Uganda (1986-2022) after establishing a co-integration relationship between the series, Autoregressive Distribution Lag (ARDL) model can be established to determine long run and short run relationships using the Autoregressive Distributed Lags (ARDL) approach. The results obtained from the analysis using this method are presented as Table 4.6

Table 4.6: Long-run relationship between agricultural Production and income per capita growth rate in Uganda 1988-2022

ARDL Long Run Form and Bounds Test

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	615.267	158.528	3.881	0.0009
LINCOME_PERCAPITA(-1)*	-1.231	0.156	-7.851	0.0000
LAGRICULTURAL_PRODUCTION**	2.779	0.706	3.931	0.0008
LLABOUR(-1)	144.296	37.407	3.857	0.0009
LCAPITAL**	-0.926	1.037	-0.892	0.3822
LINTEREST_RATE(-1)	-1.461	0.417	-3.498	0.0021
LTECHNOLOGY(-1)	1.1762	0.312	3.760	0.0011
D(LLABOUR)	29.012	25.417	1.141	0.2665
D(LLABOUR(-1))	-66.414	30.822	-2.154	0.0429
D(LINTEREST_RATE)	-0.827	0.291	-2.841	0.0098
D(LTECHNOLOGY)	0.456	0.434	1.049	0.3060
D(LTECHNOLOGY(-1))	1.161	0.478	2.425	0.0244

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LAGRICULTURAL_PRODUCTION	2.257	0.614	3.672	0.0014
LLABOUR	117.190	30.594	3.830	0.0010
LCAPITAL	-0.752	0.815	-0.922	0.3668
LINTEREST_RATE	-1.186	0.353	-3.352	0.0030
LTECHNOLOGY	0.955	0.216	4.412	0.0002
C	-499.691	130.100	-3.841	0.0009

EC = LINCOME_PERCAPITA - (2.2570*LAGRICULTURAL_PRODUCTION + 117.1908*LLABOUR -0.7523*LCAPITAL - 1.1863*LINTEREST_RATE + 0.9553*LTECHNOLOGY -499.6914)

F-Bounds Test	Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	10.82249	10%	2.080	3
K	5	5%	2.390	3.380
		2.5%	2.700	3.730
		1%	3.060	4.150
			Finite Sample: n=35	
Actual Sample Size	33			
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419
			Finite Sample: n=30	
		10%	2.407	3.517
		5%	2.910	4.193
		1%	4.134	5.761

The F- statistic, as indicated by Table 4.6 results, is 10.822, which is higher than the 10%, 5%, and 2.5% upper bounds for all significant levels. This suggests that, in Uganda from 1988 to 2022, there was a long-term correlation between agricultural production and income per capita growth rate. 615.26 is the estimated coefficient of the constant (C) based on the long-run coefficient study shown above. This indicates that, over the long term, and assuming no other changes, Uganda's income per capita increased by 615.26 between 1988 and 2022. According to this finding, there was a 615.26 rise in revenue per capita for every unit increase in agricultural productivity. The estimated coefficient and P-value is 0.0008. Because it is less than a 95% confidence interval, the results imply that agricultural production significantly determines the income per capita of Uganda from 1988 to 2022. The study shows that a long-run relationship is detected between agricultural Production and income per capita growth rate in Uganda from 1988-2022.

4.6 Unit Root Test Results Using the ADF test

In this section, the Augmented Dickey-Fuller test is used to determine whether each variable is stationary. The findings of the unit root test conducted in Table 4.7 after both the ADF tests are shown in Table 4.3. For the ADF tests, the maximum number of Slags—which the E-views statistical program automatically determined—was employed.

Table 4.7: ADF Test Results at level for Intercept, then Trend and Intercept

Variable	Intercept	Critical value 5%	P-value	Trend & Intercept	Critical value	P-value	Decision
Labour	-1.790	-2.767	0.6406	-2.453	-2.123	0.00032	Reject
Capital	-3.320	-3.658	0.5459	-3.895	-3.213	0.79670	Do not reject
Interest Rate	-1.145	-1.124	0.6547	-3.154	-4.765	0.67543	Do not reject
Technology	-4.214	-4.322	0.5649	-2.435	-3.122	0.56489	Do not reject
Agricultural Production	-4.431	-4.101	0.5670	4.235	- 3.980	0.45678	Do not reject
Income Percapita	2.321	-2.133	0.7430	3.675	-3.215	0.54211	Do not reject

Results in Table 4.7 present findings on ADF Test Results at a level for Intercept, then Trend and Intercept, the rest of the variables apart from labour were found to be unit root or non-stationary in their level form. This can be shown by comparing the test statistics' crucial values at the 0.05 level of significance with the results of the Augmented Dickey-Fuller (ADF) test. Consequently, the null hypothesis is not rejected, and it is sufficient to conclude that the variable economic growth rate in its level form has a unit root. Consequently, these variables underwent a single change and the ADF test was run on them, as Table 4.8 shows. In contrast, Table 4.7 shows that the independent variables of income per capita and agricultural production were determined to be stationary in their level forms. The null hypothesis of non-stationarity is rejected, and it is concluded that all of these variables are stationary at the level after comparing the observed values of the two independent variables for the Augmented Dick-Fuller test (ADF) with the critical values of the test statistics.

Table 4.8: ADF Test Results at first difference for Intercept, then Trend and Intercept

Variable	Intercept	Critical value 5%	P-value	Trend & Intercept	Critical value	P-value	Decision
Labour	-2.957	-2.768	0.0004	-2.453	-2.123	0.00002	Stationary
Capital	-4.544	-3.658	0.0545	-3.895	-3.213	0.00054	Stationary
Interest Rate	-3.245	-3.124	0.0054	-3.154	-4.765	0.00056	Stationary
Technology	-5.895	-5.325	0.0065	-5.657	-5.654	0.00021	Stationary
Agricultural Production	-4.431	-4.101	0.00000	4.234	- 3.980	0.00001	Stationary
Income Per capita	-3.954	-3.890	0.00043	3.675	-3.215	0.00000	Stationary

The null hypothesis of non-stationarity was rejected, and it was concluded that all of the variables that were non-stationary at the level became stationary after being differentiated once or had no unit root. It suggests that they meet the requirements for co-integration because I know that our variable was non-stationary at level but became stationary at first difference. At least one variable must be non-stationary at level but turn stationary at the first difference for co-integration to be used.

4.7 Diagnostic tests

4.7.1 Normality tests

Normality tests are used to evaluate whether the residuals from the regression model are normally distributed. This is a key assumption in many statistical analyses, as it affects the validity of hypothesis tests and confidence intervals. By checking the normality of residuals. The result obtained from the analysis using this method is presented in Figure 4.3

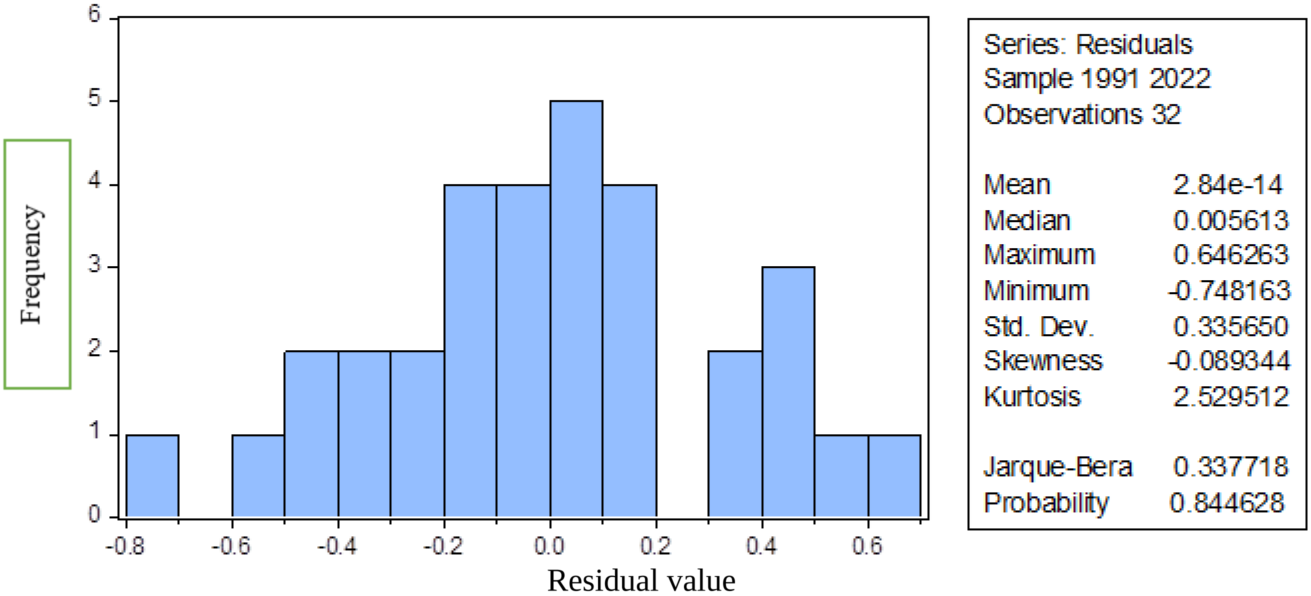

Figure 4.3: Normality Test

Because the probability value of 0.844 in the preceding figure is more than 5% and the residuals are assumed to be normally distributed, we are unable to reject the null hypothesis. The data obtained was determined to be regularly distributed, and as a result, we conclude that the residuals are normally distributed.

4.8 Heteroscedasticity Test: ARCH

Heteroscedasticity refers to the condition where the variance of the residuals in a regression model is not constant across all levels of the independent variables. This can lead to inefficient estimates and unreliable statistical tests. The result obtained from the analysis using this method is presented in Table 4.9

Table 4.9: Heteroscedasticity Test: ARCH

F-statistic	2.120247	Prob. F(1,29)	0.1561
Obs*R-squared	2.112055	Prob. Chi-Square(1)	0.1461

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.141	0.031	4.466	0.0001
RESID^2(-1)	-0.261	0.179	-1.456	0.1561

R-squared	0.068	Mean dependent var	0.112
Adjusted R-squared	0.036	S.D. dependent var	0.138
S.E. of regression	0.135	Akaike info criterion	-1.091
Sum squared resid	0.535	Schwarz criterion	-0.998
Log likelihood	18.913	Hannan-Quinn criter.	-1.061
F-statistic	2.120	Durbin-Watson stat	1.801

Prob(F-statistic)	0.156

There are other ways to check for heteroscedasticity; however, in this study, the Breush-pagan-Godfrey tests were utilized to screen for heteroscedasticity. The heteroscedasticity test is designed with the following hypothesis in mind. Table 4.9 above demonstrates that the F-statics and Chi-square versions of the test statistics yielded the same result, indicating that there is insufficient evidence to support the existence of heteroscedasticity in this specific study because the correlation coefficients are more than 0.05. As a result, the regression model's error possesses homoscedasticity or a constant variance. In this instance, it is not necessary to reject the null hypothesis that the model has no heteroscedasticity issues.

4.9 Stability Tests

Stability tests are crucial for verifying whether the regression model maintains its validity over time. These tests assess whether the model's parameters remain consistent or if there are structural changes that could affect the model's accuracy. the results of the Ramsey RESET test, which evaluates the stability and specification of the regression model. The result obtained for the analysis using this method is presented in Table 4.10

Table 4.10: Ramsey RESET Test

	Value	Df	Probability
t-statistic	0.593	14	0.5624
F-statistic	0.352	(1, 14)	0.5624

F-test summary:	Sum of Sq.	Df	Mean Squares
Test SSR	0.085	1	0.086
Restricted SSR	3.492	15	0.233
Unrestricted SSR	3.407	14	0.243

R-squared	0.879	Mean dependent var	1.243
Adjusted R-squared	0.732	S.D. dependent var	0.953
S.E. of regression	0.493	Akaike info criterion	1.723
Sum squared resid	3.406	Schwarz criterion	2.547
Log likelihood	-9.566	Hannan-Quinn criter.	1.996
F-statistic	5.989	Durbin-Watson stat	2.014
Prob(F-statistic)	0.000777		

The study performed a model specification check using the Ramsey-RESET Test to choose an appropriate estimated model. Testing whether information on model misspecification exists is greatly aided by this. Upon determining that the F-statistic or t-statistic value is above 0.05, one can determine that the model has been appropriately stated. As can be seen in Table 4.10 above, the t- and F-statistic results indicate values of 0.59 and 0.35, respectively, which are both exactly greater than 0.05. Acceptance of the null hypothesis.

CHAPTER FIVE
DISCUSSIONS, CONCLUSION, AND RECOMMENDATION

5.0 Overview

This chapter presents a discussion of findings in conjunction with the literature review and makes conclusions and recommendations based on the study to determine the responsible course of action for the study to determine the effect of agricultural production and income per capita growth rate in Uganda 1988-2022.

5.1 Discussion

5.1.1 Trend of Agricultural Production Composition and Its Effect on Income Per Capita Growth Rate in Uganda 1988-2022.

The study found that agricultural production trends over time have decreased in terms of percentage changes. Uganda's per capita income has been rising over the years, and the country's income per capita growth rate from 1988 to 2022 is moderately influenced by agricultural production. The results align with the conclusions of UBOS (2022). At current prices, the gross domestic product per capita is represented by this metric. The process involved converting national currency to US dollars at current exchange rates and then dividing the resulting amount by the total population. The results are consistent with those of Chikwama (2019), who argues that a nation's agricultural sector is crucial to its economic success. Interestingly, agriculture has made a far greater contribution to the development of developed nations than it has to developing ones, and it is essential to the growth of those nations' economies. Put differently, countries with low per capita income tend to prioritize agriculture and primary industries.

5.1.2 Casual Relationship between Agricultural Production and Income Per Capita Growth Rate in Uganda 1988-2022.

Agricultural production raises income per capita in Uganda given the study variable, but the results also show that agricultural production has a small impact on economic growth. Based on the data, the study shows that the income per capita growth rate in Uganda from 1988 to 2022 and agricultural production have a tenuous link. The findings are consistent with those of Sahoo & Sethi (2019); the study employs a standard regression approach (OLS) methodology to examine the association between economic activity and the production of each agricultural and industrial sector. The results demonstrate that industry and agriculture play a major role in India's economic growth and prosperity. The analysis indicated that the expansion of both sectors was necessary given their continuous growth.

5.1.3 Short Run and Long Run Relationship Between Agricultural Production and Income Per Capital Growth Rate in Uganda 1988-2022.

The results demonstrate a statistically significant short-term correlation between Uganda's income per capita growth rate and agricultural production from 1988 to 2022. Every correlation coefficient had a coefficient that fell below the 95% confidence interval. The F- statistic, according to the results, is 10.822, which is higher than the 10%, 5%, and 2.5% upper bounds for all significant levels. This suggests that, in Uganda from 1988 to 2022, there was a long-term correlation between agricultural production and income per capita growth rate. The analysis indicates that the relationship between agricultural production and income per capita growth is nuanced in the short term. Despite positive coefficients for agricultural production in the statistical analysis, the results did not achieve statistical significance (p-value > 0.05). This observation is consistent with the literature on the time lag associated with agricultural productivity improvements and their effects on economic growth. For instance, studies have shown that the short-term impacts of agricultural changes on economic indicators may not always be immediately significant due to the time required for productivity gains to be fully realized (Mella et al., 2014). The relationship between agricultural production and income per capita growth becomes more significant over the medium term. As agricultural advancements and investments take effect, the impact on income per capita growth becomes more pronounced. This finding aligns with research suggesting that the economic benefits of agricultural improvements often materialize over a longer horizon, the complexity of this relationship highlights the need for sustained focus on agricultural development to achieve long-term economic growth (Fan et al., 2004).

5.2 Conclusion

5.2.1 Trend of Agricultural Production Composition and Its Effect on Income Per Capita Growth Rate in Uganda 1988-2022.

In terms of percentage changes, the study discovered that trends in agricultural productivity have decreased over time. Uganda's per capita income has been rising over the years, and the country's income per capita growth rate was moderately impacted by agricultural production between 1988 and 2022. It was observed from the study to decline approaching 2021, the trends in percentage expansion of agricultural production systems usually stopped after 2010. Results from the analysis show Figure 4.1 and Table 4.2. The analysis comes to the additional conclusion that

Uganda's income per capita growth rate between 1988 and 2022 is positively impacted by the type of agricultural production. The study concluded that raising agricultural output is a key factor in producing income per person.

5.2.2 Casual Relationship between Agricultural Production and Income Per Capita Growth Rate in Uganda 1988-2022.

Based on the research variable, agricultural production raises income per capita in Uganda; nevertheless, the results also show that agricultural production has a small impact on economic growth. Concluding the data, the study shows that the income per capita growth rate in Uganda from 1988 to 2022 is correlated with agricultural production. The study concludes the data that Uganda's income per capita growth rate from 1988 to 2022 has a sporadic relationship with agricultural production. Based on the findings, the study concludes that increasing agricultural production casually increases the income per capita growth rate in Uganda from 1988-2022. It's hence concluded that the state of the production systems in agriculture generates the functional aspects of agricultural production in realizing income per capita.

5.2.3 Short Run and Long Run Relationship Between Agricultural Production and Income Per Capital Growth Rate in Uganda 1988-2022.

The results demonstrate a statistically significant short-term correlation between Uganda's income per capita growth rate and agricultural production from 1988 to 2022. Every correlation coefficient had a coefficient that fell below the 95% confidence interval. The F- statistic, according to the results, is 10.822, which is higher than the 10%, 5%, and 2.5% upper bounds for all significant levels. This suggests that, in Uganda from 1988 to 2022, there was a long-term correlation between agricultural production and income per capita growth rate.

The study concludes that the growth rate of income per capita in Uganda from 1988 to 2022 is positively correlated with agricultural productivity in both the short and long terms. The research concludes that there is a statistically significant association between agricultural productivity and per capita income in the short and long terms.

5.3 Recommendations

Increasing Agricultural Productivity: Through focused interventions, policies should place a higher priority on attempts to buck the trend of diminishing agricultural productivity. To increase productivity and guarantee food security, this involves making investments in infrastructure, better crops, and contemporary farming methods.

Enhance Agricultural Productivity: To achieve sustainable income growth, Uganda should prioritize increasing agricultural productivity. This involves investing in advanced agricultural technologies, improving farming practices, and enhancing irrigation systems. By boosting agricultural output, the country can foster higher per capita income growth. Strengthen Agricultural Policies: The government should develop and implement comprehensive agricultural policies that support farmers and agricultural businesses. This includes providing financial incentives, subsidies for agricultural inputs, and support for research and development in agriculture. Effective policies was help improve agricultural efficiency and productivity.

Promote Technological Innovation: Given the positive medium-term impact of agricultural advancements, Uganda should focus on fostering technological innovation in the agricultural sector. Investments in research and development, as well as partnerships with technology providers, can drive improvements in crop yields and farming practices.

Interest rate management: Policies should be implemented by the government and financial organizations to guarantee that farmers, especially small-scale farmers, have access to reasonable loans. Reduced interest rates have the potential to encourage growth, encourage agricultural investments, and eventually increase the incomes of farmers and rural households.

It aids to informed decision making, enhances market understanding, support policy advocacy, and helps with risk management, also it encourages collaboration with local farmers.

In conclusion, Uganda may achieve sustainable income development and poverty reduction by taking advantage of the potential and resolving the issues within the agriculture sector. To fully realize agriculture's potential as an engine of economic development, innovative thinking and well-thought-out investments are necessary.

5.4 Areas for Further Studies

Further studies can be done cross country to compare the study on agricultural production and income per capita. Lastly, while this study focused largely on the real interest rates, there is need to look at agricultural exports, value addition on agriculture and technology and its bearing on income per capita.

REFERENCES

Afzal, M., Ahmed, S. S., & Shahzad, M. W. (2019). Impact of Merchandize and Services Trade on Economic Growth of Pakistan. *Journal of Contemporary Research in Business, Economics and Finance*, *1*(1), 30-36.

Ahmed, H., L.M. Tamminen and U. Emanuelson. (2022). Temperature, productivity, and heat tolerance: Evidence from Swedish dairy production. Climatic Change, vol. 175.

Awokuse, T.O. (2018). Does agriculture really matter for economic growth in developing countries? Selected paper prepared for presentation at the *American Agricultural Economics Association Annual Meeting*, Milwaukee.

Bakari, S., & Mabrouki, M. (2017). Impact of exports and imports on economic growth: new evidence from Panama. *Journal of Smart Economic Growth*, *2*(1), 67-79.

Barro, R. (1991). Economic growth in a cross-section of countries. *Quarterly Journal of Economics* 106: 407-443

Bashir, A., Suhel, A., Azwardi, A., Atiyatna, D.P., Hamidi, I., & Adnan, N. (2019). The causality between agriculture, industry, and economic growth: Evidence from Indonesia. *Etikonomi*, *18*(2), 155-168.

Chauvin, N. D., Mulangu, F and Porto, G. (2018). Food Production and Consumption Trends in Sub-Saharan Africa: Prospects for the Transformation of the Agricultural Sector. *Working Papers 2012-11*. https://doi.org/10.1016/j.foodpol.2013.10.006

Chikwama, C. (2018). Does agriculture play an important role in economic growth and structural transformation? *Agriculture and growth evidence paper series*

Dercon, S., & Gollin, D. (2014).Agricultre in African development: Theories and strategies. *Annual Review of Resource Economics*. 6(1), 471-492. https.//ssrn.com/abstract=2507241 or http://dx.doi.org/10.1146/annurev-resource-100913-012706

Dietrich, O.; Notroff, J and Schmidt, J. (2017). "Feasting, Social Complexity, and the Emergence of the Early Neolithic of Upper Mesopotamia: A View from Göbekli Tepe". In Chacon, R. J.; Mendoza, R. G. (eds.). *Feast, Famine or Fighting?*. Studies in Human Ecology and Adaptation. Vol. 8.

Gambia Bureau of Statistics. (2018). The 2018 Statistical Abstract. *The 2018 Statistical Abstract*

Gollin, D. (2010). Agricultural Productivity and Economic Growth. *Handbook of Agricultural Economics 4*, doi: 19.1016/S157-0072(09)04073-

http://www.fao.org/zimbabwe/fao-in-zimbabwe/zimbabwe-at-a-glance/en/. [Accessed on 20 October 2023].

Kumar, R. R. (2018). Do remittances, exports and financial development matter for economic growth? A case study of Pakistan using bounds approach. *Journal of International Academic Research*, *11*(1), 18-27.

Barro, R. J., & Sala-i-Martin, X. (2004). Economic Growth. MIT Press.

Chatfield, C. (2003). The Analysis of Time Series: An Introduction. CRC Press.

FAO. (2015). The State of Food and Agriculture. Food and Agriculture Organization of the United Nations.

Smith, A. (2000). *The Role of Agriculture in Economic Development*. Academic Press.

Gardner, E. S. (1985). Exponential smoothing: The state of the art. Journal of Forecasting, 4(1), 1-28.

Goyal, A. (2010). Analyzing agricultural productivity trends in India. Agricultural Economics Research Review, 23(1), 41-50.

Hyndman, R. J., & Athanasopoulos, G. (2018). Forecasting: Principles and Practice. OTexts.

Kappel, R., Lay, J., & Steiner, S. (2005). The missing links: Uganda's economic reforms and pro-poor growth. The European Journal of Development Research, 17(3), 460-484.

Makridakis, S., Wheelwright, S. C., & Hyndman, R. J. (1998). Forecasting: Methods and Applications. John Wiley & Sons.

Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). Introduction to Linear Regression Analysis. John Wiley & Sons.

Mugagga, F. (2017). Agricultural policies and rural poverty reduction in Uganda. Development Policy Review, 35(3), 391-410.

Nalunga, S., Kagoye, A., & Luwaga, A. (2020). Climate change and its impact on agricultural yields in Uganda. International Journal of Climate Change Strategies and Management, 12(4), 533-548.

Pritchett, L. (2000). Understanding patterns of economic growth: Searching for hills among plateaus, mountains, and plains. The World Bank Economic Review, 14(2), 221-250.

Timmer, P. C. (1995). Getting agriculture moving: Do markets provide the right signals? Food Policy, 20(5), 455-472.

UBOS. (2019). Statistical Abstract 2019. Uganda Bureau of Statistics.

World Bank. (2020). World Development Indicators 2020. World Bank.

KUZNETS, S. (1961). The Role of Agriculture in Economic Development. *International Journal of Agrarian Affairs , III* (2).

Lawal, M. & Atte, O.A. (2017). An analysis of agricultural production in Nigeria. *African Journal of General* Agriculture, 2(1)

Luc Christiaensen, Lionel Demery, and Jesper Kuhl. (2018). The (Evolving) Role of Agriculture in Poverty Reduction. An Empirical Perspective. *Journal of Development Economics , 97* (2), 239-254.

Martinez-Zarzoso, Inmaculada, Vollmer, Sebastian, 2010. Bilateral trade flows and income-distribution similarity. working paper.

Morel, J., U. Kurmar, M. Ahmed, G. Bergkvist, M. Lana, M. Halling and D. Parsons. (2021). Quantification of the Impact of Temperature, CO2, and Rainfall Changes on Swedish

Muricho, S. (2019).Determinants of agricultural commercialization and its impact on welfare among smallholder farmers in *Kenya*.University of Nairobi

Mustafaa, G., Rizov, M and Kernohan, D. (2020).Growth, human development, and trade: The Asian experience. *Elsevier*,61,93-101. DOI: 10.1016/j.econmod.2016.12.007

Mustafaa, G., Rizov, M., &Kernohan, D. (2016).Growth, human development, and trade: The Asian experience. *Elsevier*,61,93-101. DOI: 10.1016/j.econmod.2016.12.007

Nguyen, V.C. (2019). Does agriculture help poverty and inequality reduction? Evidence from Vietmam: *Agricultural Economics Review*, 11(1), 44-56

Obayagbona, J. & Eboiyehi, O. (2020). Impact of agricultural output on per capita income in Nigeria: 1980-2011, *Nigerian Journal of Agricultural and Development Economics (NIJADE)*, 3(1), 141 – 150.

Ojo, E. J., Awe, I. T., & Ogunjobi, J. O. (2019). Agricultural export and economic growth in Nigeria: A multivariate Johansen cointegration analysis. *International Journal of Arts and Commerce*, *3*(3), 89-98

Praburaj, L. (2018). Role of Agriculture in the Economic Development of a Country. *www.researchgate.net/publication/334645070*

Sahoo, K., & Sethi, N. (2012). Investigating the impact of agriculture and industrial sector on economic growth of India. *OIDA International Journal of Sustainable Development*, *5*(5), 11-21.

Sosoo, V. E., Okorie, D. I., & Chen, H. (2021). Roles of commodity futures derivatives and financial crises in global food security. *Economic and Political Studies, 9*(3), 336-357. https://doi.org/10.1080/20954816.2021.1872854

UBOS (2022) *Annual Agricultural Survey 2019 Report*. Uganda Bureau of Statistics (UBOS). Kampala, Uganda.

https://www.ubos.org/wp- content/uploads/publications/04_2022AAS2019_Report.pdf

UN (2022a) *SDG Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture*. Sustainable Development. Department of Economic and Social Affairs. United Nations. Available at: https://sdgs.un.org/goals/goal2. [Accessed 15 October 2022].

UN (2022b) *SDG Goal 5. Achieve gender equality and empower all women and girls*. Sustainable Development. Department of Economic and Social Affairs. United Nations. Available at: https://sdgs.un.org/goals/goal5. [Accessed 25 September 2023].

World Bank (2022). World Bank statistical Abstracts for Uganda, World Bank national accounts data, and OECD National Accounts data files.

Bernasconi, P. (2010). Evaluating the effects of a fertilizer subsidy program in Tanzania: An instrumental variable approach. American Journal of Agricultural Economics, 92(3), 779-794.

Chen, S. (2012). Urbanization and food security in China. Food, Culture & Society, 15(4), 619

Chikwama, C. (2018). The effects of land titling on land-related investment and productivity in Uganda. Development Southern Africa, 35(4), 503-518.

Dercon, S. (2009). Rural poverty: Old challenges in new contexts. The World Bank Research Observer, 24(1), 1-.

Gollin, D. (2019). Farm size and productivity: Lessons from recent literature. IFAD Research Series, 34, 1-39.

Huo, X., & Zhang, Q. (2020). Comparing the direct and indirect carbon dioxide emissions based on the input–output model: The case of Beijing and Tianjin, China. Journal of Environmental Management, 262, 110255.

International Monetary Fund (IMF). (2023). World Economic Outlook. Washington, DC.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. The Manchester School, 22(2), 139-191.

Matsuyama, K. (1992). Agricultural productivity, comparative advantage, and economic growth. Journal of Economic Theory, 58(2), 317-334.

Mtar, K., & Belazreg, W. (2021). The nexus between agriculture, food security, and economic growth in Tunisia. The Journal of North African Studies, 26(1), 128-154.

Osabohien, R., Mordi, C., & Ogundipe, A. (2022). Determinants of food security in Sub-Saharan Africa. Springer.

Population Secretariat. (2012). State of Uganda Population Report 2012. Kampala, Uganda.

Prebish, R., & Singer, H. W. (1949). The origin and main currents of thought in modern economics. International Economic Papers, 1(1), 36-59.

Rahman, M. S., Khatun, M. N., Bhuiyan, M. N. H., & Alam, M. M. (2017). Impacts of climate variables on boro rice production: A case study in Rajshahi district of Bangladesh. Journal of the Bangladesh Agricultural University, 15(2), 212-218.

Sahoo, A., & Sethi, N. (2022). Agricultural growth, food security and economic development in India: An empirical exploration. Journal of Public Affairs, 22(1), e2181.

Tiffin, R., & Irz, X. (2006). Is agriculture the engine of growth?. Agricultural Economics, 35(1), 79-89.

Uganda Bureau of Statistics (UBOS). (2016). National Population and Housing Census 2014. Kampala, Uganda.

Uganda Bureau of Statistics (UBOS). (2020). Statistical Abstract 2020. Kampala, Uganda.

Uganda Bureau of Statistics (UBOS). (2021). Statistical Abstract 2021. Kampala, Uganda.

Xinshen, D., Shenggen, F., Derek, B., Michael, V., Lixing, L., & Zhaohua, L. (2010). Exploring the nexus of agriculture, food security, and nutrition in China. In Institutional Design of Public Programs (pp. 201-212). Routledge.

Xuezhen, Z., Jieying, X., & Xibin, Z. (2010). China's grain production: A decade of consecutive growth or stagnation?. China & World Economy, 18(4), 1-12.

Ali, M., & Byerlee, D. (2002). Productivity growth and resource degradation in Pakistan's Punjab: A decomposition analysis. Economic Development and Cultural Change, 50(4), 839-863.

Besada, H., & Werner, K. (2015). An assessment of the effects of Africa's water crisis on food security and management. International Journal of Water Resources Development, 31(1), 120-133.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251-276.

Fan, S., Hazell, P., & Thorat, S. (2000). Government spending, growth and poverty in rural India. American Journal of Agricultural Economics, 82(4), 1038-1051.

Gujarati, D. N., & Porter, D. C. (2003). Basic Econometrics. McGraw-Hill.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

Kumar, D. P. (2018). Agricultural trade and economic growth in India: An empirical analysis. Journal of International Economics, 9(1), 1-15.

Mella, J. M., & Nayga Jr, R. M. (2016). Explaining obesity among high school students in Thailand: An empirical analysis. Applied Economics, 48(56), 5511-5522.

Noula, A. G., Djiogap, C. F., & Sama, L. M. (2013). Determinants of agricultural productivity and food security in the far north region of Cameroon. International Journal of Business and Management, 8(19), 84-100.

Panofsky, H. A., & Brier, G. W. (1968). Some applications of statistics to meteorology. Pennsylvania State University.

Pesaran, M. H., & Shin, Y. (1998). An autoregressive distributed-lag modelling approach to cointegration analysis. Econometric Society Monographs, 31, 371-413.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.

Phillips, P. C., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. The Review of Economic Studies, 57(1), 99-125.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Shiferaw, B., Hellin, J., & Muricho, G. (2011). Improving market access and agricultural productivity growth in Africa: What role for producer organizations and collective action institutions? Food Security, 3(4), 475-489.

APPENDIX I: DATA FOR THE VARIABLES

Year	Labour	Capita	Technology	Interest rate	Agricultural production	Income Per capita
1988	68.32	11.13	3.19	35.01	54.27	2.61
1989	68.21	12.7	3.1	3.95	54.37	2.57
1990	69.24	15.17	3.09	6.66	53.28	7.74
1991	69.33	15.91	3.1	4.1	49.37	7.94
1992	69.36	15.21	3.09	14.2	48.2	10.12
1993	69.4	14.63	3.17	13.02	48.28	2.74
1994	69.44	16.36	4.21	9.86	46.16	7.89
1995	69.48	16.97	4.01	15.05	45.29	14.99
1996	69.52	16.97	4.72	17.72	41.03	3.36
1997	69.56	16.89	3.69	11.1	38.11	7.21
1998	69.6	15.92	3.87	21.63	38.25	2.06
1999	69.64	19.26	3.82	10.62	34.78	9.41
2000	69.67	19.23	3.23	17.33	27.5	5.24
2001	69.71	19.04	5.14	22.99	27.85	2.06
2002	69.75	19.96	3.45	10.32	23.43	1.79
2003	69.79	20.68	5.75	4.33	24.03	5.89
2004	69.83	19.94	6.62	21.76	25.01	11.94
2005	69.87	22.2	9.4	15.9	24.03	4.63
2006	69.91	20.92	9.7	10.98	22.27	8.61

2007	69.94	21.86	5.09	13.24	21.38	2.051
2008	69.98	22.74	6.39	34.74	34.87	2.62
2009	70.02	24.55	5.42	13.76	32.86	14.12
2010	70.06	26.64	4.36	11.37	28.96	3.06
2011	70.1	26.38	4.19	21.48	27.17	1.64
2012	70.14	25.78	3.49	19.01	26.03	4.49
2013	70.16	31.46	4.85	15.67	24.81	1.47
2014	70.18	26.23	2.6	15.63	23.47	9.48
2015	70.2	23.26	3.17	16.55	22.66	1.55
2016	70.22	24.87	2.08	18.23	23.45	3.49
2017	70.25	24.05	2.37	15.89	23.25	0.69
2018	71.13	23.75	2.28	14.74	22.94	4.83
2019	70	24.9	1.33	15.71	22.94	2.04
2020	69.33	23.51	1.34	16.82	23.92	1.4
2021	69.5	23.33	2.47	18.41	23.84	0.23
2022	68.82	24.1	2.24	17.59	24.01	1.01

Source of Data

https://data.worldbank.org/indicator/FR.INR.RINR

https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS

https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

https://data.worldbank.org/indicator/NY.ADJ.NNTY.PC.KD.ZG